Mendel University in Brno
Czech Society of Landscape Engineers – ČSSI, z.s.

Public recreation and landscape protection – with respect hand in hand?

Proceedings of the 17th Conference

Editors: Jitka Fialová, Dastan Bamwesigye, Věra Hubačíková

11th–13th May 2026, Křtiny

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Department of Landscape Management
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of Ing. Pavel Müller, the Director of the Podyjí National Park Administration

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Contents

A COMPARISON OF DEVELOPMENT ALONG THE SVITAVA RIVER IN BRNO IN TERMS OF RECREATION AND LAND USE
Kateřina Sedláčková, Petr Hrůza 13

A GIS-BASED INDEX TO IDENTIFY CRITICAL HOTSPOTS OF AGRICULTURAL PLASTIC PRESSURE IN VULNERABLE LANDSCAPES
Charbel Matar, Roberto Puglisi, Dina Statuto, Salvatore Margiotta, Pietro Picuno 16

AGRICULTURAL PARKS AS MULTIFUNCTIONAL RECREATIONAL LANDSCAPES IN METROPOLITAN REGIONS
Attila Tóth..... 21

AI-MEDIATED SCENARIO MODELLING FOR EXPERIMENTAL INTERVENTIONS IN URBAN VOIDS
Miroslav Čibik 25

AIR QUALITY IN THE CITY OF HRADEC KRÁLOVÉ
Markéta Holíková, Martina Brenčič, Jaroslav Rožnovský 29

APPROACHES TO THE USE OF HISTORICAL WATER MANAGEMENT FACILITIES WITHIN THE FRAMEWORK OF RECREATION AND TOURISM
Miloš Rozkošný, Kuei-chen Lin, Miriam Dzuráková 34

ASSESSMENT OF LANDSCAPE VULNERABILITY IN THE CZECH-SLOVAK BORDER REGION USING NATIONAL APPROACHES
Vilém Pechanec, Peter Mederly, Pavel Cudlín, Michal Ševčík , Karel Macků Jiří Jakubínský 38

ATTRACTIVENESS OF FOREST LANDSCAPES UNDER CLOSE-TO-NATURE MANAGEMENT
Jakub Jehlička, Kateřina Mácová, Jan Melichar, Bronislav Farkač, Hana Škopková, Emily J. Hanson. 42

BALANCING ECOLOGICAL FUNCTIONALITY AND SAFETY: ASSESSING MIYAWAKI FORESTS IN THE CONTEXT OF RECREATION
Jan Łukaszkiewicz, Beata Fortuna-Antoszkiewicz..... 47

BARRIERS AND SOLUTIONS IN THE PROFESSIONAL INCLUSION OF PEOPLE WITH PHYSICAL DISABILITIES IN BUCHAREST
Carmen Ileana Dobrescu, Darius-Stefan Nestoriuc, Camelia Teodorescu, Florin Alin Butoi, Ana-Irina Lequeux-Dinca 52

CAN WE ANTICIPATE WHAT CLIMATE CHANGE DOES TO THE RECREATIONAL POTENTIAL OF THE LANDSCAPE?
Jan Deutscher Lenka Šipanová 56

CASTLE RUINS AS SITES WHERE GEODIVERSITY AND CULTURE MEET: A CASE STUDY OF JANŠTEJN (CZECHIA)
Karel Kirchner, František Kuda, Lucie Kubalíková 61

CLIMATE DEVELOPMENT IN THE BESKYDY MOUNTAINS
Pavel Lipina, Veronika Šustková..... 66

COMPARISON OF MULTISPECTRAL DATA FROM UAV AND SATELLITE IMAGERY FOR MONITORING THE VEGETATION STATUS OF GOLF COURSES
Petr Karásek, Jiří Burian..... 72

COMPOSITIONAL APPROACHES OF HERBACEOUS PLANT COMMUNITIES IN A UNIVERSITY CAMPUS LANDSCAPE
Alica Saková, Michaela Hrúzová, Marek Hus 76

CULTURAL HERITAGE CONSERVATION AND SUSTAINABLE TOURISM IN NIGERIA: PERCEIVED KNOWLEDGE, PROBLEMS, AND POLICY DIRECTION
Dastan Bamwesigye, Henry Okeokpa Chima, Jitka Fialova, Evans Yeboah 82

CYCLING ROUTES AS RECREATIONAL CONNECTIONS BETWEEN THE CITY OF NITRA AND ITS SURROUNDING LANDSCAPE
Mária Bihuňová, Miroslav Čibik, Attila Tóth..... 87

DEGREE LEVEL AS DIFFERENTIATING FACTOR IN ENVIRONMENTAL SENSITIVITY IN RECREATIONAL USE OF NATURAL ENVIRONMENTS
Stanislav Azor, Štefan Adamčák, Michal Marko, Ľudmila Kuriplachová..... 91

DESIGN OF CREATING AN EDUCATIONAL TRAIL SELEC – INOVEC
Vladimír Juško, Hrvoje Sivrić , Matej Rozkopál..... 95

DESIGN AND ESTABLISHMENT OF HERBACEOUS PLANTINGS IN RURAL ENVIRONMENTS AND THEIR CONTRIBUTIONS TO PUBLIC SPACE QUALITY
Marek Hus 100

DESIGNING A RECREATIONAL GREENWAY IN A FORMER RAILWAY CORRIDOR: THE RADOŠINKA CYCLING ROUTE
Attila Tóth, Branislav Králik..... 106

DESIGNING LANDSCAPE FRAMES AND PROCESSES – CONTEMPORARY DILEMMAS IN THE AGE OF CLIMATE CHANGE
Rosłon-Szeryńska Edyta, Jacek Materski..... 110

DEVELOPMENT OF BUSINESS EVENTS IN DESTINATION KOŠICE BASED ON COOPERATION WITH THE SLANSKÉ HILLS REGION
Ivana Kavulič, Branislav Kršák 116

DEVILS AND ANGELS IN CZECH TOPONYMS
Marek Havlíček, Ivo Dostál, Aleš Bajer, Vilém Pechanec..... 120

DIVERSITY OF CYNIPID WASPS ON OAKS IN THE URBAN GREENERY OF NITRA
Ján Kollár, Katarína Miklášová, Jozef Porvazník, Ladislav Bakay..... 126

EDUCATION IN PARKS – PLANT COLLECTIONS AND EXHIBITIONS
Beata Fortuna-Antoszkiewicz, Jan Łukaszkiewicz, Andrzej Długoński, Nataliia Boiko..... 131

ENVIRONMENTAL EDUCATION AND LEGAL SOCIALIZATION
Jana Dundelová, Martina Urbanová..... 137

EXPLORING INCLUSIVE TOURISM: ACCESSIBILITY OF TOURISM PRODUCTS FOR TOURISTS WITH ACCESS NEEDS IN SERENGETI NATIONAL PARK, TANZANIA
Awadhi Titu Mussa, Ondabu Kiage, Judy Kibe, Veronika Piscová 143

FLOOD EXPOSURE OF SLOVAK BIOSPHERE RESERVES
Adam Čaplák, Henrich Grežo..... 147

FOREST CLASSROOM AS A TOOL OF LANDSCAPE MANAGEMENT: INTEGRATING ENVIRONMENTAL EDUCATION, FORESTRY AND GAME MANAGEMENT
Monika Fárka, Jitka Fialová, Dastan Bamwesigye 151

FOREST THERAPY AND FOREST BATHING IN 5 EUROPEAN COUNTRIES – BASIC DESCRIPTION
Jitka Fialová, Dastan Bamwesigye, Şevval Polat, Elif Şenel, Emilia Janeczko, Malgorzata Woznicka, Krzysztof Czyżyk, Linas Daubaras, Rasa Povilioniene, Pietro Picuno 156

FORMS OF APPLICATION OF GRASS–HERBACEOUS PLANT COMMUNITIES IN URBAN ENVIRONMENTS
Marek Hus, Anna Pástorová..... *162*

FROM RESIDUAL SPACE TO RECREATIONAL ENVIRONMENT: THE ROLE OF CO-DESIGN IN THE ACTIVATION OF HOUSING ESTATES
Roberta Štěpánková, Tamara Valičková, Miroslav Čibik *169*

GENDER DIFFERENCES IN SEASONAL DECLINE OF PHYSICAL ACTIVITY IN NATURAL ENVIRONMENTS AND THEIR ASSOCIATIONS WITH HEALTH LIMITATIONS
Karin Baisová, Michal Marko , Štefan Adamčák, Jana Luptáková..... *173*

GEOSYSTEM SERVICES AND DISSERVICES: AN APPLICATION OF THE CONCEPT ON ABANDONED QUARRIES
Lucie Kubalíková *177*

GIS-BASED SPATIAL EVALUATION OF RECREATIONAL POTENTIAL IN THE LANDSCAPE UNDER ENVIRONMENTAL AND SOCIO-ECONOMIC CONSTRAINTS
Radovan Pondelík, Martin Zápotocký *181*

HISTORICAL HERITAGE AND MODERN TOURISM IN DOBROGEA, ROMANIA: THE IMPACT OF PHYSICAL AND DIGITAL ACCESSIBILITY
Camelia Teodorescu, Ana-Irina Lequeux-Dinca, Florin Alin Butoi, Darius-Stefan Nestoriuc, Carmen Ileana Dobrescu *185*

HISTORICAL WATER MANAGEMENT STRUCTURES AND THEIR CURRENT POTENTIAL (THE EXAMPLE OF THE BESKIDS AND OTHER AREAS)
Aleš Vyskočil , Jaromír Florian , Zbyněk Sviták , David Honek , Miloš Rozkošný , Miriam Dzuráková .
..... *189*

IDENTIFICATION OF THREATS IN URBAN GREEN SPACES IN WARSAW BY THE USE OF
A VOLUNTEERED GEOGRAPHIC INFORMATION (VGI) TOOL
Kinga Kimic, Paulina Polko *193*

IMPORTANCE OF PHYSICAL ACTIVITY IN NATURAL ENVIRONMENTS FOR MENTAL AND PHYSICAL RECOVERY OF STUDENTS IN PERFORMING ARTS
Michal Marko , Štefan Adamčák , Stanislav Azor..... *198*

INCREASING THE SUSTAINABILITY OF AGRO-TOURISM ACTIVITIES WITHIN THE AGROECOLOGY CONCEPT THROUGH GIS TECHNOLOGIES
Dina Statuto, Roberto Puglisi, Charbel Matar, Salvatore Margiotta, Pietro Picuno *202*

INDUSTRIAL RUINIFORM LANDSCAPES BETWEEN DEGRADATION AND TOURISM RECONVERSION: CASE STUDY THE STEELWORKS OF CĂLĂRAȘI MUNICIPALITY, ROMANIA
Florian Alin Butoi, Carmen Ileana Dobrescu, Camelia Teodorescu, Ana-Irina Lequeux-Dinca, Darius-Stefan Nestoriuc *206*

INFLUENCE OF RESILIENT MODULUS AND SOIL SHEAR PARAMETERS ON THE DESIGN OF FOREST AND RURAL PAVEMENTS
Aimar Martin *211*

INNOVATION TRANSFER IN ECOTOURISM: THE TANZANIAN MANAGEMENT MODEL AND ITS APPLICABILITY IN SLOVAKIA
Veronika Piscová, William Marandu, Juraj Hreško *216*

INTEGRATED APPROACH TO THE USE OF GEOHERITAGE AND GEODIVERSITY IN GEOTOURISM
Ľubomír Štrba, Branislav Kršák, Csaba Sidor..... *220*

INTEGRATING NATURE INTO HIGHER EDUCATION: FOREST BATHING
Cihan Seçilmiş, Cansev Özdemir, İlker Kilic, Jitka Fialová, Dastan Bamwesigye, Emilia Janeczko, Malgorzata Woznicka, Krzysztof Czyżyk, Linas Daubaras, Vaida Vaitkute, Pietro Picuno *224*

INTEGRATING WATER FEATURES INTO A RECREATIONAL SPACE
Gabriel Kuczman, Viera Paganová *229*

INTERGENERATIONAL LEARNING AS A TOOL FOR ENVIRONMENTAL EDUCATION AND SUSTAINABLE LANDSCAPE CONSERVATION
Lenka Kamanová, Kateřina Pevná *234*

LANDSCAPE TRANSFORMATION IN THE AREA OF THE HRIŇOVÁ RESERVOIR DURING 1764–1971
Adam Čaplák, Henrich Grežo *238*

LANDSCAPE-ARCHITECTURAL PROPOSAL OF MONOTHEMATIC EDUCATIONAL PATH – WATER AS A MAIN TOPIC
Sofia Boulghalg, Mária Bihuňová *243*

LANDSLIDE SCARPS, AS EXEMPLIFIED BY RECREATIONAL URBAN AREAS IN EUROPE AND SOUTH AMERICAN COASTAL CITIES
Andrzej Długoński, Beata Fortuna-Antoszkiewicz, Jan Łukaszkiewicz, Jacek Krych *247*

LEARNING GAINS AND STUDENT RESERVATIONS: EVALUATING A GPT-BASED AI ASSISTANT IN GEOGRAPHY TEACHING
Emil Drápela *252*

MINING HERITAGE IN THE CULTURAL LANDSCAPE OF THE VYSOČINA REGION: RESIDENTS' AWARENESS AND PERCEPTION OF TOURISM VALUE
Blanka Šimánková Hornová, Tomáš Čihák, Stanislava Pachrová *256*

NATURAL HAZARDS WITHIN THE REACH OF IMPORTANT HIKING TRAILS IN THE TATRA MOUNTAINS (SLOVAKIA)
Gabriel Bugár, Veronika Piscová, Juraj Hreško *260*

NON-FOREST WOODY VEGETATION AS A SIGNIFICANT ELEMENT IN INCREASING ECOLOGICAL STABILITY IN CULTURAL LANDSCAPE
Milena Moyzeová *265*

OCCURRENCE OF TROPICAL DAYS IN CITIES
Jaroslav Rožnovský *272*

OPPORTUNITIES FOR RECREATIONAL AND EDUCATIONAL USE OF THE WATER UTILITY TECHNICAL SITE
Viera Paganová, Gabriel Kuczman *277*

PERCEIVED CONSEQUENCES OF CHILDREN'S SENSE OF PLACE: A FOUR-PATHWAY DEVELOPMENTAL MODEL
Dominik Rubáš, Eliška Prokopová, Magdalena Pohlová, Anežka Nejedlová, Tomáš Matějček *282*

PERI-URBAN RECREATION AND BIODIVERSITY SERVICES BALANCING IN BRNO: STAKEHOLDER PRIORITIES AND MANAGEMENT FOR MASARYK FOREST KŘTINY
Dastan Bamwesigye, Jan Deutscher, Jitka Fialova, Petr Kupec *287*

PHENOLOGICAL MONITORING OF ALLERGENIC GRASSES IN RECREATIONAL ZONES: RISKS OF AN EARLY POLLEN SEASON IN THE CONTEXT OF REGIONAL FLOWERING VARIABILITY
Andrea Srubková *294*

PLANNING OF THE RECREATIONAL ACTIVITIES WITHIN REGIONAL DEVELOPMENT IN FORESTRY: LINKING TO POLICIES AND PLANNING
Kateřina Holušová, Otakar Holuša *299*

PREMISES FOR TOURISM DEVELOPMENT IN URBAN AREAS USING PPGIS TECHNIQUES
Ana-Irina Lequeux-Dincă, Camelia Teodorescu, Alin Butoi, Darius Nestoriuc, Eugen Grama..... *303*

PROPOSAL FOR A GEOTOURISM TRAIL TO ENHANCE THE OFFER OF THE MALÉ KARPATY GEOPARK
Jana Šnajdrová, Ľubomír Štrba, Branislav Kršák, Csaba Sidor..... *307*

RECOMMENDATIONS FOR EFFECTIVE AND SUSTAINABLE PRESENTATION OF THE SIGNIFICANCE, FUNCTIONS AND HISTORY OF WATER MANAGEMENT ELEMENTS AND SYSTEMS
Miloš Rozkošný, Kateřina Sedláčková, Hana Hudcová, Miriam Dzuráková *311*

RECONVERTING RESIDUAL SPACES INTO RELAXATION HUBS FOR THE ACADEMIC COMMUNITY
Darius-Stefan Nestoriuc, Ana-Irina Lequeux-Dinca ,Camelia Teodorescu, Carmen Ileana Dobrescu, Florian Alin Butoi *316*

RECREATION IN CZECH NATIONAL PARKS: TOURISM INTENSITY VS. VULNERABILITY OF PRIORITY AREAS
Tomáš Janík, Vladimír Zýka, Martin Erlebach Dana Fialová, Tereza Kůsová, Jiří Vágner, Jan Pergl, Jiří Sádlo, Josef Kutlvašr, Klára Kušková, Michaela Vítková, Barbora Mrkvová, Dušan Romportl *320*

REVITALISATION OF A HISTORIC PARK FOR THERAPEUTIC USE: CASE STUDY OF THE PSYCHIATRIC HOSPITAL IN VEĽKÉ ZÁLUŽIE
Soňa Bellérová, Attila Tóth , Katarína Melichová..... *325*

SINGLE-PROMPT CREATION OF WEB MAP APPLICATIONS FOR TOURISM AND NATURE PROTECTION USING OGC SERVICES
Martin Zápotocký, Radovan Pondelík *331*

SMALL VILLAGES AS PART OF THE LANDSCAPE: LANDSCAPE-BASED APPROACHES TO RURAL DEVELOPMENT
Attila Tóth, Soňa Bellérová, Katarína Slobodníková *336*

SUSTAINABILITY OF THE TERRITORIAL ECONOMY AND THE IMPACT OF EUROPEAN PROJECTS IN SMALL TOWNS IN ROMANIA: A CASE STUDY OF BALCEȘTI, VÂLCEA (ROMANIA)
Camelia Teodorescu, Ana-Irina Lequeux-Dinca, Diana Ionescu Anculete, Stefania Elena Calinoiu, Florian Alin Butoi *340*

SUSTAINABLE NATURAL HABITATS – IMPORTANT CONDITION FOR SUSTAINABLE TOURISM
Pavel Cudlín, Vilém Pechanec, Ondřej Cudlín, Renata Včeláková, Marcela Prokopová, Ahmed Mohammed Ahmed Alhuseen, Jan Purkyt..... *344*

SYNERGY OF EDUCATION AND RECREATION IN LANDSCAPE PROTECTION: INTEGRATING DENDROLOGICAL COLLECTIONS OF ARBORETUM MLYŇANY INTO UNIVERSITY CURRICULA
Katarína Miklášová, Jozef Porvazník, Ján Kollár..... *348*

THE EFFECT OF VERTICAL ZONATION ON THE COMPOSITION OF ENTOMOCOENOSES IN THE SELECTED MEADOW BIOTOPES OF THE BESKYDY PROTECTED LANDSCAPE AREA (NW SLOVAKIA)
Radoslav Kvasničák , Monika Bestwinová, Michal Rožek *352*

THE IMPORTANCE OF COMPOSED TREE FORMS IN RURAL AND URBAN ENVIRONMENTS
Beata Fortuna-Antoszkiewicz, Jan Łukaszkiewicz..... *358*

THE INSTITUTIONAL FRAMEWORK OF EDRM IN SIMANJIRO DISTRICT (TANZANIA) AND ITS IMPLICATIONS FOR TOURISM STABILITY
Jumanne M. Paul, Veronika Piscová *363*

THE POTENTIAL FOR UTILIZING HISTORIC GREEN SPACES WITHIN THE RESIDENTIAL URBAN STRUCTURE
Bronislava Poljak Lamrichová, Zuzana Vinczeová, Attila Tóth *367*

THE ROLE OF CONIFEROUS PLANTS IN ENHANCING ADAPTABILITY, AESTHETIC AND RECREATION VALUES OF URBAN LANDSCAPES
Jan Łukaszkiewicz, Beata Fortuna-Antoszkiewicz *373*

THE ROLE OF DESIGN AND QUALITY CONTENT IN THE LANDSCAPE- ARCHITECTURAL PROPOSAL OF AN EDUCATIONAL TRAIL
Petra Zrubcová, Mária Bihuňová *376*

TREES IN PUBLIC AND RECREATIONAL SPACES AS A RISK FACTOR UNDER WEATHER ANOMALIES
Edyta Rosłon-Szeryńska *380*

TRENDS IN SUPPORTING OUTDOOR PHYSICAL ACTIVITY IN PUBLIC SPACES BASED ON WARSAW PARTICIPATORY BUDGETING (WPB)
Kinga Kimic, Paulina Polko *387*

UNDERSTANDING ECOLOGICAL ROLES OF ORGANISMS AMONG KINDERGARTEN CHILDREN: IMPLICATIONS FOR ENVIRONMENTAL EDUCATION
Alexandra Maruniaková, Ivan Ilko, Katarína Segečová, Viera Peterková *392*

UNVEILING THE IN-BETWEEN: A TYPOLOGICAL FRAMEWORK FOR REGENERATING URBAN VOIDS
Miroslav Čibik, Gabriel Kuczman *398*

URBAN FORESTS AS BIODIVERSITY REFUGEES IN CULTURAL LANDSCAPES
Ivo Machar, Vilém Pechanec, Pavel Borusík *403*

URBAN TREES FOR PEOPLE AND CLIMATE: BALANCING ECOSYSTEM SERVICES AND LONG-TERM VITALITY IN PUBLIC SPACES
Jozef Porvazník, Ladislav Bakay, Katarína Miklášová *407*

URBAN VOIDS AS LIVING LABORATORIES: AN EDUCATIONAL FRAMEWORK FOR RESEARCH-BASED REGENERATION
Miroslav Čibik *411*

USE OF MEDICINAL PLANTS AS A PART OF CULTURAL INTERPRETATION AND ENVIRONMENTAL EDUCATION
Tomáš Kopta, Jarmila Neugebauerová, Tereza Štorková, Aleš Jezdinský, Pavel Híc, Tomáš Koutecký, Dana Surá, Kateřina Smékalová *415*

VOLEC II – “THE FOREST ROAD NETWORK INFLUENCE ON RUNOFF FROM FORESTS IN CHANGING CLIMATIC CONDITIONS”
Petr Kupec *419*

WASTEWATER MANAGEMENT AND RECREATIONAL TOURISM IN DAR ES SALAAM: A REVIEW OF CURRENT CHALLENGES
Azizi Selemani Msuya, Veronika Piscová *423*

WEEDS IN THE CONTEXT OF EXPERIENTIAL EDUCATION: SUPPORTING THE EDUCATION AND RECREATION OF SENIORS
Jan Winkler, Kateřina Pevná, Lenka Kamanová, Helena Pluháčková, Amir Mugutdinov, Magdalena Daria Vaverková *427*

WHY IS GLASS DANGEROUS FOR BIRDS
Pavla Kotásková, Jitka Fialová *431*

ZERO-EMISSION SPORT AND RECREATIONAL FLYING?
Jiří Chlebek, Jitka Fialová, Pavla Kotásková, Dastan Bamwesigye, Miroslav Červenka *436*

Z-GENERATION AND THOSE BEYOND. HOW SHOULD THEY PERCEIVE DROUGHT ADAPTATION OPTIONS WITHIN ENVIRONMENTAL AND RECREATIONAL EDUCATION?
Jan Kocum, Bohumír Janský, Simona Kohoutová *441*

A COMPARISON OF DEVELOPMENT ALONG THE SVITAVA RIVER IN BRNO IN TERMS OF RECREATION AND LAND USE

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Abstract
The industrial areas of Brno through which the Svitava River flows are gradually being revitalized. Emphasis is also placed on integrating the river into the surrounding area and utilizing it for recreational purposes. The aim of this article is to compare the current state with the situation in 2018. The area under consideration will primarily include locations within the city limits that directly border the Svitava River. The article will focus on locations where changes have taken place in recent years and will evaluate them in terms of their use for recreation.

Key words: Bike path, land use changes, urban landscape

Introduction

Brno lies at the confluence of the Svratka and Svitava rivers, both of which flow through urban areas. The Svratka passes mainly through residential zones and has recently attracted attention for flood control and recreation, while the Svitava, once dominated by industry, has historically constrained city growth.

During the Industrial Revolution, workers straightened the Svitava riverbed, creating a visually unattractive channel with steep banks (Kuča, 2000). Although Brno is revitalising the surrounding industrial areas, the Svitava remains less attractive for recreation than the Svratka. This article compares changes near the Svitava River that affect its recreational potential.

The surroundings of Brno's rivers are undergoing major changes. This research examines whether riverbeds are considered valuable components of the urban landscape or viewed primarily as threats and obstacles to the city's development. It also evaluates whether the city fully utilises the potential that rivers offer or focuses mainly on flood protection.

Material and methods

The Svitava River springs near the town of Svitavy at an altitude of 475 m above sea level. Its flow is 98 km long, and the basin is 1146.9 km^2. In Brno, it enters the Svratka River in the city's southern part. Several important streams and larger cities—Svitavy, Letovice, Doubravice nad Svitavou, Rájec-Jestřebí, Blansko, and Brno—lie along its course. In Brno, the Svitava is 14 km long (CUZK, 2026). Its average flow rate at Bílovice nad Svitavou is 3.8 m^3/s (Povodí Moravy, 2026). The river passes through seven city districts: Obřany, Maloměřice, Brno-North, Židenice, Černovice, Brno-South, and Tuřany. There are several larger weirs on the Svitava, and four millraces or distributaries in the Brno area. A bike and walking path runs along most of the flow within Brno.

Svitava was a water source for the industrial part of the city, but over time, it became an obstacle to their development. The waterlogged floodplain was a limitation, especially for the railway development, which would have to cross numerous distributaries (Kuča, 2000). The first regulation was carried out during the revolutionary years of the mid-19th century, in 1848. The second wave of regulation took place after the Second World War and had a much less devastating impact on the river floodplain (Dřímal, Peša, 1969).

When discussing the Svitava River, one cannot overlook the Svitava Millrace (also known as the Svitava Ditch or Stará Ponávka). It branches off from the river in the Tkalcovská area and, passing through the industrial part of Brno and a number of brownfield sites, joins the Svratka River. Historically, this site has seen very interesting development, but today it is a neglected stream along most of its length, partially channelled.

The data collected in previous years during the preparation of articles and the thesis will be used for comparison. Data collection was conducted through fieldwork and the use of map materials, primarily aerial photographs and flood control plans. The article examines areas where significant land-use changes have occurred.

Results

The biggest and most positive changes are undoubtedly taking place on the site of the former factory. The Nová Zbrojovka area is undergoing a major change in land use. Compared to our previous visit in 2018, the right riverbank is essentially in the same state. Between the river and the residential area, there is a space used primarily by local residents for recreation. A major change, however, is the unmarked educational path running through the area. It was established in 2021 and introduces visitors to the region's industrial history. The brownfield site of the former factory on the left bank was recently completely demolished, and a new district is being built in its place. While in 2018 the area was inaccessible and neglected, now, in addition to new residential buildings, a park and a public sports facility have been created, and there is a café and, during the summer, an openair movie theatre. The entire area, which was originally cut off from the river, now connects to the riverbed and incorporates the river as a valuable element of the urban landscape. The formerly impassable brownfield, which divided the area between the railway line and the Svitava River, is now becoming a space suitable for leisure activities.

As mentioned earlier, a bike path runs along the Svitava River. It is used not only by local residents but also for recreational purposes. The problem with this bike path is its intersections with roads, particularly Hladíkova and Křenová Streets. The intersection with the busy four-lane Hladíkova Street was resolved in 2022 with an underpass. Cyclists and pedestrians can now safely cross to the other side. The intersection with Křenová Street, a few dozen meters further on, has not yet been resolved, and although it is not as risky as the previous problem, it is still a street with relatively heavy traffic and public transportation. Building an underpass is also a potential solution. A traffic solution using traffic lights does not seem ideal given the nearby intersection.

A number of flood control measures are currently being implemented or planned along the rivers in the Brno area, including the Svitava River. Most of the proposed measures aim to optimise the flow profile of the Svitava riverbed, which, in the south, is trapezoidal in shape, with steep slopes and riverbed diking. The modifications call for removing the dikes, widening the flow profile, and constructing new berms. The goal of the comprehensive flood control measures in the city of Brno is not only to protect people and property, but also to better integrate the river into the urban area and make it accessible to the public (Voda v Brně, 2026).

Discussion

Transforming rivers in cities from water sources for factories back into valuable elements of the urban landscape is a goal pursued by many cities, not only in Czech Republic. This is often a difficult task, as many of these rivers are surrounded by brownfields and factories. Many waterways have also been channelised, particularly during the Industrial Revolution and later in the second half of the 20th century. Their integration into the built-up area and the enhancement of their recreational use are thus often part of a comprehensive plan that must be coordinated not only with flood control plans but also with the zoning plan. A good example is the Svratka River in Brno, where improvements have recently been completed. These improvements make the river more accessible to the surrounding area, enhance its flood safety, and, above all, transform the area into a space naturally used for recreation. Similarly, the Úhlava and Radbuza rivers in Plzeň have also been integrated into the city. There are many such positive examples throughout the country, whether the rivers are large or small. The areas surrounding waterways in cities are once again becoming places where local residents enjoy spending their free time (Lacina, Schneider, 2016).

Conclusion

Although the final kilometres of the Svitava River will never again look as they did before regulation, and human intervention will always be visible here, the situation is nonetheless improving. The finalised city zoning plan, development on brownfield sites, and growing resident interest undoubtedly play a role in this. The good news is that both experts and the general public view the river as a valuable element of the urban landscape. We will always see remnants of the past along the Svitava; this river, which was one of the pillars of Brno’s industrial glory, is now heading toward a brighter future.

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Souhrn
Článek se zabývá probíhajícími změnami podél řeky Svitavy v Brně. Tyto změny souvisejí s novou výstavbou a protipovodňovými opatřeními. Současný stav oblastí, které v posledních letech prošly změnami, je porovnán se stavem zaznamenaným od roku 2018.

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A GIS-BASED INDEX TO IDENTIFY CRITICAL HOTSPOTS OF AGRICULTURAL PLASTIC PRESSURE IN VULNERABLE LANDSCAPES

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Abstract
The intensification of plasticulture may generate substantial quantities of agricultural plastic waste (APW), posing increasing risks to ecological integrity and landscape quality, especially in close proximity to protected sites or to areas subjected to mass summer tourism. This study proposes the Landscape Vulnerability to Agricultural Plastic Index (LVAPI), a GIS-based composite index combining the Agricultural Plastic Pollution Risk Index (APPRI) with a Landscape Sensitivity Index (LSI), to map critical hotspots of plastic pressure across an Italian Southern region (*i.e.*, Basilicata). APPRI was computed by integrating plastic waste indices per crop type with relative risk indices, reflecting the micro- and nanoplastic (MNP) generation potential associated with each plastic application. LSI integrates three equally weighted sensitivity components: slope-based soil sensitivity, water sensitivity based on proximity to the regional hydrographic network, and ecological sensitivity based on proximity to Natura2000 protected sites. Applied at 10 m spatial resolution across 435,134 ha of agricultural land, LVAPI identified high-vulnerability hotspots covering 18,716 ha (4.30%), concentrated in some regional areas characterized by intensive agricultural production, ecologically vulnerable landscapes, intensive summer tourism, or close to drinking water watershed. As a proxy-based screening tool, LVAPI supports spatial prioritization of protection measures, rather than predicting field-scale micro- and nanoplastics concentrations.

Key words: Agricultural plastic waste, GIS, Landscape sensitivity, Microplastic risk, Natura2000 sites.

Introduction

Plastic materials are widely used in agriculture, generating significant Agricultural Plastic Waste - APW (Statuto et al., 2024). Italy is among the main APW producers in Europe, with high contributions from Sicily and Apulia (Hachem et al., 2024). In Basilicata, GIS-based studies estimated both plastic-covered areas (2,062.23 ha) and APW quantities (~1,875 tonnes), mainly near sensitive coastal zones (Statuto et al., 2024; Cillis et al., 2022b). Plastic residues degrade into Micro- and NanoPlastics (MNPs), affecting soils and biota (Briassoulis, 2023), and are transported to aquatic systems through runoff and erosion (Picuno C. et al., 2019; Rehm et al., 2021). Landscape features and proximity to protected areas influence contamination patterns (Convertino et al., 2023). Existing tools such as Plastic Waste Index (PWI) and Agricultural Plastic Pollution Risk Index (APPRI) focus on plastic pressure (Lanorte et al., 2017; Hachem et al., 2024) but neglect landscape sensitivity, which is crucial in Mediterranean environments (FAO, 2021). This study addresses this gap by proposing a specific Index (Landscape Vulnerability to Agricultural Plastics Index - LVAPI), which combines APPRI with a Landscape Sensitivity Index (LSI) based on slope, hydrological proximity, and distance from Natura2000 sites. Applied to the Basilicata region at 10 m resolution, it identifies areas where high plastic pressure overlaps with high vulnerability, supporting targeted mitigation and policy actions.

Materials and Methods

The study area is the Basilicata region (≈9,992 km²), a Southern Italian region characterized by diverse topography and agricultural systems dominated by cereals, grassland, and olive groves - with plastic-intensive crops concentrated in the "*Metapontino*" district. The presence of 84 *Natura2000* sites, including some coastal areas subjected to intensive summer tourism that are adjacent to intensive plasticulture, highlights high ecological sensitivity. The analysis was performed in *QGIS 3.44* through: land use selection; identification of plastic applications using the PWI framework (Hachem et al., 2024); area calculation and PWI adjustment with ISTAT (2025) data (Hachem et al., 2024); APW estimation; APPRI computation using risk indices (Briassoulis, 2023; FAO, 2021; Hachem et al., 2026); LSI derivation from slope, hydrological, and ecological factors (Ferrara et al., 2020); and LVAPI calculation and classification (Hachem et al., 2024). The workflow represents a regional-scale screening approach for vulnerability mapping. ISTAT data were used to refine mixed land-use classes (Hachem et al., 2024). Weighted PWI values were calculated for vineyards (363.0 kg ha^{-1} yr^{-1}) and

irrigated arable land (268.0 kg ha^{-1} yr^{-1}), accounting for crop distribution and protected cultivation systems. PWI values are reported in Table 1.

Tab. 1: Plastic applications and corresponding PWI values assigned to each Corine Land Cover class (adapted from *Hachem et al., 2024)*.

Land Use Class	PWI (kg ha^{-1} yr^{-1})	APPRI (kg RRI ha^{-1} yr^{-1})
Non-irrigated arable land	207.3	2,124
Irrigated arable land	268.0	2,510
Vineyards	363.0	2,827
Orchards	1005.4	6,821
Olive groves	80.3	699
Mixed crops	238.0	2,317
General agricultural areas	268.0	2,510

APPRI was computed to link APW to MNP contamination risk, following Hachem et al., (2024). The Relative Risk Indices RRI values from Briassoulis, 2023 and (FAO, 2021), as consolidated by (Hachem et al., 2026), represent the MNP release potential of each plastic application. APPRI = $\Sigma(APW_i \times RRI_i)$, where APW_i is annual waste and RRI_i the risk index reported in Table 2. Values were normalized (0–1) and classified into low, medium, and high using equal intervals.

Tab. 2: RRI for plastic applications used in the APPRI calculation (Hachem et al., 2026).

Plastic Application	RRI
Agrochemical containers	11.2
Mulching films	10.5
Irrigation pipes	9.5
Vineyard plastic support	9.5
Bags for fertilizers	9.35
Silage films	8.1
Protective nets	8.0
Covering films	6.3

The LSI was derived by combining three equally weighted components at 10 m resolution, each classified on a 1–3 scale. Equal weighting was adopted to avoid bias in the absence of validated schemes. Slope-based sensitivity was obtained from the TINITALY DTM using the MEDALUS framework (Ferrara et al., 2020), with thresholds: low (0–6°), moderate (6–18°), and high (>18°). Water sensitivity was based on distance from the hydrographic network: high (<500 m), moderate (500–2,000 m), and low (>2,000 m), reflecting erosion-driven transport processes (Rehm et al., 2021). Ecological sensitivity was defined by proximity to Natura 2000 areas using the same 500 m threshold, supported by evidence of higher MNP contamination near sensitive environments (FAO, 2021). The three components were then combined as:

$$LSI = (S_{soil} + S_{water} + S_{eco}) / 3$$

This simplified approach ensures transparency and reproducibility, with potential refinement through future calibration. LVAPI was calculated as LVAPI = APPRI × LSI and normalized (0–1) by dividing by the maximum value of 3.0, representing the highest hotspot condition. The index was classified into Low (0–0.33), Medium (0.33–0.66), and High (>0.66) using equal intervals, consistent with Hachem et al., (2026).

Results

The LSI showed marked spatial variability across Basilicata. Soil sensitivity (mean = 2.09) reflects the predominantly hilly–mountainous terrain (Ferrara et al., 2020), while water sensitivity (mean = 2.01) highlights widespread proximity to drainage networks, increasing runoff-driven transport (Rehm et al., 2021). Ecological sensitivity was lower (mean = 1.23), as most areas lie beyond 500 m from Natura2000 sites, though these create localized high-sensitivity zones (FAO, 2021). Overall, LSI ranged from 1.0 to 3.0 (mean = 1.83), with higher values along river corridors, steep slopes, and

protected areas. The APPRI map (Figure 1) showed clear spatial patterns of plastic pressure, with a mean value of 0.263. The highest values occur in the Metapontino coastal plain (Zone A), dominated by intensive orchards (APPRI/ha = 6,821 kg RRI ha^{-1} yr^{-1}). Moderate values were observed in vineyards of the Vulture area (Zone B; 2,827 kg RRI ha^{-1} yr^{-1}), while olive groves and non-irrigated arable land (Zone C; 699 kg RRI ha^{-1} yr^{-1}) showed the lowest pressure. The LVAPI map (Figure 2) highlights a heterogeneous distribution of landscape vulnerability. Low LVAPI dominates (415,446 ha, 95.47%), mainly in extensive cereal, pasture, and olive systems. Medium LVAPI is limited (972 ha, 0.22%) and reflects transitional conditions. High LVAPI hotspots cover 18,716 ha (4.30%), identifying areas where both plastic pressure and landscape sensitivity are high, concentrated in three main zones.

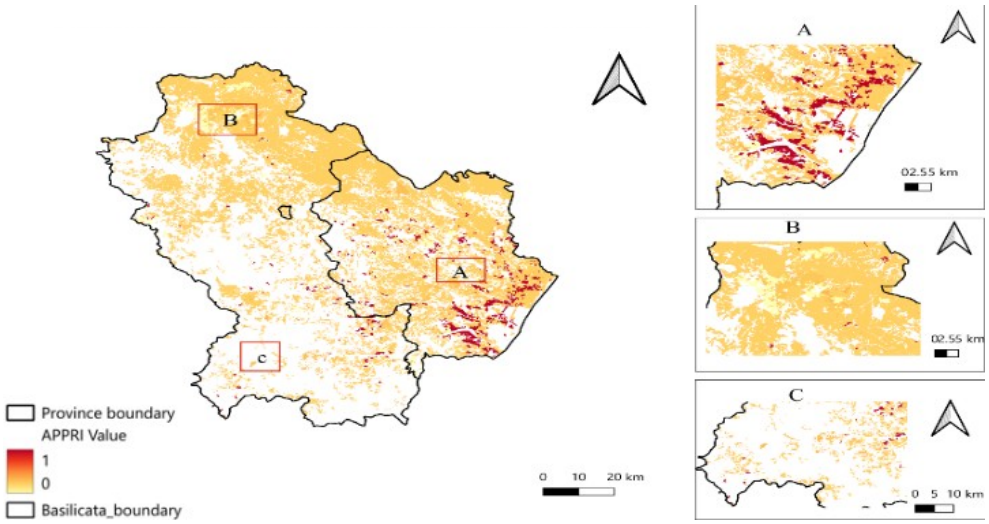

Fig. 1: Agricultural Plastic Pollution Risk Index (APPRI) across Basilicata, with three inset zones. Zone A (Metapontino). Zone B (Vulture) and Zone C (Agri-Pertusillo). White areas indicate non-agricultural land uses receiving APPRI = 0.

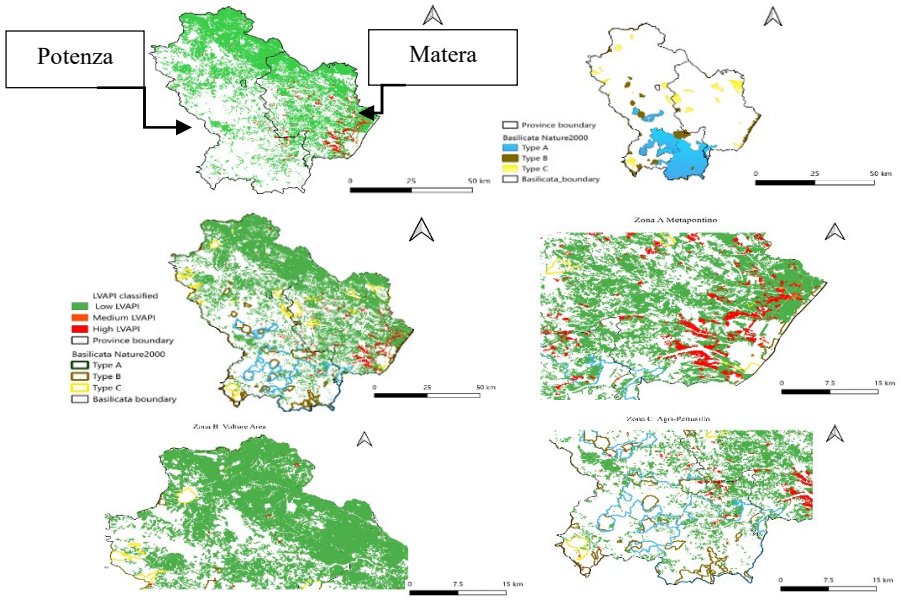

Fig. 2: Spatial analysis of the Landscape Vulnerability to Agricultural Plastic Index (LVAPI) in Basilicata region, Italy, and its relationship with Natura 2000 protected areas. Top left: Spatial distribution of LVAPI across Basilicata classified into three vulnerability classes: Low (LVAPI < 0.33, 415,446 ha, 95.5%), Medium (0.33 ≤ LVAPI < 0.66, 972 ha, 0.2%), and High (LVAPI > 0.66, 18,716 ha, 4.3%). Top right: Spatial distribution of Natura 2000 protected sites in Basilicata (Data source: EEA, 2022). Middle left: LVAPI classified map overlaid with Natura2000 protected site boundaries. Middle right: Zone A — Metapontino (eastern Matera province). Lower left: Zone B — Vulture (northwestern Potenza province). Lower right: Zone C — Agri-Pertusillo (south-central Basilicata).

Zone A — Metapontino Coast shows the highest LVAPI concentration, driven by intensive orchards and protected horticulture (*e.g.*, strawberry tunnels and melon crops). These hotspots lie adjacent to Natura 2000 sites along the Ionian coast, indicating a critical risk for protected habitats (Cillis et al., 2022a).
Zone B — Vulture Viticulture Area exhibits a contrast between low vulnerability inside protected forested areas and localized High LVAPI in surrounding vineyards, highlighting the exposure of protected areas to plastic pressure (Zavattoni et al., 2026).
Zone C — Agri-Pertusillo Watershed represents a key critical area, where High LVAPI zones border the SAC protecting the Pertusillo reservoir, with implications for water security due to erosion-driven MNP transport (Rehm et al., 2021).

Discussion
The LVAPI results show that vulnerability to agricultural plastic pollution depends not only on plastic pressure but also on landscape sensitivity. The identified hotspots confirm that areas where intensive plastic use overlaps with sensitive environmental conditions are the most critical. The Metapontino coastal plain represents the main hotspot, due to high plastic-intensive cultivation combined with proximity to Natura2000 sites, highlighting potential risks for protected ecosystems (FAO, 2021; Zavattoni et al., 2026). In the Vulture and Agri-Pertusillo areas, vulnerability is influenced by landscape factors such as slope, hydrological connectivity, and proximity to sensitive environments, supporting the role of erosion and runoff in MNP transport (Picuno C. et al., 2019; Rehm et al., 2021). Compared to existing approaches (Lanorte et al., 2017; Hachem et al., 2024), LVAPI improves spatial assessment by integrating plastic pressure with landscape sensitivity. However, the model is based on proxy variables and simplified assumptions (*e.g.*, equal weighting), and should be considered as a screening tool. Future research should validate the index with field data and test alternative weighting schemes.

Conclusion
The GIS-based LVAPI index, integrating agricultural plastic pressure and landscape sensitivity to identify vulnerability hotspots applied to Basilicata, highlights critical areas concentrated in some regional areas located particularly close some Natura 2000 sites. The results show that environmental risk depends on both plastic intensity and landscape characteristics. As a proxy-based tool, LVAPI supports spatial planning and targeted APW management, b further validation with field data is required.

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Souhrn
Zemědělský plastový odpad představuje v středomořských krajinách rostoucí zátěž pro životní prostředí, zejména v blízkosti chráněných lokalit nebo oblastí s intenzivním turistickým ruchem. Tato studie představuje index LVAPI, založený na GIS, který identifikuje kritická místa, kde se vysoká zátěž plasty překrývá s vysokou citlivostí krajiny, a který byl aplikován na region Basilicata (≈9 992 km²; 84 lokalit sítě Natura 2000). LVAPI kombinuje APPRI – odhad rizika znečištění plasty pomocí indexů specifických pro jednotlivé plodiny a dat ISTAT (2025) – s LSI, který integruje sklon, blízkost vody a ekologickou citlivost v rozlišení 10 m. Oblasti s vysokou zranitelností pokrývají 18 716 ha (4,30 %), hlavně ve třech zónách: pobřežní nížina Metapontino, vinařská oblast Vulture a povodí Agri-Pertusillo, které se všechny vyznačují blízkostí lokalit Natura 2000. Oblasti s nízkou zranitelností tvoří 95,47 % zemědělské půdy. Rámec LVAPI podporuje cílené strategie řízení a je přenositelný do jiných středomořských regionů.

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AGRICULTURAL PARKS AS MULTIFUNCTIONAL RECREATIONAL LANDSCAPES IN METROPOLITAN REGIONS

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Abstract
Agricultural landscapes located within metropolitan regions are increasingly recognised as important components of multifunctional green infrastructure. While traditionally perceived primarily as spaces for food production, contemporary planning approaches emphasize their broader ecological, social and cultural functions. The concept of agricultural parks represents an innovative strategy for integrating agricultural production, recreation and landscape protection within urbanised territories. This paper explores agricultural parks as a specific form of multifunctional recreational landscape where productive agricultural land simultaneously provides ecosystem services, recreational opportunities and landscape identity. The study focuses on selected European case studies, including Landschaftspark Belvedere in Cologne, Parco delle Risaie in Milan and Espai Rural de Gallecs in the Barcelona metropolitan area. These examples demonstrate different approaches to the spatial organisation, governance and management of agricultural landscapes functioning as public open spaces. The analysis highlights the role of landscape architecture, green-blue infrastructure and nature-based solutions in transforming conventional agricultural landscapes into accessible and attractive recreational environments without compromising their productive function. Attention is paid to spatial design strategies such as recreational path networks, landscape interpretation and biodiversity-supporting elements integrated into the agricultural matrix. The findings illustrate how agricultural parks can contribute to sustainable metropolitan development by preserving farmland, enhancing biodiversity and offering new forms of everyday recreation in productive landscapes.

Key words: multifunctional landscapes; urban agriculture; green infrastructure; nature-based solutions; landscape architecture

Introduction

Agricultural landscapes located within metropolitan regions are increasingly recognised as important components of multifunctional green infrastructure, providing a wide range of ecological, social and cultural ecosystem services (Lohrberg et al., 2016). Contemporary landscape architecture emphasises the integration of productive, recreational and environmental functions within urbanised territories, reflecting broader shifts towards sustainable and resilient spatial development (Tóth et al., 2014; Shkaruba et al., 2026). Urban and peri-urban agriculture has historically played a significant role in shaping the spatial structure and identity of cities. In recent decades, this relationship has been redefined through new planning approaches that integrate food production with recreation, education and landscape protection (Lohrberg et al., 2016; Lohrberg et al., 2023). These approaches highlight the potential of agricultural landscapes to function not only as productive systems but also as accessible public spaces contributing to the quality of life in metropolitan regions. At the same time, landscape architecture increasingly adopts landscape-based approaches that connect ecological processes with social use and cultural values. Previous research demonstrates how recreational landscapes and public spaces can be designed to support biodiversity, environmental education and community engagement (Tóth et al., 2018; Miklášová et al., 2022; Bihuňová & Pomahačová, 2022). Such interventions often build on the transformation of existing landscape structures, including agricultural land and rural elements, into multifunctional environments (Čibik et al., 2022; Kuczman et al., 2022). In this context, the concept of agricultural parks represents an innovative strategy for integrating agricultural production with recreational use and landscape protection. These landscapes combine top-down planning approaches with bottom-up initiatives, reflecting diverse governance models and participatory processes (Štěpánková & Kristiánová, 2015; Bellérová & Hus, 2025). They also contribute to the regeneration of underutilised agricultural land and the strengthening of landscape identity in peri-urban areas (Paganová & Kuczman, 2024). Agricultural landscapes further play a key role in addressing contemporary environmental challenges, including climate change adaptation, biodiversity loss and sustainable resource management. Their integration into green-blue infrastructure systems enhances ecosystem services and supports more resilient metropolitan regions (Rózová et al., 2023; Branduini, 2024; Komšo et al., 2023). This paper explores agricultural parks as

multifunctional recreational landscapes in metropolitan regions, focusing on selected European case studies. The aim is to analyse spatial, functional and management approaches that enable the coexistence of agricultural production and public use, and to identify key principles for the design and planning of productive landscapes as part of contemporary green infrastructure systems.

Material and methods

The study is based on a qualitative case study approach focusing on three agricultural parks: Landschaftspark Belvedere (Cologne, Germany), Parco delle Risaie (Milan, Italy) and Espai Rural de Gallecs (Barcelona metropolitan area, Spain). These sites represent different approaches to integrating agricultural production, recreation and ecological functions in metropolitan landscapes. The methodology combines landscape walking, observation of users, and spatial mapping. Landscape walking was used to assess spatial structure, accessibility and user experience directly in the field. Mapping and spatial analysis focused on path networks, land use patterns and the relationship between productive and recreational functions. This combined approach enabled a comparative evaluation of the selected sites and the identification of key design and organisational principles of agricultural parks.

Results

The analysis of the selected case studies demonstrates that agricultural parks successfully integrate productive agricultural functions with recreational use, creating multifunctional landscapes within metropolitan regions.

In Landschaftspark Belvedere (Cologne), agricultural production is embedded within a planned green infrastructure system, where arable land is directly accessible through a network of recreational paths. The spatial design allows visitors to experience agricultural processes visually and physically, without disrupting production. This creates a clear coexistence of farming and recreation, supported by strong landscape-architectural structuring (Fig. 1).

Fig. 1: The Landschaftspark Belvedere in Cologne designed by Lohrberg Stadtlandschaftsarchitektur enhances urban biodiversity and provides attractive spaces for recreation (Photos: Attila Tóth).

In Parco delle Risaie (Milan), the relationship between agriculture and recreation is based on the preservation of traditional rice fields and active farms. Recreational use is integrated through informal paths and direct contact with the agricultural landscape, enabling users to experience seasonal changes and farming practices. Here, agricultural production itself forms the main recreational attraction, with minimal transformation of the landscape structure (Fig. 2).

In Espai Rural de Gallecs (Barcelona metropolitan area), agricultural production is combined with ecological management and an extensive recreational network. Organic farming, biodiversity-supporting elements and educational activities are integrated with cycling and walking routes. The area functions as both a productive landscape and a recreational destination, supported by a structured governance system (Fig. 3).

Across all case studies, a key common feature is the direct spatial and functional linkage between agricultural production and recreation. This linkage is achieved through accessible path networks, visual openness of the landscape and the integration of ecological and cultural elements within the agricultural matrix. Rather than separating functions, agricultural parks enable their coexistence, transforming productive landscapes into everyday recreational environments.

Fig. 2: The Parco delle Risaie in Milan is a hotspot of both tangible and intangible urban agricultural heritage with preserved and operating farms and rice fields, providing urban agricultural landscapes for recreation (Photos: Attila Tóth).

Fig. 3: The Espai Rural de Gallecs is an agricultural island in the highly urbanised metropolitan area of Barcelona. It provides spaces for active recreation and natural experience (Source: Barcelona Agrària, Diputació de Barcelona – left; Photo: Jorge Franganillo – right)

Discussion

The results confirm that agricultural parks can function as effective multifunctional landscapes, where productive agricultural use and recreation are not separated but spatially and functionally integrated. This supports broader landscape-architectural approaches emphasising the combination of ecological, social and productive functions within green infrastructure systems (Tóth et al., 2014; Shkaruba et al., 2026). These findings correspond with the concept of urban and peri-urban agriculture as a flexible and context-dependent system (Lohrberg et al., 2015) that can simultaneously provide food production, recreation and cultural value (Lohrberg et al., 2023). Furthermore, the direct accessibility of agricultural landscapes and the visibility of production processes enhance user experience and strengthen the relationship between people and landscape. This reflects current approaches in landscape architecture that emphasise experiential, educational and community-oriented dimensions of public space (Tóth et al., 2018; Miklášová et al., 2022). Overall, the study highlights that the successful integration of agriculture and recreation depends on context-sensitive design, appropriate management and the preservation of the productive character of the landscape.

Conclusion

The study demonstrates that agricultural parks represent an effective approach to integrating agricultural production with recreational use in metropolitan regions. The analysed case studies show that productive landscapes can remain functional while becoming accessible and attractive public spaces. This integration supports sustainable urban development by enhancing landscape quality, biodiversity and everyday recreational opportunities.

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Souhrn
Článek se zabývá zemědělskými parky jako multifunkčními krajinnými celky, které v metropolitních regionech propojují zemědělskou výrobu s rekreací. Na základě vybraných evropských případových studií ukazuje, jak mohou produktivní zemědělské oblasti fungovat jako veřejně přístupné prostory díky propojení sítí stezek, ekologických prvků a strategií krajinářského designu. Zjištění poukazují na potenciál zemědělských parků podporovat udržitelný rozvoj, posilovat biologickou rozmanitost a poskytovat nové formy každodenní rekreace v rámci produktivních krajinných celků.

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AI-MEDIATED SCENARIO MODELLING FOR EXPERIMENTAL INTERVENTIONS IN URBAN VOIDS

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Abstract
Urban voids, often emerging as residual gaps within compact urban structures, represent both spatial challenges and opportunities for innovative design interventions. This research explores the potential of artificial intelligence (AI) as a tool for generating experimental design scenarios for the regeneration of such spaces. The study focuses on a vacant lot located within a strictly urbanized environment, characterized by fragmented spatial conditions and limited development potential. The research applies AI-based modelling to generate a series of possible spatial interventions that reinterpret the role of the site within the surrounding urban fabric. Rather than producing a single design solution, the AI system is used to explore multiple speculative scenarios reflecting different spatial, ecological, and programmatic strategies. These generated proposals are subsequently analyzed and categorized according to their spatial logic, degree of intervention, and relationship to the existing urban structure. The resulting scenarios form the basis for a structured set of recommendations that contribute to a working database of potential regeneration strategies for urban voids. The findings suggest that AI-assisted modelling can serve as a supportive exploratory tool in early design stages, expanding the range of possible spatial strategies and supporting decision-making processes in the regeneration of small-scale urban gaps within dense city environments.

Key words:AI-mediated design, generative modelling, spatial scenarios, performative urbanism, experimental urbanism

Introduction

Urban voids represent underutilized or residual spaces within compact urban structures that often lack a clear function, yet hold significant potential for transformation (Žolobaničová et al., 2025; Vinczeová et al., 2025). Emerging as a result of historical development, demolition, or incomplete urban planning, these spaces disrupt spatial continuity while simultaneously offering opportunities for innovative interventions. In recent years, artificial intelligence (AI) has begun to influence design processes, particularly in the early stages of ideation. AI-assisted tools enable the rapid generation of multiple spatial scenarios, allowing designers to explore a wider range of possibilities beyond conventional approaches (Čibik and Jankechová, 2023). This study investigates the use of AI-mediated scenario modelling as a method for exploring alternative transformations of urban voids. Rather than seeking a single optimal solution, the research focuses on comparing multiple predefined spatial strategies applied to the same site, with the aim of expanding the understanding of potential design approaches in the regeneration of small-scale urban gaps.

Materials and methods

Study area: The research focuses on a selected urban void located on Vajanského nábrežie in Bratislava, Slovakia. The site is situated within the compact urban structure of the city center, directly adjacent to a primary urban artery along the Danube riverfront. The void is defined as a residual gap between two existing buildings, representing a discontinuity in the otherwise continuous street frontage. The selected site originates from a broader database of identified urban voids within the central zone of Bratislava, developed through prior research. These spaces emerge as a result of historical transformations, demolition processes, or incomplete urban development, and often lack a clearly defined function or identity.

Data Sources and Software Tools: The primary input data consisted of a high-resolution street-level photograph capturing the frontal view of the selected urban void and its immediate urban context. This image served as the base layer for all subsequent transformations.

The preparation and processing of data involved a combination of the following tools:

- **Adobe Photoshop 2026, AI-based generative image tools (Generative Fill)**, Used for:
  1. precise spatial selection of the void area

2. masking and layer control
3. iterative refinement of generated outputs
4. scenario generation based on text prompts
5. controlled transformation of the selected area (remove tool)

- **ChatGPT (based on GPT-5.3 architecture, OpenAI, 2026)**, Used for:
  1. prompt formulation, and text refinement
  2. methodological structuring

The workflow was designed to ensure that:
Only the internal area of the void was modified, while all surrounding urban elements (buildings, street profile, sidewalk) remained unchanged. This approach enabled a consistent comparative framework across all generated scenarios.

Research Approach: The research adopts a scenario-based exploratory approach combining principles of urban design, case study methodology, and AI-assisted image generation. The selected urban void was used as a fixed spatial framework within which multiple transformation scenarios were systematically tested. The aim was not to produce a single optimal design solution, but rather to explore a range of possible spatial futures under controlled conditions.

Methodology
Step 1: Selection of the study site and preparation of the visual base
A specific urban void was selected as the case study site. A street-level photograph of the selected site was used as the primary visual input. This photograph served as the fixed base for all subsequent transformations. The surrounding urban context — especially the buildings, street, and sidewalk — was treated as constant, while only the interior of the void was considered variable.

Step 2: Definition of the intervention boundary
The editable area was manually selected in Adobe Photoshop (Fig. 1). The selection followed the actual spatial limits of the void, including the inner edges between the adjacent buildings and the existing frontage line. This step was critical because the intention was to modify only the internal area of the gap and to preserve the surrounding urban frame unchanged.

Fig. 1: AI-assisted workflow: selection of the intervention area, generative fill application, and prompt-based scenario definition within a fixed urban context. Source: author.

Step 3: AI-assisted scenario ideation
At the conceptual stage, six possible intervention scenarios were developed through an iterative process combining author-driven thinking and AI-assisted ideation. ChatGPT was used to help formulate and structure alternative spatial strategies for the same site. These suggestions were not adopted automatically; they were reviewed, adjusted, renamed where necessary, and accepted by the author as the final scenario framework. The final scenario set consisted of:

1. Managed Urban Succession
2. Green Buffer (Public Park)
3. Micro-Public Space (Pocket Park)

4. Infill Lightweight Structure
5. Temporary / Tactical Urbanism
6. No Intervention (Preserved Void)

Step 4: Prompt formulation
Each predefined scenario was translated into a separate text prompt describing its spatial character, type of intervention, vegetation structure, expected program, and level of occupation. The prompts were intentionally scenario-specific so that each output represented a distinct design logic rather than a random visual variation.

Step 5: AI-based image generation
The prepared prompts were then used in AI image-generation tools to produce visual scenarios. The objective was not to create a completely new urban scene, but to test how different spatial concepts could be inserted into the same real context.

Step 6: Iterative refinement and selection
For each scenario, multiple outputs were tested and compared. During this process, it became clear that AI tools frequently tended to alter edges, proportions, or adjacent surfaces beyond the intended boundary. Because of this, the outputs had to be iteratively refined through repeated prompt adjustment, repeated generation, and visual selection of the most plausible result.

Step 7: Comparative scenario analysis
The final set of retained scenarios was then compared as a structured experimental series. Since all scenarios were derived from the same base image and the same spatial frame, they could be analyzed comparatively in terms of:

- degree of intervention,
- spatial logic,
- relation to the existing urban structure,
- and programmatic or ecological character.

Step 8: Interpretation of results
The resulting scenarios were interpreted not as final architectural proposals, but as speculative spatial models. Their purpose was to explore the range of possible futures for the selected urban void and to test the usefulness of AI-assisted visualization as a support tool in the early stages of design thinking.

Results
The AI-assisted process produced six distinct spatial scenarios representing different transformation strategies applied to the same urban void under a fixed visual framework (Fig. 2). By modifying only the interior of the site while preserving the surrounding urban context, the results enable direct comparison between alternative intervention approaches.

The scenarios range from minimal intervention (*No Intervention*, *Managed Urban Succession*), through environmentally and socially oriented strategies (*Green Buffer*, *Micro-Public Space*), to more intensive transformations (*Temporary Urbanism*, *Infill Lightweight Structure*). Each scenario reflects a specific spatial logic, including ecological continuity, environmental buffering, social activation, architectural insertion, and temporary adaptation. The results demonstrate that a single urban void can accommodate multiple plausible spatial futures depending on the selected intervention strategy. At the same time, the use of AI revealed limitations in maintaining strict spatial boundaries and required iterative refinement and authorial selection. Consequently, the generated outputs should be understood as speculative representations supporting comparative analysis rather than precise design proposals.

Conclusion
This study examined AI-assisted scenario modelling as a tool for exploring transformations of urban voids within compact urban structures. Using a controlled image-based approach, it demonstrated that a single site can accommodate multiple distinct spatial strategies within the same urban framework. The results highlight that urban voids represent adaptable spaces with diverse development potential, ranging from minimal ecological intervention to architectural insertion. At the same time, the research confirms that while AI expands exploratory capacity, it requires careful control and authorial validation.

The outputs should therefore be understood as speculative representations rather than precise design solutions. Overall, the study shows that AI-assisted modelling can effectively support early-stage urban design by enabling comparative analysis and broadening the range of possible spatial scenarios.

Fig. 2: Comparative visualization of six AI-assisted scenarios applied to a single urban void under identical spatial conditions. Source: author.

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Souhrn

Příspěvek se zabývá využitím AI asistovaného scénářového modelování při zkoumání možností transformace městských prázdnot v kompaktní urbánní struktuře. Na základě případové studie je ukázáno, že jeden prostor může nést více rovnocenných návrhových scénářů s odlišnou prostorovou logikou. Výsledky potvrzují, že AI je vhodným nástrojem pro rané fáze návrhu, přičemž generované výstupy je nutné chápat jako spekulativní a vyžadující autorskou interpretaci.

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AIR QUALITY IN THE CITY OF HRADEC KRÁLOVÉ

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Abstract
Hradec Králové is traditionally regarded as a city with a high proportion of greenery, representing an inspiring example of an urban environment. Consequently, both visitors and residents experience diverse urban climates within the city. The Czech Hydrometeorological Institute (CHMI) operates two climatological stations (Nový Hradec Králové and Svobodné Dvory) and one air quality monitoring station (Brněnská) within the municipal area. The urban climate is further studied under the project *"Mitigation of the negative impacts of meteorological extremes (temperature, wind, and precipitation) on public health and the environment in large agglomerations."* Air temperature and humidity measurements are currently conducted at eight locations across the city. In this article, we present the results of an assessment of the urban climate and air quality with regard to the plan to plant additional fruit orchards as part of the urban greenery. We monitor the potential of fruit trees not only as adaptation elements of urban landscapes but also as bioindicators of pollution. As a specific case study, we provide the results of a microanalysis using the SEM/EDX method, identifying the nature of pollutants deposited on the surface of an apple leaf from the Na Potoce orchard.

Key words: urban environment, urban greenery, fruit trees, bioindication

Introduction

Currently, more people inhabit cities and large urban agglomerations than rural areas. This increasing concentration of inhabitants is inherently associated with energy production and environmental pollution. Under urban conditions, natural variability can be altered, which may impact, for instance, the health status of the urban population (Dobrovolný et al., 2012). The urban climate in the Czech Republic is characterized by the formation of urban heat islands, where built-up areas exhibit higher temperatures than the surrounding rural regions. The intensity of this phenomenon is influenced by the building structure, surface types, and the proportion of vegetation (Lehnert et al., 2023).

The city of Hradec Králové is situated in the Elbe Lowland (Polabská nížina) at an altitude of up to 240 m a.s.l., at the confluence of the Elbe and Orlice rivers, without significant topographic relief. From an urban climate perspective, it is crucial that the municipal territory also includes the extensive Hradec Forests (Hradecké lesy) and several ponds and water bodies, which significantly influence temperature and moisture conditions. A major advantage of Hradec Králové is that it ranks among the few cities in the Czech Republic with an extensive area of greenery. This is established by the original master plan from the early 1920s, designed by the architect Josef Gočár (1880–1945). In his concept of urban design, Gočár emphasized the significance and necessity of large-scale greenery. His vision focused on preserving green belts that naturally enter the city along the rivers. He created a ring road system encircling these belts and the entire city center, which has a positive effect on the microclimate and topoclimate of the urban environment.

As new structures are progressively built within the city, the urban environment continues to evolve. Urban surfaces are largely composed of materials that were not present in the original landscape. These materials possess distinct properties, particularly regarding radiation and energy balance. Water is rapidly drained from the city, while new emissions are generated. The issue of the urban environment has become a central subject of research, as the comforts of city life can, in certain situations, transform into negative impacts on the inhabitants (Rožnovský et al., 2023).

The utilization of vegetation for passive biomonitoring represents an effective method for assessing air quality in urban environments. In this context, the leaves and fruits of woody plants function as natural passive samplers that, due to their specific structure and epicuticular waxes, selectively accumulate a wide spectrum of aerosol particles (Prybysz et al., 2020). Unlike monitoring stations that provide real-time data, biological surfaces integrate the history of exposure throughout the entire growing season.

This study presents a methodological demonstration of using apple tree leaves for the detection of anthropogenic aerosols in an urban environment. The objective is to demonstrate the potential of leaf biomass for characterizing the immission situation within a specific microclimate and to identify the influence of traffic and other air pollution sources, even in locations situated outside major traffic hotspots.

Materials and methods

The climatological characteristics of any location within our territory are derived from measurements conducted at the climatological stations (hereinafter referred to as CS) of the CHMI, in accordance with the manual for observers of automated meteorological stations (Lipina et al., 2014). Within the territory of Hradec Králové, these include the Nový Hradec Králové and Svobodné Dvory sites. To characterize the urban climate, a network of specialized meteorological stations was established across various urban settings to evaluate the influence of different surfaces, built-up areas, and both scattered and continuous greenery.

For the study of aerosol particle deposition, an in-situ analysis of the native biomatrix was selected. This procedure involved fixing apple leaves onto aluminum stubs using conductive carbon tape, followed by sputter-coating with a thin layer of gold. The samples were analyzed in high vacuum mode (HV mode). The predicted dehydration of the plant tissue within the microscope chamber was employed as a methodological tool to enhance the microtopography of the leaf surface. This process revealed microstructural irregularities and grooves, resulting in the visual separation of deposited aerosols from the biological substrate. In the original hydrated state of the tissue, these particles would have been less identifiable within the micro-grooves.

Given the heterogeneity of the leaf surface, a combination of morphological and point EDX analysis was utilized. This methodology enables the detailed characterization of specific pollution markers directly within the biomatrix and provides insight into the interaction mechanisms between particulate matter and plant tissue. Point analysis targeted selected representative particles to determine their elemental composition and identify potential sources of anthropogenic contamination within the given microclimate.

Results

Figure 1a illustrates the progression of average monthly maximum air temperatures at CS Hradec Králové – Svobodné Dvory and CS Hradec Králové – Nový Hradec during the 2025 growing season. As observed, the differences in monthly averages for maximum temperatures are minor, however, more pronounced variations are evident in the average monthly minimum air temperatures season (Fig. 1b). of 2025 on the CS.

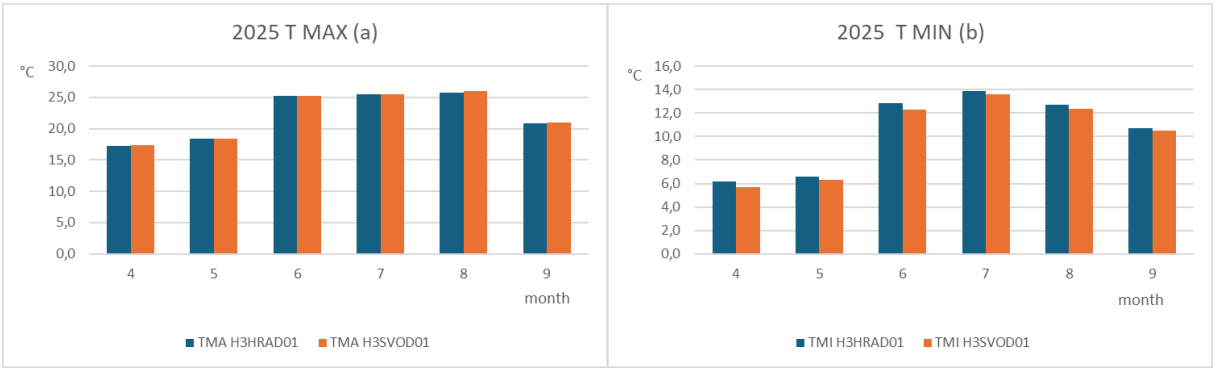

Fig. 1a,b: Average monthly maximum and minimum air temperature (°C) during the 2025 growing season at the climatological stations Hradec Králové – Svobodné Dvory (H3SVOD01) and Hradec Králové – Nový Hradec (H3HRAD01).

Regarding assessing thermal conditions for recreation within the city territory, it is essential to understand the temperature progression in individual urban areas with different surfaces and types of vegetation. To illustrate the differences between various urban locations, Figure 2 shows the maximum air temperature progressions for greenery (Jiráskovy sady), the city center (Velké náměstí), and forest cover (Lesní hřbitov). During the warmest periods, air temperature differences between the evaluated sites can exceed 8°C.

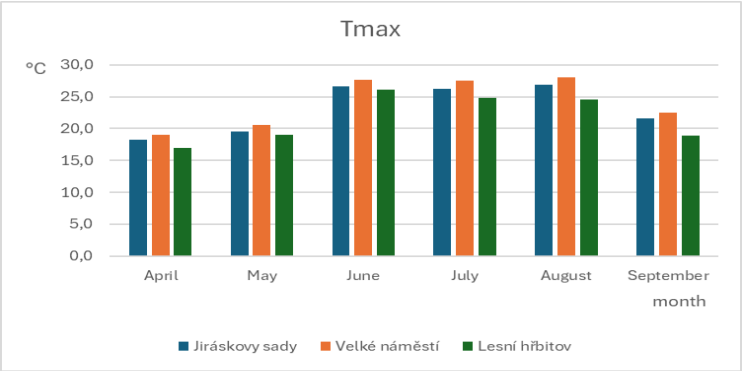

Fig. 2: Maximum air temperatures (°C) during the months of the warm half-year in 2025

This capacity of vegetation to regulate the urban microclimate is closely linked to the physiological and physical properties of the foliage, which also serve as a sink for pollutants within the urban ecosystem. Analysis of the apple leaf microtopography (Fig. 3) revealed a specific structure that fundamentally influences particle deposition. The leaf surface exhibits a finely structured labyrinth of micro-grooves and cuticular folds, forming a natural barrier for the deposited aerosol. This complex network of microstructures, further enhanced by controlled dehydration within the SEM environment, functions as an effective cumulative trap that mechanically fixes aerosol particles within the biomatrix.
This retention effect is likely amplified within the urban heat island microclimate, where stress conditions (high temperatures and low humidity) may lead to further roughening of the cuticle and increased surface micro-roughness. These structural changes in the tissue enhance the potential of leaf biomass to accumulate technogenic dust throughout the growing season, establishing the leaf as a relevant medium for monitoring long-term immission loads in a given locality

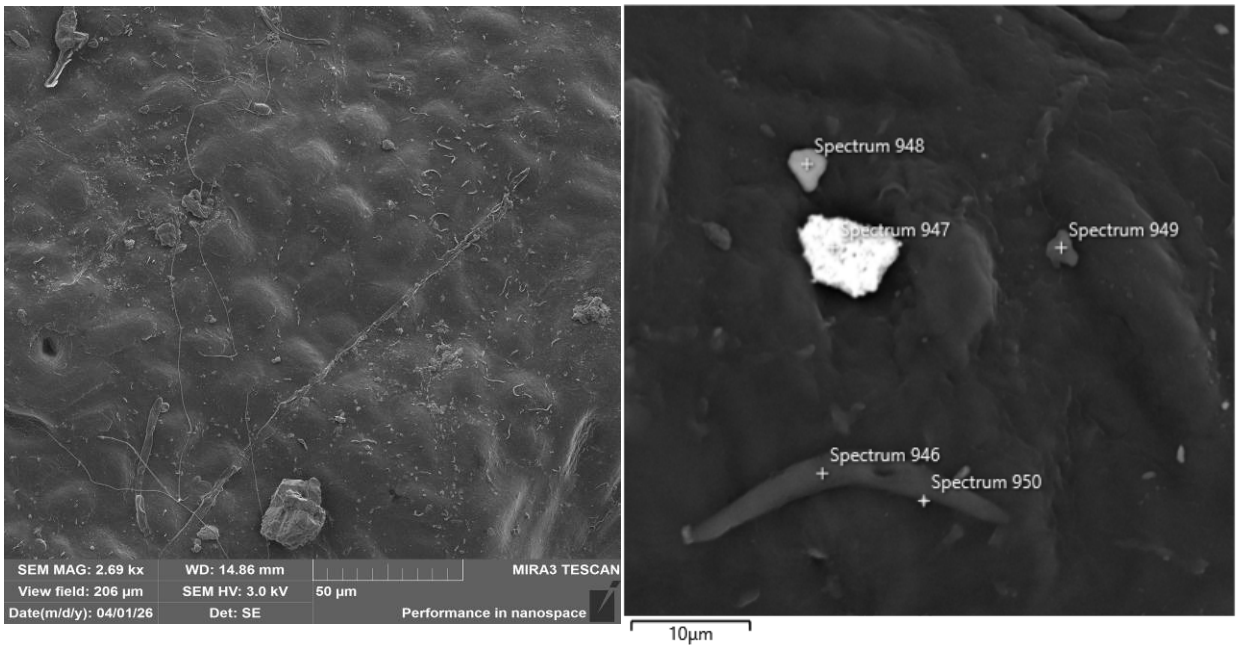

Fig. 3, 4: (Left) Scanning electron micrograph showing the structured cuticular relief with a labyrinth of micro-grooves serving as a natural trap for aerosol deposition. (Right) Backscattered electron (BSE) image highlighting dust particles (bright spots) on the organic leaf substrate due to their high atomic contrast.

The results of the point analyses of selected particles deposited on the apple leaf surface are presented below. The use of a backscattered electron (BSE) detector enabled efficient visual screening of the surface (Fig. 4). Due to high atomic contrast, particles with a higher atomic number (metals) appear as distinctly bright or luminous spots against the gray organic background of the leaf.

Detailed point microanalysis of the deposited particles (Table 1) confirmed the high heterogeneity of the sample and allowed for a distinction between the natural biogenic background and anthropogenic contamination. While spectra 946 and 949 correspond to biogenic structures with a dominant presence of carbon (approx. 76 wt. %) and oxygen (23 wt. %), a significant proportion of iron (32.56 wt. % Fe) was identified at point 947, accompanied by trace elements such as aluminum, silicon, and calcium. A significant share of iron (8.74 wt. %) was also detected at point 950, indicating the widespread presence of finer metallic dust within the investigated microenvironment.
The presence of aluminosilicates at point 948 (Si 3.44 wt. %, Al 3.00 wt. %) indicates the deposition of particles of geogenic origin (soil dust). The image also reveals the presence of organic microstructures (e.g., a fungal hypha in the lower part of Fig. 4). In BSE mode, these structures do not exhibit bright contrast, methodologically confirming their distinct, non-metallic nature—a finding further supported by the detection of potassium (K) as a biomass marker.

Tab. 1: Elemental composition of analyzed spectra (wt. %)

Spectrum Label	C	O	Al	Si	S	K	Ca	Fe
946	76.60	22.32	—	—	—	1.08	—	—
947	32.46	32.89	0.63	0.56	0.46	—	0.45	**32.56**
948	59.20	33.8	3.00	3.44	—	0.19	—	0.38
949	76.36	23.05	—	—	—	0.59	—	—
950	77.37	12.73	—	0.24	—	0.72	0.19	**8.74**

Conclusion

Our analyses of temperature conditions in the city of Hradec Králové confirmed that air temperatures in the urban environment partially differ from climatological station data depending on the surface, built-up area, and vegetation. The highest air temperatures were recorded in the built-up central part of the city, whereas temperatures in Jiráskovy sady and the Forest Cemetery stands were lower, making them more favorable for residents during extreme weather events.
This methodological demonstration confirmed that the apple leaf is a valid tool for the biomonitoring of urban aerosols. The BSE mode allowed for the distinction between the biogenic background and technogenic contamination, represented by sharp-edged particles with a high iron content (32.56 wt. % Fe). Their morphology corresponds to a mechanical origin (brake wear, corrosion), while their presence at the orchard locality Na Potoce suggests a widespread dispersion of emissions even outside major traffic hotspots.
The detection of potassium (K) in organic structures (e.g., fungal hyphae) served as a reliable marker for differentiating biomass from technogenic pollutants. Although metallic particles represent a numerically minority component of the aerosol here, their exact identification is a key indicator of the locality's environmental load. This pilot study thus demonstrates the potential of leaf biomass as a data source for the specific origin of air pollution which standard monitoring networks do not account for.

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Souhrn
Hradec Králové je tradičně vnímán jako město s vysokým podílem zeleně a v tomto ohledu představuje inspirativní příklad urbánního prostředí. Návštěvníci i obyvatelé města se zde tak pohybují v rozdílném městském klimatu. Český hydrometeorologický ústav (ČHMÚ) zajišťuje na území města měření na dvou klimatologických stanicích (Nový Hradec Králové a Svobodné Dvory) a na jedné stanici kvality ovzduší (Brněnská). Městské klima je studováno v rámci projektu *„Omezení negativních dopadů meteorologických extrémů (teploty, větru a srážek) na veřejné zdraví a životní prostředí ve velkých aglomeracích“*. Na území města probíhá měření teploty a vlhkosti vzduchu na 8 místech. V článku uvádíme výsledky hodnocení městského klimatu a kvality ovzduší s ohledem na záměr vysazovat další ovocné sady v rámci městské zeleně. Sledujeme potenciál ovocných dřevin nejen z hlediska adaptačních prvků městské zeleně, ale také jako bioindikátorů znečištění. Jako konkrétní příklad uvádíme výsledky mikroanalýzy pomocí metody SEM/EDX. Jedná se o identifikaci charakteru znečišťujících látek deponovaných na povrchu listu jabloně (sad Na Potoce).

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APPROACHES TO THE USE OF HISTORICAL WATER MANAGEMENT FACILITIES WITHIN THE FRAMEWORK OF RECREATION AND TOURISM

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Abstract
The protection, preservation and use of industrial heritage, including water management facilities and their systems, are among the main areas of care for historic buildings and monuments around the world. The purpose of the article is to compare approaches to the possible use of preserved or reconstructed historic water management facilities and their equipment (not only the buildings themselves, the premises of the facility complexes, but also machines, tools for operation and maintenance, etc.) within the framework of recreation for residents of the surrounding environment and tourism for visitors to the places and areas in which these facilities are located. In many cases, this is part of secondary use, when the original function of the facility has ended. In some cases, it is necessary to balance the requirements for maintaining a defined functionality with the need to present this historic heritage, the purpose of which is also to promote awareness of the field of water management, related industries and the historical development of the area. The article is based on research on sites in the Czech Republic and Taiwan.

Key words: Industrial heritage; restoration of historical buildings; use of historical buildings

Introduction
Water (water management) structures of various origins, ages and purposes are witnesses to the development of human civilization and evidence of technical skill. Today, we view these objects as an integral part of our industrial (cultural) heritage. This in itself represents a very diverse group of structures, which at the same time represent a wide range of often incommensurable qualities (Ryšková, Dzuráková, 2022). The question of society's relationship to industrial structures, but also to furniture and production know-how, has been a relatively frequent topic for several decades. In accordance with the principles of TICCIH (The International Committee for the Conservation of the Industrial Heritage), emphasis is gradually being placed on identifying the technical and technological values of industrial structures, on the degree of authenticity and continuity of function, on the description of the technological flow and systemic links of the objects. These criteria are subsequently incorporated into the process of assessing the significance of the given structures from the perspective of monument protection, together with traditionally used architectural, artistic-aesthetic and urban planning criteria and historical contexts.

Materials and methods
The methodology of the research work is based on a search of professional literature, methodological guidelines of state administration institutions, legislation in the fields of water management, protection of cultural monuments, which are valid or available for the territory of the Czech Republic and Taiwan. Subsequently, a field survey was carried out in selected locations, focused on documenting the condition of selected objects and/or functional units of water management objects, approaches to reconstruction, maintenance and use, whether for the performance of selected water management functions or the performance of other social functions. The obtained data was evaluated by comparative analysis, which will allow comparing the condition and approaches in both countries, which are characterized by different conditions from many perspectives (climatic conditions, cultural and social customs, etc.), but from the perspective of the development of water management are characterized by similar processes, the development of technologies and individual fields (water management, collection and treatment of wastewater, implementation and use of irrigation, development of hydropower).

Results
The Czech Republic and Taiwan maintain above-standard relations. Cooperation is very strong, especially in the areas of economy, technology, science and culture, and is accompanied by frequent

informal political contacts. In the European context, the Czech Republic is one of Taiwan's closest partners.

The protection of technical monuments and industrial heritage in the Czech Republic is mainly enshrined in the Act on State Monument Care. The National Monument Institute (NPÚ) plays a key role in practical protection and in the decision-making process on granting monument protection, which professionally assesses the value of objects, keeps records of monuments and issues opinions on their modifications. In the case of industrial heritage, not only age is assessed, but also technological, architectural and historical value (Ryšková, Dzuráková, 2022). The aim is to preserve authentic structures and technical equipment, even though objects are often adapted for new uses (for example, cultural centers or apartments). The entire system is therefore based on a combination of legal protection, expert assessment and a controlled permitting process, which is intended to ensure that industrial heritage does not disappear, but can also be used sensitively in the present.

In Taiwan, the protection of technical monuments and industrial heritage is primarily regulated by the Cultural Heritage Preservation Act. Its administration falls under the Ministry of Culture and the specialized agency Bureau of Cultural Heritage (BOCH), with local governments also playing an important role. Industrial heritage (e.g. former factories, sugar refineries, mines, railway facilities or ports) is considered part of cultural heritage alongside traditional historical monuments. The emphasis is on so-called adaptive use, i.e. preserving the historical structure of a building while reusing it for new functions (e.g. converting factories into cultural centers or galleries).

The approach to the new use of historical water management facilities and their functional units in the Czech Republic and Taiwan differs in many respects, although both systems are based on a common goal, which is the preservation of technical and cultural heritage and its adaptation to the current needs of society.

In the Czech Republic, it is typical that the technical and functional continuity of water management facilities is often maintained. Structures such as weirs, mills or hydroelectric power plants often remain part of the active infrastructure, for example within the framework of river regulation or energy production. The adaptation of these facilities is rather gradual and in parts, combining the original technical function with new uses. A typical example is mills that continue to be used as small hydroelectric power plants, or facilities that simultaneously fulfill technical, residential or recreational functions. This approach can be described as a model where the “function persists”, while the connection to the landscape and the water network also plays a significant role, which allows at least partial preservation of the original operation. In addition, there is a second line of adaptation, where historical facilities are converted into housing, offices or cultural facilities, but these are often individual, rather isolated projects than large-scale area conversions.

Fig. 1: View of the historic pumping station of the water utility complex, which serves as a museum, part of an educational and entertainment water park, and as a backdrop for cultural and social events (Taipei, Taiwan).

In Taiwan, the situation is different, as there is more often a complete transformation of former water management areas. The original technological function usually disappears and the objects are transformed into cultural parks, museums or creative spaces. The result is large-scale revitalized complexes that serve as new cultural destinations and places of public life. This approach can be

summarized as a model where “the function ends, but the object lives anew”, with the emphasis placed on the cultural and social value of the place and its new identity.
Differences are also evident in the area of museum and cultural use. In the Czech Republic, partial musealization is often involved, when, for example, waterworks or mills are converted into technology museums, while the rest of the object can remain in other operations or be used privately. In Taiwan, on the other hand, it is common for entire areas to be revitalized at once, for example former waterworks or industrial complexes that are transformed into so-called heritage parks or cultural districts, often with significant support from the state or cities and with an emphasis on tourist and cultural effects.
A significant difference is also reflected in the preservation of the technical function. In the Czech Republic, a high proportion of “living heritage” remains, as many weirs, mills or hydroelectric power plants still fulfill their original or partially modified function. In Taiwan, on the other hand, most of the historical water management systems have been modernized or replaced, and the original operation has thus ceased in most cases.
Another difference lies in the possibilities of housing and commercial use. In the Czech Republic, individual adaptation is very common, for example, the conversion of mills into family houses, apartments or studios. In Taiwan, this type of use is less widespread and more often the objects are changed into cultural enterprises, cafes, galleries or spaces for the creative industry, with the whole process being more coordinated by cities or state institutions.
There are also differences in the area of tourist use. In the Czech Republic, technical tourism is rather dispersed, for example in the form of educational trails along waterways, canals or rivers (Figure 3). In Taiwan, on the other hand, large concentrated units are being created, such as heritage parks or water culture parks (Figures 1 and 2), which concentrate the interpretation of water management heritage in one place and emphasize its cultural significance.

Fig. 2:. Information board with a plan of the entire water park area with links to still functional water treatment and distribution facilities for the urban agglomeration (Taipei, Taiwan).

Fig. 3: An example of a functional unit of water management systems with a flood control function, irrigation function and transport waterway (Pomoraví, Bať a Canal, Czech Republic), in which the social function (support and use within tourism) has gained importance.

Discussion
In both countries, methods and ways of adapting and reusing unused industrial objects and complexes have been investigated (Li, Wang, 2025; Fetisov, 2015). In practice, two main ways of further use are distinguished for historical water management objects (mills, weirs, waterworks, dams, canals, pumping stations): (1) preservation or restoration of the water management function and (2) adaptive conversion to another purpose when the original function disappears or is significantly reduced. In the case of water management objects, approaches that lead to the preservation of the continuity of technology in the landscape are generally applied in the Czech Republic, while in Taiwan, approaches that transform the industrial past into a cultural and urban experience are generally applied.

Conclusion
The approach to the new use of historical water management objects and their functional units in the Czech Republic and Taiwan differs in many respects, although both systems are based on a common goal, which is the preservation of Overall, it can be said that the Czech Republic applies a rather fragmented model of adaptation, where individual objects are incorporated into the current use independently and often retain part of their technical function and links to the landscape. On the contrary, Taiwan uses an area model, in which entire complexes are transformed at once with an emphasis on cultural, social and touristic effects. Both approaches are functional, but differ in the degree of continuity on the one hand and the degree of transformation on the other.

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Souhrn
Ochrana, zachování a využití průmyslového dědictví, kam patří i vodohospodářská zařízení a jejich systémy, patří mezi hlavní oblasti péče o historické budovy a památky po celém světě. Účelem článku je porovnat přístupy k možnému využití dochovaných nebo rekonstruovaných historických vodohospodářských zařízení a jejich vybavení (nejen samotných budov, prostor komplexů zařízení, ale i strojů, nástrojů pro provoz a údržbu atd.) v rámci rekreace obyvatel okolního prostředí a cestovního ruchu pro návštěvníky míst a oblastí, ve kterých se tato zařízení nacházejí. V mnoha případech se jedná o součást druhotného využití, kdy původní funkce zařízení skončila. V některých případech je nutné vyvážit požadavky na zachování definované funkčnosti s potřebou prezentace tohoto historického dědictví, jejímž účelem je také podpora povědomí o oblasti vodohospodářství, souvisejícím průmyslu a historickém vývoji oblasti. Článek vychází z výzkumu lokalit v České republice a na Tchaj-wanu.

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ASSESSMENT OF LANDSCAPE VULNERABILITY IN THE CZECH-SLOVAK BORDER REGION USING NATIONAL APPROACHES

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Abstract

Currently, there are important methodological procedures (applications) for landscape vulnerability assessment on both sides of the border Czech-Slovak Republic border. In Slovakia it is the application "Horia obce" and in the Czech ESAI+. However, both approaches focus only on their territories, taking into account administrative borders and the availability of national datasets.

In our study (carried out in the framework of the Interreg project JIZKES), the two methodologies were first compared at the level of the concept of the evaluation. This was followed by an analysis of the data used and the possibility of equivalent data sets on the other side of the border. Both methods were then applied, first on the home side and then on the opposite side, at the extent of the selected adjacent counties, to produce seamless maps of the whole study area. The main differences were identified in the climate data used (value, resolution) and the detail of the habitat map. The resulting maps were published on the project's public map portal. Finally, the applicability of the methodologies was evaluated using the SWOT method to create a (new) unified landscape vulnerability methodology applicable in both countries.

Key words: GIS, landscape analyses, vulnerability

Introduction

The effects of climate change are evident worldwide and have various impacts—environmental, social, and economic. The fundamental principle of mitigating these impacts is understanding the causes, identifying vulnerable areas, and proposing appropriate adaptation and mitigation measures. These steps must respect the character of the landscape being assessed. Landscape research is very often limited by administrative state borders, which certainly do not correspond to the boundaries of ecosystem units. However, natural processes and other driving forces of landscape change operate in a broader context and must be analysed within logical, functional, and natural boundaries. This is doubly true for research on climate and its manifestations.

Landscape processes, not only along the Czech-Slovak border, do not recognise administrative boundaries but are shaped and operate based on natural conditions and the locally specific nature of land use. Analyses and adaptation measures implemented within the boundaries of administrative units are thus insufficient and do not deliver the expected benefits to the landscape or human society, partly due to the mutual interaction of various measures implemented in neighboring areas.

Currently, there are key analyses and applications for assessing landscape vulnerability on both sides of the border—on the Slovak side, this is the “Horia obce” application, and on the Czech side, the ESAI+ assessment of environmental sensitivity and landscape productivity loss. However, both approaches address only their respective territories, taking into account administrative boundaries, the availability of national data, and expert knowledge.

Materials and methods

Based on our own knowledge, extensive literature review, and direct discussions, we identified relevant methodological approaches used in the Czech Republic and Slovakia. These were analysed in terms of their objectives, concepts, and methodologies, followed by a comparison of their key components. The data and information sources used were then analysed. The focus of the analysis was on identifying their role in the analysis, assessing their availability across the entire territory of interest, and determining the existence of identical datasets or their equivalents in the other country. Finally, both methodologies were applied first in the home country and then in the neighbouring territory, and seamless maps of the entire cross-border area were created. The data and results were compared and evaluated.

Results

ESAI method

The methodology defines vulnerability assessment at the level of individual landscape segments. A key feature of the procedure is the large number of spatial overlay operations performed on individual layers, which result in extensive segmentation of landscape units (Pechanec et al., 2021). This is advantageous for the subsequent aggregation of vulnerability values for any administrative or natural unit. Still, it increases the volume of generated data and the demands on how individual values are presented.

- Clearly quantified outputs in four thematic groups and a single overall landscape vulnerability index,
- Designed for the habitat level, detailed landscape analysis,
- Ability to display results at various scales—municipalities, districts, regions,
- Enables assessment of the fulfilment of ecosystem functions and services,
- Direct mechanism for designing and targeting mitigation and adaptation measures (Prokopová at al., 2026),
- Comprehensive approach to degradation (multiple causes),
- Ability to compare results with other countries (Italy, Greece, Romania).

ESAI total index values for susceptibility to degradation: i) extremely high in more than half of the selected area in the Czech Republic—predominantly agricultural land, ii) extremely high in roughly one-third of the selected area in Slovakia – with a higher proportion of forested areas, iii) in the border cadastral areas of municipalities, the ESAI values show lower vulnerability to degradation in the Czech Republic – this is due to more detailed climate data and data on the occurrence of natural habitats in the Czech Republic compared to data in Slovakia.

Values for the thematic groups “Intensity of Human Activity” and “Climate Status” are similar in both territories: i) both thematic groups reach extremely high to moderate values in the Czech Republic—most notably in the South Moravian Region and, to a lesser extent, in the Moravian-Silesian Region; ii) in Slovakia, most notably in the Nitra Region, and to some extent in the Trenčín and Žilina Regions. Values for the Vegetation Condition thematic group show low susceptibility to degradation in mountainous areas: in the Czech Republic, the Moravian-Silesian Beskids; in Slovakia, the Strážovské vrchy and Malá Fatra. The thematic group “Soil Condition” yields nearly opposite values; areas with deeper, less skeletal soil and minimal slope exhibit low susceptibility to degradation.

„Vedúci! Horia obce” method

The aim of the “Leaders! The Towns Are Burning!” method (VHO) is to identify the levels of vulnerability of towns to the impacts of climate change, specifically in three main areas: heat waves, drought, and extreme precipitation (Nánásiová et al., 2023). The basic principle of the VHO method can be described as the calculation of an index, which is derived as the sum of the contributions of input indicators multiplied by automatically assigned weights using the statistical method known as Data Envelopment Analysis (DEA). For important indicators, experts set a lower threshold for their contribution to the resulting index, which must be met. Conversely, for less relevant indicators, an upper limit is set for their contribution to the index. Based on the index values, municipalities are divided into 10 groups (quantiles) representing the level of vulnerability, where a higher value indicates a higher risk.

The methodology is characterised by the fact that it processes all input data into a single value for the entire administrative territory using the weighted average method. This approach is thus suitable for comparing municipalities or higher administrative units, but it is not suitable for the detailed spatial localisation of the vulnerable segment. An advantage is that, for most of the climate indicators used, national climate data are not used, but rather data from the European project Copernicus -CAMS, which seamlessly cover the entire territory of both countries and fully meet our basic premise of fully compatible data without any internal barriers, uniformly describing the state of the entire area of interest, albeit at the cost of lower spatial resolution.

The following points can be seen as particularly positive aspects of the VHO method:

*0 The landscape vulnerability assessment also includes the impact on people (the procedure better addresses social aspects and adaptive capacity),

*1 Authorised climate data (CAMS) extending beyond national borders are used, incorporating climate scenarios (assessment of future threats),

*2 Clearly defined causes of vulnerability and relationships between layers; it separately assesses three real threats (heat waves, drought, extreme precipitation),

*3 Direct interpretation of results for municipalities and the option to aggregate data across various administrative units,
*4 Faster data updates - standardised data, accessible (for the Slovak Republic) and partially updated,
*5 The procedure does not rely on “subjective” expert classification of individual factors - impact is assessed statistically,
*6 The result is available in graded categories - making it easier to interpret,
*7 • There is the option to add weights—depending on the perceived or documented importance of certain areas.

The following can be seen as the main drawbacks of the Slovak approach:

1. The indices are expressed only at the level of the entire municipality (the lowest administrative unit) - it is not possible to calculate indices for other types of areas (e.g., landscape units, by land use type),
2. There is no single comprehensive index or metric; only three separate indices for different types of threats.
3. The results cannot be used for spatially localised adaptation measures (for different types of landscapes); only a general assessment of a municipality’s vulnerability and possible measures is possible,
4. Insufficient input data for natural factors (soil, water, vegetation, habitats), which are important in terms of landscape vulnerability.
5. Specific calculation issues regarding certain input layers (e.g., in the Czech Republic, two layers are unavailable: per capita income/municipality, Roma settlements; the methodology for calculating climate data is also partially different).
6. With the data used, certain linear elements - significant for representing green and blue infrastructure in the landscape - are lost (ignored).

A comparison of the differences between lowlands, foothills, and mountainous areas shows that lowlands are particularly critically endangered. A comparison of territories along the state border indicates that the territory of the Czech Republic exhibits higher vulnerability. However, this difference is primarily caused by the differing spatial resolution of certain input data and other factors that affect the overall consistency of the data and their comparability.

Discussion

During the analysis, it became clear that cross-border cooperation is essential for its successful implementation. Together, the participants discussed and expanded their knowledge regarding the availability of individual datasets, licensing rules, and contact points for obtaining data, as well as the significance of individual attributes and a shared understanding of key terms.

When adapting the Slovak approach to national conditions, it was necessary to utilise advanced knowledge of the landscape’s parameters (model inputs) and information on available data relevant to these purposes. On the Czech side, this issue was primarily addressed by researchers from CzechGlobe, who have long specialised in these topics within the quantification of the benefits of individual landscape ecosystem functions, using specific indicators modified with regard to the format and quality of national data.

The data were compared iteratively, first based on an analysis of the metadata of the spatial data used, followed by a direct analysis of data samples (again requiring cross-border coordination, where each partner was able to quickly and efficiently provide the required data samples). The output is a tabular identification of matching and differing datasets/expert knowledge, their interrelationships, and their convertibility.

Conclusion

The results are available both as static maps, which can be downloaded for free from the project website, and, in particular, on the project’s map portal, where users can interactively explore the resulting data layers. Based on these findings, a new, unified methodology for assessing landscape vulnerability was developed and applied during the course of the project.

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Souhrn
Příspěvek představuje výsledky z metodického srovnání národních přístupů k hodnocení zranitelnosti krajiny v České a Slovenské republice. Identifikuje silné a slabé části jednotlivých metodických přístupů, stejně jako dostupnost, a měřítko použitých dat. Základní rozdíly lze spatřit v základní analyzované jednotce (biotop x administrativní jednotka obce) a v prostorovém detailu použitých klimatických dat.
Mezi klíčové vlastnosti ESAI patří: i) jasně kvantifikované výstupy ve čtyřech tematických skupinách a jeden celkový index zranitelnosti krajiny, ii) komplexní přístup k degradaci krajiny, iii) určeno pro analýzu na úrovni biotopů a podrobnou analýzu krajiny, iv) umožňuje posoudit plnění ekosystémových funkcí a služeb, v) součástí je metodika pro navrhování a zacílení opatření ke zmírnění dopadů a adaptaci. Mezi klíčové vlastnosti VHO patří: i) hodnocení zranitelnosti krajiny zahrnuje také dopady na obyvatelstvo (postup lépe zohledňuje sociální aspekty a adaptační schopnosti), ii) Využívají se ověřená klimatická data (CAMS) přesahující státní hranice, která zahrnují klimatické scénáře, iii) jasně definované příčiny zranitelnosti a vztahy mezi vrstvami; samostatně hodnotí tři reálné hrozby (vlny veder, sucho, extrémní srážky), iv) přímá interpretace výsledků pro obce a možnost agregace dat napříč různými správními celky, v) postup se neopírá o „subjektivní“ odbornou klasifikaci jednotlivých faktorů – dopad je posuzován statisticky, vi) existuje možnost přidat váhy – v závislosti na vnímaném nebo zdokumentovaném významu určitých oblastí.

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ATTRACTIVENESS OF FOREST LANDSCAPES UNDER CLOSE-TO-NATURE MANAGEMENT

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Abstract
This study examines how communication framing shapes the attractiveness of forest environments under close-to-nature management. In an experiment with a representative Czech sample, participants evaluated forest scenes under different management regimes with ecological, historical, or no labels. Attractiveness was mainly driven by perceived naturalness and complexity, with only minor differences between management types. Communication framing did not uniformly increase attractiveness but selectively altered interpretation of specific features.

Key words: Environmental perception, non-market forest functions, forest attractiveness, recreational preference, communication framing

Introduction

In recent years, the Czech public has increasingly had the opportunity to encounter the so-called innovative (or experimental) management practices such as coppicing or forest grazing (silvopasture). Once widespread, these practices shaped the structure of lowland broadleaved forests in Central Europe for centuries (Čížek et al., 2016; Slach et al., 2021). In the Czech lands, these traditional practices were gradually abandoned and replaced by intensive forest management characterized by closed canopies and long production cycles. This shift has had negative consequences for species directly associated with open forest ecosystems (Vild et al., 2024). Today, both coppicing and forest grazing are being reintroduced at selected sites to restore habitats for species threatened by the loss of these environments (Kozdasová et al., 2024).

Because these management practices have largely disappeared from public awareness, their acceptance by the public may be problematic. Coppice (or coppice-with-standards), for example, may not fit common expectations regarding forests (Kneifl et al., 2016), and the presence of grazing livestock in forests may evoke concern or fear. Apart from coppicing and silvopasture, we also focus on another close-to-nature management that has potential to evoke negative reactions: deadwood retention.

This study focuses on whether, and how, providing information that emphasizes (a) the ecological function of these practices, especially their role in supporting biodiversity, and (b) their historical and cultural value, may influence public perceptions of these management practices.

Material and methods

To address these questions, we conducted an experimental study involving visual representations of forest environments under specific managements. As a basis for visual stimuli, we used photographs of various locations characterised by the presence of the Pannonian oak-hornbeam forests and Euro-Siberian steppe oak woods vegetation types with a predominance of the pedunculate oak (*Quercus robur*) and the sessile oak (*Quercus petraea*), including Hodonínská dúbrava Natura 2000 – one of the focal sites for both coppice reintroduction and silvopasture.

The visual stimuli were designed in such a way that allowed for single-attribute manipulations. As a baseline image, an open-forest environment was chosen. From this image, the representations of management in question were created by changing a single attribute:

- baseline image + tree density → closed-canopy forest
- baseline image + early coppices → early stage of coppice-with-standards
- baseline image + old polycormones → late stage of coppice-with-standards
- baseline image + sheep → silvopasture
- baseline image + woody debris → forest with deadwood

Multiple rounds of testing were performed during the preparation of the stimulus set in order to ensure the validity of the visual representation and sensitivity of participants to manipulation.

The experiment also involved textual stimuli containing contextual information about the management practices. These texts (henceforth “labels”) were derived and adapted from texts on information signs present at the management sites. Labels were manipulated in terms of the information framing – either the ecological function of the management was emphasized, or its historical value.
Participants were presented with three stimuli: an open forest environment (presented as “thinning” in the label condition), a closed-canopy environment (“standard commercial forest”) and a representation of one of the specific managements: – coppice-with-standards, silvopasture and deadwood management. Additionally, we also included a representation of an old coppice forest (one that the public is more likely to encounter than the young coppices). Together with the images, participants answered a battery of questions related to perceived attributes of the environments. These included perceived naturalness, prospect, complexity, familiarity or stewardship. Overall attractiveness as well as recreational preference were rated on 7-point Likert scale (so were the perceived attributes). Two multi-item identity scales were also measured: environmental identity (based on Clayton et al., 2021) and cultural continuity scale (based on Sani et al., 2007). Experimental conditions differed in the presented forest management and in the presence of labels (ecological, historical or no label).

In this paper, we focus on the effects of visual attributes and labelling (information framing) on attractiveness.

We hypothesize that forest management affects attractiveness indirectly via perceived environmental characteristics, with naturalness, complexity, familiarity, stewardship, and historicity increasing attractiveness (Braun Kohlová et al., 2021; Tveit et al., 2006). Managements are expected to alter these perceptions. Contextual labels are expected to systematically shift perception – ecological labels affecting naturalness and historical labels affecting historicity – thereby influencing attractiveness. These effects are expected to be moderated by environmental and cultural identity, respectively.

Study design and hypotheses were preregistered at [https://osf.io/p63vf]. Data and analytical documentation is available at [https://osf.io/nq3ph].

Data from 2 200 participants were collected (1153 women, 1046 men, 1 undisclosed, mean age 50, age range [18; 86]). The sample was balanced in terms of education, socioeconomic status, region and other sociodemographic variables. Before the final analysis, data from 41 participants were discarded due to suspicious response uniformity.

The relationship between the outcome variables and the mediators was modelled using Bayesian multilevel modelling with the help of the ‘brms’ package (Bürkner, 2017) in R (R Core Team, 2026). Prior distributions were informed by results of the pilot study (regression analysis conducted on a sample of 142 participants).

Results

Attractiveness ratings were generally high across all conditions and showed minor but systematic variation between management types in the no-label condition with the thinning and early coppice having the lowest average rating (5.23 and 5.32) and late coppice and closed-canopy the highest (5.69), showing that participants favoured the less open environments.

Separate models were fit for the conditions with no label, and for ecological and historical labels. Figure 1 below shows the mediation effects of perceived characteristics on the overall attractiveness (without label).

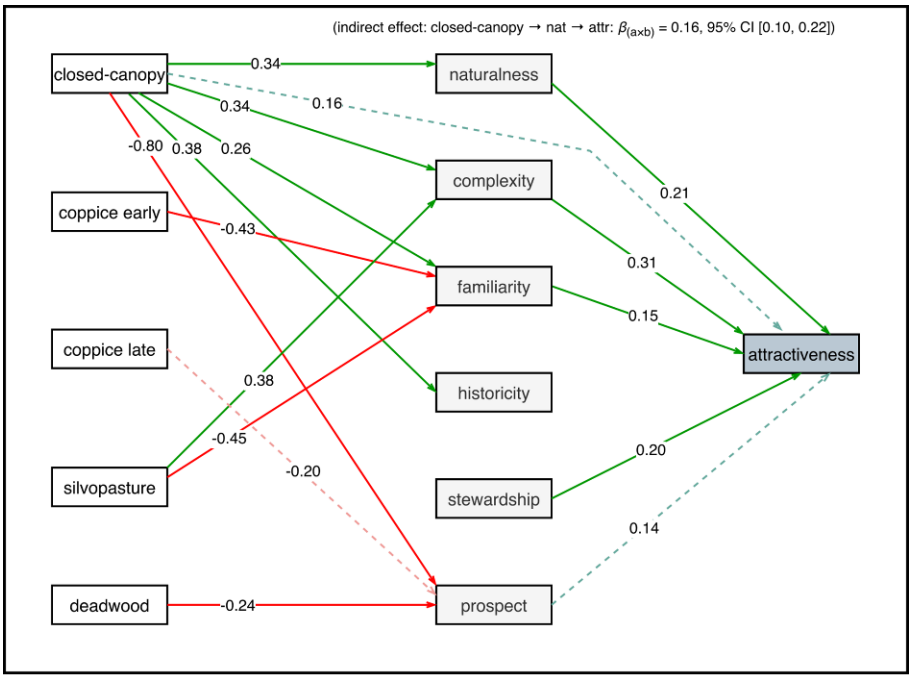

Fig. 1: Path diagram: no-label condition
Lines represent directional paths with standardized coefficients (β). Solid lines indicate effects whose 95% highest density interval (HDI) lies entirely outside the region of practical equivalence (ROPE; [-0.1, 0.1]). Dashed lines indicate effects for which up to 10% of the HDI overlaps the ROPE.

We can see that the higher attractiveness of closed-canopy forest is driven by higher perceived naturalness, complexity, familiarity and even historicity (although this environment represents in fact, the "modern" type of forest). Does this perception pattern change by introducing contextual information?

Figure 2 shows the posterior distributions for naturalness parameters in different management conditions without and with an ecological label.

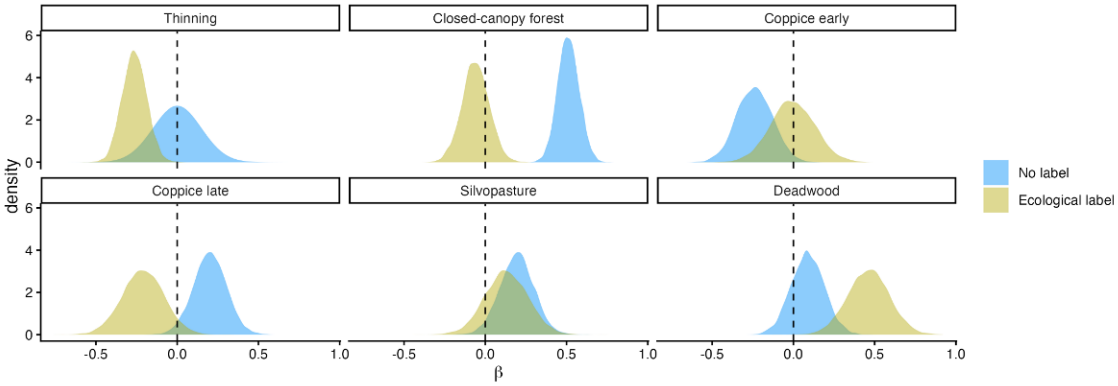

Fig. 2: posterior distributions: management*label → naturalness

The effect of ecological framing is not straightforward. For closed-canopy forest, labelled as management that can negatively affect biodiversity, the label decreases naturalness, although this is not reflected in the total indirect effect on attractiveness (Figure 3). As hypothesized, for deadwood, the effect is opposite and there is an indirect effect on attractiveness. Expected change of naturalness occurs also in early coppice condition, but without a positive effect on attractiveness. The negative impact of ecological framing on thinning is likely related to participants focusing on the "human intervention" side of the label and not necessarily the ecological upsides and thus rating the forest as less natural. Early coppices, on the other hand, are viewed as more natural when ecologically framed, but the overall attractiveness remains low: unfamiliarity might be the major driver here – despite contextualization, coppicing remains a rather alien phenomenon.

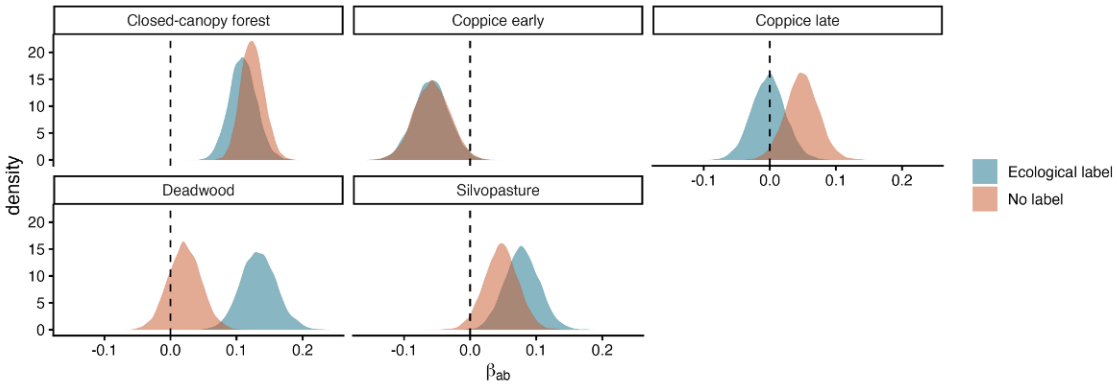

Fig. 3: posterior distributions: indirect effect management*label → naturalness → attractiveness

The mediation effect of perceived historicity on attractiveness was minor and so the boosting by historical labelling did not change the overall perception of the forests. Individual variables, including identity measures, did not considerably affect the overall pattern sketched here.

Discussion

Attractiveness is primarily driven by perceived naturalness and complexity, with additional contributions from stewardship and familiarity, and this structure remains stable across label conditions. Increased tree density (closed-canopy) consistently increases attractiveness through strong indirect effects of these perceptual dimensions, despite reducing visual openness of the scene. Labels do not have a general positive effect on attractiveness but instead selectively modify how specific forest features are interpreted, particularly enhancing the perceived naturalness of ambiguous elements such as woody debris. Further analysis should focus on management-specific effects of labels on other perceived characteristics that affect attractiveness, especially complexity.

Conclusion

We do not delve into detail in this paper, however, the overall picture is more complex, as different perceptual pathways can counterbalance each other and lead to relatively small differences in overall attractiveness. While certain management types influence specific perceived characteristics, these effects do not always translate into clear differences in attractiveness.

It is likely that the Czech public will encounter currently less-familiar forms of forest management more frequently in the future, driven by ongoing changes in forest policy and adaptation of forest management to climate change. Our results suggest that public perceptions of forestry practices are, among other aspects, grounded in how close to nature and how diverse (visually complex) the forests are. Perceptions are stable, but communication can draw attention to certain elements within forest scenes and thereby affect the overall attitude towards close-to-nature managements.

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Souhrn
Tato studie zkoumá, jak lesní hospodaření blízké přírodě ovlivňuje vnímanou atraktivitu a zda kontextové informace (informační cedule) toto vnímání mění. V rámci percepčního experimentu účastníci hodnotili vizuální znázornění lesních prostředí podléhajících různým režimům hospodaření, včetně lesů s uzavřeným porostem, mlácení (v rané a pozdní fázi), lesního pastvinářství a zachování mrtvého dřeva. Podmínky se lišily podle přítomnosti a typu informačních cedulí (ekologické, historické nebo žádné). Atraktivita byla modelována jako výsledek vnímaných environmentálních charakteristik s využitím bayesovských víceúrovňových mediačních modelů.
Napříč podmínkami byla atraktivita primárně ovlivněna vnímanou přirozeností a komplexností, s dodatečným přínosem ze strany známosti a správy. Při absenci štítků byly rozdíly mezi typy hospodaření relativně malé, ačkoli lesy s uzavřeným porostem a pozdní výmladkové lesy byly hodnoceny jako mírně atraktivnější než otevřenější nebo neznámá prostředí. Štítky neměly jednotný vliv na atraktivitu, ale ovlivňovaly vnímání určitých typů hospodaření. Ekologické rámcování zvýšilo vnímanou přirozenost a atraktivitu mrtvého dřeva, zvýšilo přirozenost raného mlázového porostu (aniž by to ovlivnilo celkovou atraktivitu) a zároveň snížilo vnímanou přirozenost lesů s uzavřeným porostem. Historické rámcování mělo celkově omezený vliv.

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BALANCING ECOLOGICAL FUNCTIONALITY AND SAFETY: ASSESSING MIYAWAKI FORESTS IN THE CONTEXT OF RECREATION

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Abstract
The integration of nature into urban environments must carefully balance requirements of public recreation with long-term landscape protection. Recently, the Miyawaki "micro-forest" method has gained immense popularity as a rapid urban greening solution. However, this study critically assesses the functional and ecological realities of such densely planted structures against their promotional narratives. By applying conceptual modeling based on tree biomechanics, we demonstrate that the extreme planting density inherent to the Miyawaki method results in intense competition for light from the juvenile phase onward. This developmental trajectory results in spindly, pole-like tree habits characterized by high height-to-diameter (H/D) ratios, small crowns, and compromised mechanical stability. This structural vulnerability notably increases the risk of stem breakage and windthrow, posing direct safety hazards to park visitors. Consequently, these plantings fail to provide long-term microclimatic benefits - such as effective shading and transpiration cooling - essential for comfortable recreational spaces. Furthermore, their impenetrable, thicket-like structure limits spatial readability and safe accessibility, severely restricting their utility for public recreation. We conclude that while micro-forests offer a short-term visual greening effect, they cannot substitute traditional, thoughtfully spaced group plantings that ensure long-term landscape resilience, functional ecological services, and safe public use.

Key words: dense plantings, height-to-diameter ratio, landscape architecture, tree biomechanics, urban greening

Introduction

The sustainable development of contemporary urban agglomerations necessitates the integration of multifunctional green infrastructure. This often leads to a strong collision between the needs associated with mass public recreation and the long-term goals of landscape protection. In recent years, a rapid greening technology commonly referred to as Miyawaki "micro-forests" has gained immense popularity. This technique aims to rapidly restore degraded urban spaces into thriving ecosystems, yet its broader application remains controversial due to complex spatial, financial, and social dynamics in dense city environments [Qi et al. 2024, 2025; Zeybek 2025]. A thorough semantic and methodological analysis proves that this concept often blurs the rigorous definitional boundaries adopted in landscape ecology and forest sciences. Small, isolated patches of greenery created using the Miyawaki method constitute an experimental dense plantation rather than a fully-fledged, self-regulating forest ecosystem.

The widespread acceptance of this method by city administrations frequently stems from a fundamental temporal error in the planning process: favoring investments that provide a rapid visual effect while ignoring the long biological time required to develop stable tree structures. Nevertheless, recent literature emphasizes the significant social and cultural dimensions of these plantings. Barns et al. [2025] observe that the cultivation of Miyawaki forests can enliven values of human-nature care, functioning as sites of multi-species gathering and environmental stewardship. Similarly, Narraway et al. [2025] emphasize that new, participatory tree planting initiatives can nurture cultural value and build community resilience by strengthening the bonds between people and local landscapes. However, while these social and educational benefits are highly valuable, they must be rigorously weighed against the ecological and biomechanical realities these dense structures impose on the public.

Material and methods

The study was conducted using conceptual modeling based on the synthesis of tree biomechanics, urban forestry literature, and landscape architecture principles. A critical review of peer-reviewed literature concerning the height-to-diameter (H/D) ratio and tree stability under static loads, particularly drawing on the biomechanical mechanisms established by Peltola [2006] and the *Static-Integrated-Assessment* (SIA) method [Sinn & Wessolly 1989], was performed to evaluate the physical resilience of densely planted trees. Furthermore, to assess the impact of such dense structures on pedestrian

safety, the study integrated principles from *Crime Prevention Through Environmental Design* (CPTED) audits, as explored and developed by Cozens et al. [2022]. A comparative matrix was developed to contrast the morphological evolution and structural stability of extremely dense plantings (the Miyawaki method) with traditional, moderately spaced group plantings. Visual and schematic models were created to illustrate the biological versus functional trajectories over a multi-decadal timeline.

Results

Deconstructing the myths of rapid greening evaluating the actual value of dense plantings requires a deconstruction of the promotional promises surrounding the Miyawaki method. The premise of creating "biodiversity oases" is challenged by the fact that rigorous competitive pressure rapidly leads to the dominance of a few aggressive taxa, limiting the formation of multilayered biological diversity. Furthermore, while Schirone et al. [2010] highlight that the Miyawaki method aims to simulate natural processes of ecological succession by densely planting intermediate and late successional species simultaneously, the rapid elongation of the main axis is fundamentally a pathological stress reaction to severe light deficit, not a physiological indicator of ecosystem maturity. Schirone et al. [2025] demonstrate that tiny forests in Italy offer strong pedagogical value and can reconnect people with natural rhythms. However, true bioclimate parameters - such as effective urban cooling and human thermal comfort - depend heavily on specific tree traits, spatial arrangements, and the contrasting interactions between species and sites [Rahman et al. 2020]. These advanced climatic functions cannot be fully replicated by the overcrowded, unventilated structures characteristic of juvenile micro-forests.The critical aspect of evaluating the Miyawaki method in recreational areas remains the rigorous analysis of tree structural mechanics. The planting density of 3 to 7 seedlings per square meter forces immediate, ruthless spatial competition for light. This forced allocation of carbon assimilates results in apical dominance at the expense of necessary *secondary* radial growth and the development of lateral branches. This trajectory produces spindly, pole-like morphological forms with critically impaired statics.

The scientific and engineering indicator used to valorize this phenomenon is the *height-to-diameter* ratio (HDR). According to Sharma et al. [2019], HDR is an important tree and stand stability measure that is significantly affected by stand density, inter-tree spacing, and competition. Stable, free-growing trees are characterized by appropriate trunk taper and a safe, low H/D ratio, ensuring stress distribution to an extensive root system. In contrast, in dense plantings, the H/D ratio reaches critical warning values, and the bending moment generated by aerodynamic loads in the upper parts of vestigial crowns translates into massive stresses in the weakened basal zone [Peltola 2006]. These mechanisms are explicitly contrasted in the comparative matrix [Figure 1], highlighting the differences between the slender, fracture-prone habit in the Miyawaki system and the resilient, balanced crowns of group plantings.

The deficit of extensive, spatial crowns in overcrowded trees results in an extremely low *Leaf Area Index* (LAI) in the upper canopy. This parameter is directly proportional to the tree's capacity for transpiration cooling and shading efficiency, both of which are essential for thermal comfort in pedestrian zones. Moreover, the physical thicket of trunks blocks natural ventilation.

In parallel with climatic dysfunction, micro-forests pose significant challenges for environmental criminology and pedestrian safety. Extremely dense undergrowth forms a solid optical barrier that drastically limits the spatial readability of urban parks. CPTED audits emphasize that natural surveillance and visual clarity are crucial for deterring crime and enhancing perceived safety [Cozens et al. 2022]. The reduction of sightlines and spatial transparency significantly increases the psychological sense of threat. In areas of active pedestrian mobility, the presence of such visual screens can lead to potentially tragic collisions, as research on pedestrian-crossing configurations has shown that restricted visibility is a primary contributing factor to accidents [Gitelman et al. 2017]. This raises questions about the safety of the Miyawaki technique when implemented for recreational purposes near high-traffic paths.

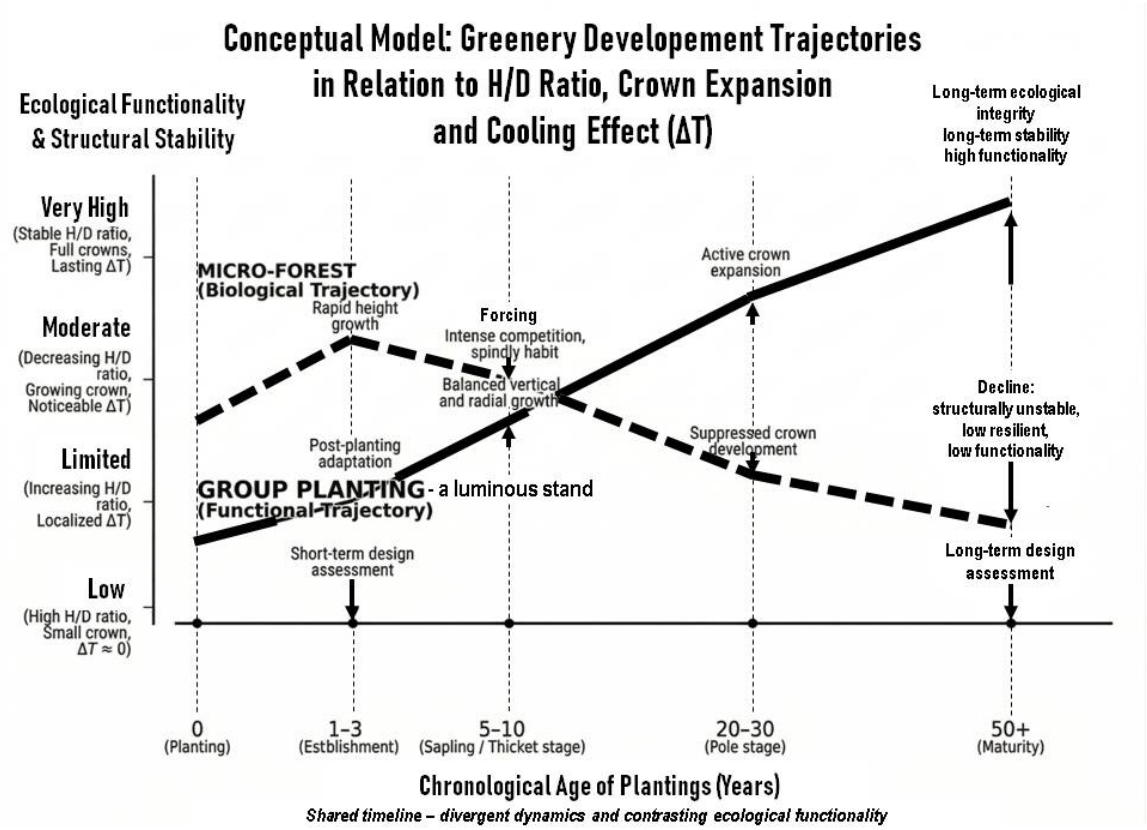

Fig. 1: Comparative matrix contrasting the morphological traits, mechanical stability, and long-term climatic functions of extreme-density Miyawaki micro-forests with moderately spaced group plantings.

Discussion

The widespread adoption of the Miyawaki method often overlooks long-term ecological consequences in favor of short-term biomass accumulation. The evolution of a micro-forest is characterized by an early, rapid growth spike that falsely elevates the project assessment [Schirone et al. 2010]. However, as intraspecific competition escalates, this is followed by a drastic decline in ecological and functional value, as trees with critically high height-to-diameter (H/D) ratios become biomechanically unstable and prone to windthrow [Peltola 2006; Sharma et al. 2019]. Conversely, a traditionally designed park planting matures sustainably, increasing its value. While the technique holds promise for enhancing urban sustainability, its integration into planning policies requires careful consideration of spatial, financial, and social dynamics, as its broader application in diverse urban environments remains controversial [Zeybek 2025].

Professionals note that its feasibility in temperate urban climates is hindered by high tree mortality due to competition and the need for further longitudinal research [Qi et al. 2024]. These authors exploring perceptions among UK landscape professionals, found that, despite support for the method in specific landscapes, major concerns remain regarding high initial costs, maintenance intensity, and the public perception of untamed green spaces [Qi et al. 2025]. Furthermore, the requirement for substantial soil preparation raises concerns regarding cost and feasibility in dense urban environments [Zeybek 2025].

Despite these ecological and financial challenges, the method's popularity is largely driven by its social dimensions. The cultivation of Miyawaki forests enlivens values of human-nature care and functions as a catalyst for community gathering [Barns et al. 2025]. Participatory tree-planting initiatives nurture the cultural value of new urban green spaces, building community resilience and strengthening local bonds [Narraway et al. 2025]. However, this social enthusiasm must be reconciled with environmental criminology; unmanaged, thicket-like green spaces can quickly become perceived safety hazards, requiring ongoing audits to prevent crime and disorder [Cozens et al. 2022]. Ultimately, while the method attempts to bypass the earliest stages of ecological succession and offers strong pedagogical value [Schirone et al. 2025], these findings underscore the necessity of prioritizing functional longevity, mechanical stability, and safe public use over short-term visual impacts in urban forestry.

Conclusion

A synthetic assessment of the Miyawaki method reveals serious limitations for creating safe and ecologically efficient recreational spaces:

- extreme planting density triggers intense light competition, resulting in trees with critically high height-to-diameter (H/D) ratios and compromised biomechanical stability, which significantly elevates the risk of windthrow and stem breakage in public areas;
- despite providing a rapid short-term visual effect, the suppressed crown development in micro-forests severely limits their long-term capacity to deliver essential microclimatic ecosystem services, such as effective transpirational cooling and shading;
- the impenetrable, thicket-like structure of dense plantings restricts spatial readability and natural surveillance; in accordance with Crime Prevention Through Environmental Design (CPTED) principles, this lack of visibility diminishes perceived pedestrian safety and increases collision risks in active recreational zones.

In the conclusion, achieving rational landscape architecture requires a methodical **return to thoughtfully spaced group plantings**, which provide young trees with balanced developmental space, preventing an uncontrolled vegetative race and allowing them to form statically stable trunks and durable crowns.

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Souhrn
Tento článek kriticky hodnotí Miyawakiho metodu „mikrolese“ v kontextu městské rekreace a bezpečnosti. Pomocí koncepčního modelování založeného na biomechanice stromů dokazujeme, že extrémní hustota výsadby vede k intenzivnímu soupeření o světlo, což má za následek vysoký poměr výšky k průměru (H/D) a sníženou strukturální stabilitu. Tyto vytáhlé stromy představují bezpečnostní riziko kvůli zvýšenému nebezpečí vyvrácení větrem a zlomení kmene. Kromě toho hustá, houštinovitá struktura omezuje viditelnost chodců a neposkytuje dostatečné mikroklimatické výhody, jako je stín a ochlazení. Studie dospěla k závěru, že tradiční, rozptýlené skupinové výsadby nabízejí lepší dlouhodobou ekologickou funkčnost, odolnost a veřejnou bezpečnost ve srovnání s krátkodobými vizuálními efekty metody Miyawaki.

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BARRIERS AND SOLUTIONS IN THE PROFESSIONAL INCLUSION OF PEOPLE WITH PHYSICAL DISABILITIES IN BUCHAREST

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Abstract This study aims to examine in detail the real and complex obstacles faced by people with physical disabilities when seeking employment, but also after employment, as well as their daily activities in an organized environment. In order to understand these difficulties from their perspective, the barriers they encounter and which must be overcome must be examined, presenting a realistic picture of the situation. The results should serve as a basis for developing concrete recommendations to employers, public institutions, and decision-makers with the aim of promoting inclusive policies, removing stereotypes, and creating a fair professional landscape for all.The study has four objectives: to classify barriers to recruitment and employment (subjective factors: employer attitudes and fear of discrimination; objective factors: physical accessibility and application procedures), identifying everyday obstacles in the workplace (infrastructural and technological accessibility, social dynamics), correlating and systematizing the solutions proposed by people with disabilities, and effectively disseminating the findings to facilitate the implementation of change. The methodology is qualitative, based on structured technological interviews with open-ended questions. The data will be analyzed through synthesis to encourage participants to share their personal experiences and propose detailed suggestions.

Key words: specific barriers, employment, disabilities, physical accessibility, equity, inclusive policies

Introduction

The purpose of this study is to highlight the employment experiences of people with physical disabilities and the barriers they face in integrating into the labor market, as well as to promote solutions proposed by community members themselves (Daniel et al., 2025; Nevala et al, 1014). Disability is a complex phenomenon, shaped by the social environment, which any person may acquire during their lifetime (Kehayia et al., 2014; Kim et al., 2020). Disabilities can be sensory, motor, intellectual (communication and learning deficits), and mental (impairment of cognitive functions). (National Authority for the Rights of Persons with Disabilities, 2023). Under national and international law, people with disabilities have the following recognized rights: equality before the law; the guarantee of adequate living conditions that ensure their independence; equal access to education; access to high-quality health services; equal participation in social life; and the right to work based on competence in order to achieve financial independence. (Ministry of Investments and European Projects, 2020). There are international legal institutions that defend the rights of people with disabilities, including the UN General Assembly and the Council of Europe. As a member of these organizations, Romania adheres to the aforementioned policies. In 1990, the State Secretariat for People with Disabilities was established. The Romanian Constitution dedicates a separate article to people with disabilities. In 1992, Law No. 53 on the special protection of persons with disabilities and Law No. 57 on the employment of persons with disabilities were enacted. An important milestone was marked by the entry into force of the National Strategy for the Protection, Integration, and Social Inclusion of Persons with Disabilities for 2006–2013 and Law No. 448/2006 on the Protection and Promotion of the Rights of Persons with Disabilities. At the national level, the National Strategy on the Rights of Persons with Disabilities 2022–2027 was approved on April 15, 2022. The strategy implements the provisions of the UN Convention and aims to ensure their enforcement. (National Authority for the Rights of Persons with Disabilities, 2023). At the local level, Bucharest develops local policies based on national strategies through specific documents: the Strategy for the Development of Social Services in the Municipality of Bucharest 2023–2030; the Annual Action Plan of the DGASMB; and the National Strategy “A Fair Romania” 2022–2027.

Methodology

In conducting this study, we employed a mixed-methods approach, specifically using interviews and visual analysis (represented through word clouds). Through structured interviews, we collected information regarding the job search experience, the difficulties encountered, and the aspirations of people with disabilities, identifying common issues by disability category as well as those faced by

employers. Respondents were contacted via online platforms such as Zoom and Teams, with the help of social media, associations, and NGOs. Following the interviews, certain keywords representative of the experiences of people with disabilities in the workplace and during job interviews were selected from interactions with coworkers and employers. These discussions with respondents helped shed light on the barriers they face in their professional lives and when choosing a job, and the way employers behave (whether they value their qualities and skills without regard to disability, or discriminate against them by refusing to hire them out of fear of reduced productivity and additional costs) can determine whether people with disabilities are hired or not.

Results and Discussion

Enablers and Barriers to the Entry of People with Disabilities into the Labor Market

In Romania, employment for people with disabilities is a priority. In reality, however, they face a number of barriers to employment, resulting in an employment rate for people with disabilities that is much lower than that of the general population. The right to a job is very important for the lives of people with disabilities; it is essential that the job be freely chosen and reflect their training and personal skills. The main factor influencing their employment is education. The educational system in Romania creates a number of disadvantages due to the number of children who are not enrolled in school or who drop out early, especially in rural areas.

A frequently cited reason why they cannot secure a job is health issues, such as the need for sick leave or time off to visit the hospital, as well as tardiness or absences. Their qualifications often differ from the official requirements of certain jobs. Employment provides people with disabilities with financial independence, helping them improve their quality of life, achieve social inclusion, and gain professional recognition. In addition to personal financial benefits, participation in economic activities contributes to increased public revenue. Other significant barriers to the professional inclusion of people with disabilities include deficiencies in transportation infrastructure, which affect their physical mobility to the workplace, the absence or limitation of workplace accommodations, and attitudinal barriers from coworkers. The process of guiding people with disabilities toward the labor market reveals a disconnect between their professional profiles and market demands, due to the disregard of individual skills and aspirations. It is necessary to develop specialized career guidance programs based on a unified methodology for assessing individual competencies, with this task being handled by multiple agencies, departments, and ministries.

The process for people with disabilities to find employment

To find employment, people with disabilities should contact an employment agency. The focus is on enabling people with disabilities to be active in society and in the workplace, with the goal of ensuring they are not excluded from society but rather encouraged to participate in economic and social life. At the same time, society helps them build self-esteem, reduce dependence, maintain good health, enjoy a longer life expectancy, and foster social relationships (Lindsay et al., 2021). The law on the protection and promotion of their rights recognizes the right to work and earn an income in accordance with labor legislation and to create all the necessary conditions for them to choose and practice their profession. Any person with a disability who is employed is an asset to society and to the community to which they belong. A person with a disability can hold any type of job if they are in the right environment, where they can be productive. Employment opportunities are generally identified through job postings or through NGOs, a suitable example being Motivation Romania. However, the information process faces obstacles, as the posted announcements lack clarity and appeal. There is also an inconsistency between the initial requirements and the duties ultimately assigned, compounded by an omission of employee benefits and perks. These challenges are compounded by a lack of accommodations for people with disabilities and the emergence of forms of discrimination. To promote employment opportunities in the public and private sectors, institutions with at least 50 employees must hire a number of people with disabilities representing at least 4% of the total workforce. Employers who fail to meet the employment quota have two compensatory options: paying a monthly amount equal to 50% of the national minimum gross base salary multiplied by the number of unfilled positions for people with disabilities, or directing these funds toward the purchase of products or services from authorized entities where people with disabilities are employed. The state facilitates the integration of people with disabilities through various tax and financial incentives for employers, including the deductibility of expenses when calculating taxable income, subsidies for the costs of workplace adaptations, and the purchase of assistive equipment or accessibility technologies (Cun, 2014). In the case of home-based work, the costs of transporting raw materials and finished products from the workplace to the home and vice versa are covered. (Law No. 448 of December 6,

2006) Employers receive financial assistance for training and career guidance programs to retain human capital in the labor market.

Employment of people with physical disabilities in the labor market

Fig.1: Initial Professional Context

Fig. 2: The Hiring Process and Initial Perceptions

In the first section of the interview, based on the responses collected, the interviewed people with disabilities who had higher education obtained their first job between the ages of 18 and 30. Most respondents mentioned that their preferred fields were jewelry making, crafts, and unique arts within the industry, as well as IT and front-office roles (fig. 1 and fig. 2). Additionally, most found these job opportunities through online job postings or newspaper ads.

In the second section of the interviews, respondents mentioned that discussions about their disability are avoided; instead, they are asked about their skills—specifically, that they are expected to be focused, concentrated, serious, and dedicated to their work. Most said they have an accessible workplace, which usually refers to their workstation and the technologies used for work.

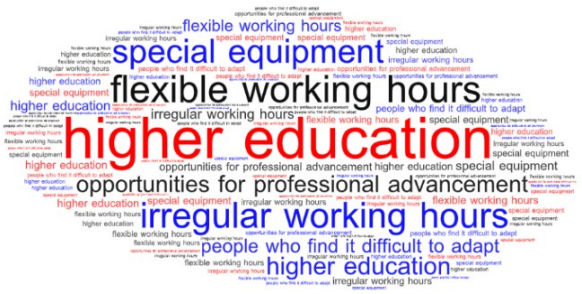

Fig 3: Work Experience and Adaptation

Fig. 4: Obstacles and Solutions

In the third section (fig. 3), most respondents with a college education adapt easily, depending on their job, and have opportunities for career advancement; they are satisfied with their work schedule as well as with the equipment at their workplace. However, there are also people who have a harder time adapting, requiring special equipment and a somewhat flexible schedule.

In the fourth section, most respondents said they prefer physical obstacles, which they often find easier than those involving people (fig. 4). They also need support in the form of: the possibility of a flexible schedule, a potential health insurance plan, or simply through communication, understanding, and teamwork from their coworkers.

Fig. 5: Opinions and Recommendations

In the fifth section (fig. 5), the interviewees primarily request attention, acceptance, and patience in the workplace, financial incentives and tax exemptions, the creation of more jobs, reimbursement for other types of transportation in special cases, on-the-job training, and monitoring of professional performance.

Conclusions

Expectations in the workplace refer to the roles that people with disabilities consider realistic. They often face challenges related to these expectations, managing their condition, self-advocacy, and support. On a social level, people with disabilities face challenges related to workplace accessibility, transportation, and stigma, and are concerned about employers' lack of trust, lower wages, and physical access to the workplace. The communities they belong to must demonstrate greater understanding, better communication, and a spirit of teamwork. Job postings need to meet certain standards so that they become more transparent and explicitly include principles of equity. In this regard, there should be a rigorous alignment of requirements related to physical abilities with job duties, avoiding unjustified selection barriers. At the same time, the role of educational institutions in providing tailored vocational training must be strengthened. Greater attention to people with disabilities would facilitate an effective transition from school to the labor market, ensuring their inclusion in society.

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Souhrn

Článek se zabývá náročným procesem přijímání osob se zdravotním postižením do zaměstnání. Popisuje průběh tohoto procesu a míru jeho přístupnosti, stejně jako řešení navrhovaná některými osobami se zdravotním postižením a určitými nevládními organizacemi s cílem usnadnit těmto lidem přístup k zaměstnání, a tím i k normálnímu životu. Tyto iniciativy se neustále vyvíjejí a podporují integraci těchto osob do dnešní společnosti.

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CAN WE ANTICIPATE WHAT CLIMATE CHANGE DOES TO THE RECREATIONAL POTENTIAL OF THE LANDSCAPE?

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Abstract
One of the most important factors that condition recreational potential of the landscape is landcover. At the same time, the existence of landcover types is heavily impacted by climatic conditions. In this article, we try to find links between landcover type changes in the future and their expected effect on recreational potential. Current landcover types are taken over from the CORINE inventory and predicted future climate date was purchased from the Czech Hydrometeorological Institute. The study Is performed in an upland experimental catchment representing similar areas in the Czech Republic. By analysing water requirements of landcover types via their potential evapotranspiration and available precipitation we conclude their current status quo and sustainability. Using predicted future climatic data, we track the increasing water requirements to the tipping point towards negative water balance. This indicates the need for change in landcover. There we arrive at a new sustainable status quo and discuss the associated changes in recreational potential between the two points in time.

Key words: Corine landcover, climate modelling, water balance, tipping point

Introduction

Climate change is one of the driving environmental factors in land cover change and both are intricately connected. In the conditions of Central Europe, forest ecosystems are the most affected (Cherubini et al., 2018). Forests meanwhile do not only produce wood and other non-wood products, but they are also responsible for several important ecological functions, notably recreational activities, and the psychic health of the population. Increasing temperatures, changes in precipitation patterns, and more extreme climatic events lead to decreasing forest stability. Under these conditions, their ability to fulfil their expected ecological and recreational roles is limited.

In this paper, we analyse water requirements of current landcover types via their crop coefficients, potential evapotranspiration (Allen et al., 1998) and available precipitation. Using predicted future climatic data, we track the increasing water requirements to the tipping point towards negative water balance. This indicates the need for change in landcover. There we arrive at a new sustainable status quo and discuss the associated changes in recreational potential between the two points in time. The climatic data were obtained from the Czech Hydrometeorological Institute, and they are an experimental combination of their global and local models which should be well suited to predict future local climate including the expected hydroclimatic extremes associated with climate change. The modelling exercise in this case is burdened with a lot of uncertainty being based on climatic models and evapotranspiration models with no real-world verification possible. Therefore, the results are not analysed using extensive statistical methods, rather a simple linear trend is used as an indication of expected changes. This paper aims to simply start a conversation of possible future scenarios using unique beyond state-of-the-art climate predictions.

Material and methods

The material for this experiment was the Nová Říše catchment (Figure 1.). It is the headwater catchment of the Řečice river located north of the Nová Říše reservoir and the streamflow in its discharge outlet is monitored by CHMI since 1980. The catchment is mainly covered by forest, almost 70 percent of total area which is 16,8 km^2 (Table 1) and is found in mean altitude of around 600 m a.s.l. Its soils consist mostly of the B hydrological category of soils (Janeček et al., 2012) and steep slopes represent more than 20% of total catchment area. These conditions can be described as indicative of a typical upland region. This catchment is used as a representative of other similar location in the CR.

Tab. 1: Basic hydrogeographic characteristics of the Nová Říše experimental catchment

Experimental Catchment Nová říše	
Catchment area	16,8 km^2
Mean altitude	602 m a.s.l.
Slope	Percentage of total area
Less than 10 %	78.45
More than 10 %	21.55
Hydrological cathegory of soils	Percentage of total area
B	85
C	15
Landcover cathegory	Percentage of total area
2.1.1. Arable land	17.83
2.3.1. Meadows	4.99
2.4.3. Arable land with vegetation	4.33
3.1.2. Coniferous forest	63.85
3.1.3. Mixed forest	4.15
3.2.4. Shrubs	4.85

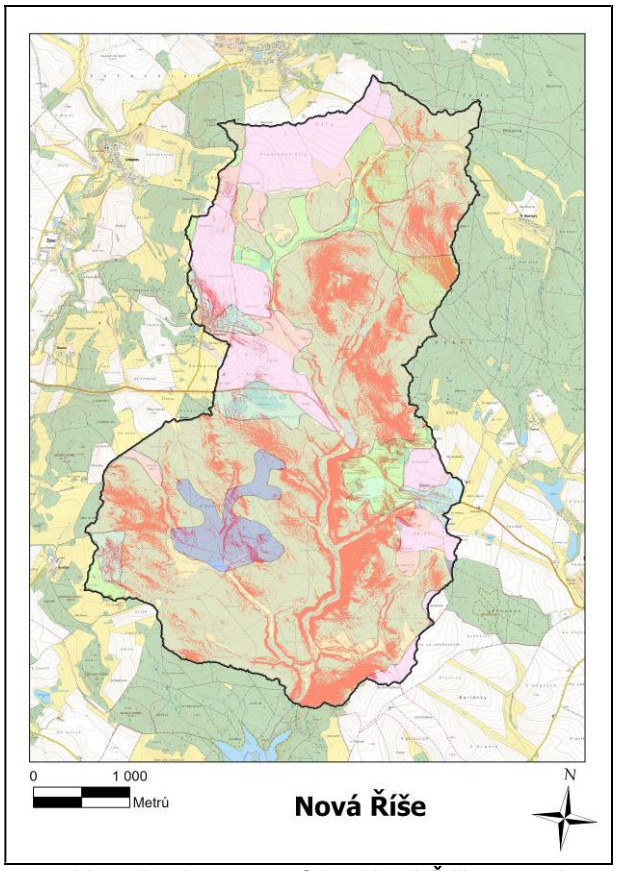

Fig. 1: Situation and localisation map of the Nová Říše experimental catchment

Our goal was to rely on maximum simplification and the use of freely accessible data from public specialized databases, we mainly used the following:
1. Research Institute for Soil Monitoring and Protection, v. v. i. (https://mapy.vumop.cz/mapa.php) – a large amount of information on soils in the Czech Republic is available here. For the purposes of the

project, we primarily used hydrological soil groups as an indicator of infiltration rate relevant for the realistic representation of water behaviour in the soil environment.
2. CORINE Land Cover mapping (https://landcover.cenia.cz/corine-land-cover/) – this is a pan-European mapping initiative in which the landscape is divided into specific land cover classes. Currently, data from 2018 is available. The land cover categories allow us to easily determine land use within the watershed. Individual categories may exhibit specific behaviours in relation to the water balance and evapotranspiration.
3. Czech Office for Surveying, Mapping and Cadastre (ČUZK) (https://geoportal.cuzk.cz/) – orthophotos and a digital terrain and relief model (DMR) are available here, which was used to determine basic slope and aspect ratios.

Climatic data

We obtained a set of experimental climate data (daily precipitation and temperature) from the Czech Hydrometeorological institute (CHMI) based on their Aladin climate projection model. The data are localised for the area of the catchment and represents a very long period 2015 – 2100. We used two different scenarios: RCP 4.5 and 8.5. to simulate an optimistic (4_5) and a realistic (8_5) climate scenario to allow better interpretation of the results.

Evapotranspiration

We used the climatic data to run a simulation of potential evapotranspiration development in the catchment area. We used the FAO56 paper guidelines to calculate it (Allen et al., 1998). We used the CORINE landcover categories and their respective crop coefficients to calculate actual evapotranspiration for each day (Nistor et al., 2018). From these daily values we than calculated yearly amounts.

Results

Here we present the results of climatic analyses of changing evapotranspiration and overall water balance in an upland experimental catchment until the and of the 21st century.

For the optimistic RCP 4,5 scenario, the changes in the water balance are not too profound (Figure 2.). The analyses of the linear trends indicate that temperature is steadily rising by 0,02 °C each year with ca 42 % accuracy, which is similar to evapotranspiration which also increases by 0,48 mm per year and 44 % accuracy. This increase in evapotranspiration seems to be off set by slightly increasing precipitation. The potential tipping seems to occur at around 2060 when the increase in temperature and evapotranspiration both seem to accelerate. It is likely that for the upcoming 20-40 years (2020s-2060s), the landscape should remain stable as is with no drastic changes in land cover. After 2060s however, it is likely that large scale changes in land cover will be needed.

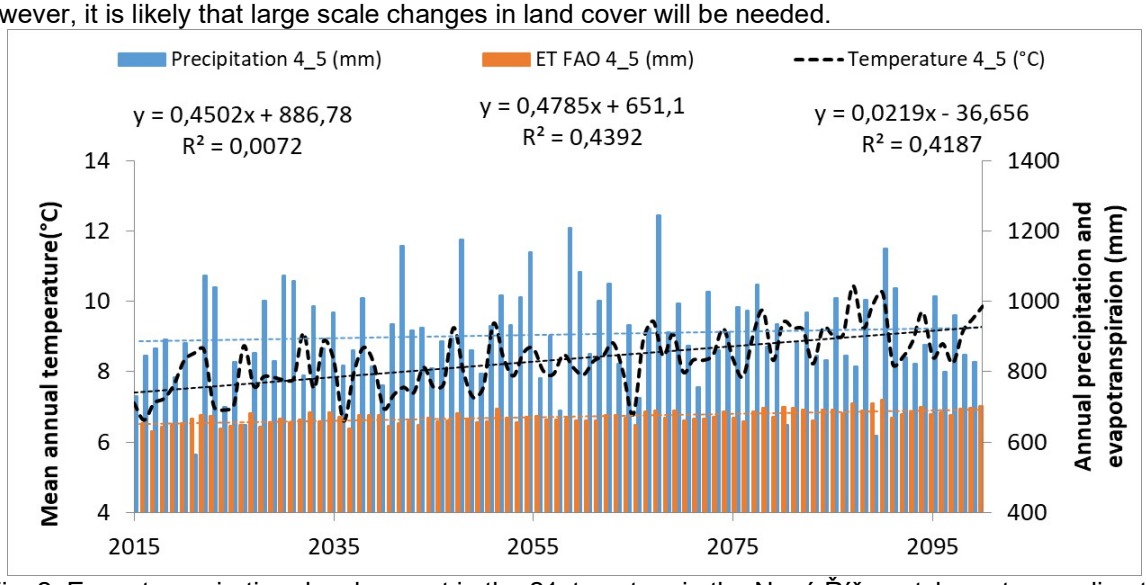

Fig. 2: Evapotranspiration development in the 21st century in the Nová Říše catchment according to the RCP 4,5 scenario

For the more realistic RCP 8,5 scenario, the changes in the water balance are more profound and occur significantly faster. The analyses of the linear trends indicate that temperature will be steadily rising by 0,05 °C each year with ca 68 % accuracy, which is again similar to evapotranspiration which will increase by 1,1 mm per year and 66 % accuracy. The potential tipping seems to occur already at around 2050 when the increase in temperature and evapotranspiration both seem to accelerate. It is therefore likely that already after the next 20-25, large scale changes in land cover will be needed. By

the end of the century (2080) the evapotranspiration demands start to be so high that even the slightly increasing precipitation does not fully cover them. This indicates extensive changes in the landscape and a shift of climax vegetation from forest towards steppes.

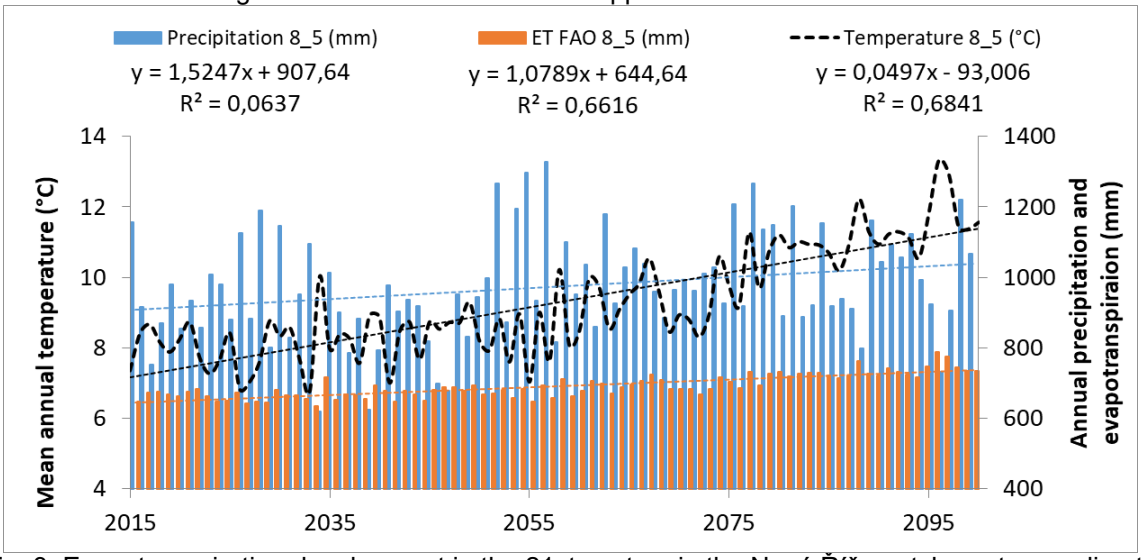

Fig. 3: Evapotranspiration development in the 21st century in the Nová Říše catchment according to the RCP 8,5 scenario

Discussion

Using the analysis of climatic projections, we were able to look into the future of the landscape and landcover types in the experimental catchment. We were able to identify tipping points when the evapotranspiration demands the current landcover types will be simply too high to sustain. According to which climate scenarios was used, already in the 2040s or 2050s the first tipping point could be reached. It is likely that the coniferous forests now covering more than 60 % of the catchment area will be very drought stressed and most of it will have to be replaced by some other form of landcover type (most likely different type of forest with less evapotranspiration demands and better drought resistance). At the same time, the arable land now covering more than 20 % will be in need of ever-increasing irrigation for sustenance. In the realistic RCP 8,5 scenario another tipping point was identified occurring in the 2080s when the very existence of forest cover seems questionable. It is likely that during this time, the forest as we know them will be very hard to keep alive and manage. A large-scale change from forest to steppe landscape cover can be expected.

It is important to understand that the recreational potential of forests and steppes can be significantly different. Forest ecosystems offer increased shading, more pleasant microclimate, aesthetic pleasure and greater feeling of cover and safety, which all support a range of recreational activities and psychic regeneration. On the contrary, steppes offer an open landscape with long views and specific biological richness, however due to higher exposition to sunlight, extreme heats, fierce winds, and limited shelter opportunities, their recreational potential is lower, or more seasonally dependent. Notably, large-scale deforestation to steppes in these latitudes can cause significant changes in other environmental benefits, notably: warming of regional climate up to +1°C in the summer months (Cherubini et al., 2018); the loss of microrelief supporting soil water recharge (Juřička et al., 2022); and the loss of stemflow supporting hotspots of infiltration (Hemr et al., 2023). All these secondary effects can play a role in further accelerating the negative climate changes. The difference in the recreational function of these ecosystems therefore lies not only in their physical characteristics, but also in visitors' preferences and specific environmental conditions. While forests are perceived as more versatile and comfortable for recreation, steppes represent a more specific type of landscape suited to less demanding or specialized forms of leisure activities.

Conclusion

Using unique beyond state-of-the-art climate predictions of local climate, we performed an analysis of actual evapotranspiration demands of current landcover types in an experimental catchment. We used freely available geographical data and standard FAO procedures to offer the most potential reusability of our approach. We were able to identify two tipping points when the evapotranspiration demands the current landcover types will be simply too high to sustain which will lead to largescale changes in land cover. We expect the move from forest climax towards steppes. These changes will have a profound effect on recreational potential since both ecosystem types are significantly different in what they offer

the population in case of recreational activities. Most notably we expect a loss in the psychological health and regeneration which is uniquely attributed mostly towards forest ecosystems.

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Souhrn

S využitím jedinečných klimatických předpovědí místního klimatu, které přesahují současný stav techniky, jsme provedli analýzu skutečných požadavků na evapotranspiraci u stávajících typů povrchového pokryvu v experimentálním povodí. Využili jsme volně dostupné geografické údaje a standardní postupy FAO, abychom zajistili co největší potenciál pro opětovné použití našeho přístupu. Podařilo se nám identifikovat dva bod zlomu, kdy budou požadavky na evapotranspiraci u stávajících typů povrchového pokryvu prostě příliš vysoké na to, aby je bylo možné udržet. V závislosti na použitých klimatických scénářích by prvního bodu zlomu mohlo být dosaženo již v 40. nebo 50. letech 21. století. V realistickém scénáři RCP 8,5 byl identifikován další bod zlomu, k němuž dojde v 80. letech 21. století, kdy se samotná existence lesního porostu jeví jako nejistá. Lze očekávat rozsáhlou změnu krajinného pokryvu z lesního na stepní.

Očekáváme přechod od zralého lesního porostu ke stepi. Je důležité si uvědomit, že rekreační potenciál lesů a stepí se může výrazně lišit. Lesní ekosystémy nabízejí větší stín, příjemnější mikroklima, estetický zážitek a větší pocit úkrytu a bezpečí, což vše podporuje celou řadu rekreačních aktivit a psychickou regeneraci. Naopak stepi nabízejí otevřenou krajinu s dalekými výhledy a specifickým biologickým bohatstvím, avšak kvůli vyšší expozici slunečnímu záření, extrémním vedrům, prudkým větrům a omezeným možnostem úkrytu je jejich rekreační potenciál nižší, resp. více závislý na ročním období. Rozdíl v rekreační funkci těchto ekosystémů tedy nespočívá pouze v jejich fyzikálních vlastnostech, ale také v preferencích návštěvníků a specifických podmínkách prostředí. Zejména očekáváme ztrátu v oblasti psychického zdraví a regenerace, která je jedinečným způsobem připisována především lesním ekosystémům.

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CASTLE RUINS AS SITES WHERE GEODIVERSITY AND CULTURE MEET: A CASE STUDY OF JANŠTEJN (CZECHIA)

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Abstract
Geocultural sites are perceived as sites where links between geodiversity and culture are particularly strong and interconnected. They may be represented by quarries, anthropogenic landforms, and historical buildings or constructions. Thanks to their values, geocultural sites possess an important potential for geotourism and geoeducation, but at the same time, they may become endangered by threats such as natural degradation, vegetation overgrowth, overtourism, inappropriate use, or indifference to their values. This contribution introduces a case study of Janštejn castle ruins situated in Jihlavské vrchy Highland (Czechia). The area represents a typical granitic landscape with the occurrence of rock walls, tors, frost cliffs and blocky accumulations. The ruins of Janštejn castle are situated on the rocky elevation formed by the Moldanubian granite. The construction of the castle dates back to the 14th Century, and it significantly affected the surroundings due to the extraction of local material and anthropogenic transformation of the relief. The site has been described in terms of geomorphological processes and landforms, mapped by the use of 3D laser scanning, and assessed by geomorphosite concept. Based on the SWOT analysis, threats and opportunities were identified, and possible management measures, proposals for further sustainable use, and research directions were designed.

Key words: geocultural site, geomorphosite, geomorphological mapping, cultural heritage, granitic landscape

Introduction

Geocultural sites are defined as locations where geological features interact with cultural elements, such as historical, archaeological, or religious structures, so that geoheritage and cultural values are jointly expressed (Reynard and Giusti, 2018, Bollati et al., 2023). Generally, geocultural sites possess an important potential for geotourism and geoeducation, but at the same time, they may become endangered by numerous threats (degradation, vegetation overgrowth, overtourism, inappropriate use).

Castle ruins may be considered geocultural sites par excellence as the interplay of geomorphological settings and architectonical aspect is highly relevant there. Usually, they are situated on distinctive landforms, which are closely related to and influence the proper construction of castle or its architectonical disposition. These landforms are very often important from geoheritage point of view (e.g., outcrops, rocky promontories, frost cliffs, tors) and moreover, they may be modified by anthropogenic activity that resulted from the requirements in the period of construction (e.g. formation of defence walls, ramparts or ditches, extracting local stone as a resource for construction, re-arrangement or removal of the blocks and debris from natural accumulations etc.). Castle ruins are also important regarding the use of natural stone and local material. Logically, the castle ruins are also important from archaeological point of view. At last but not least, castle ruins serve as inspiration for artists and their geomythological relevance is also very high, representing an important part of local identity and folklore. All these aspects increase not only cultural, but also natural heritage values of the site, they are closely connected and thus, represent an important resource for geoeducation, geotourism and recreation.

The interconnection between human activities and landscape diversity is particularly evident in areas that have been settled for a long time with suitable bedrock and other natural resources, which allowed a wide range of uses in human activities. In our context, these specific areas include territories formed by granite rocks, which are characterized by distinctive rock micro- and mesoforms. Within the framework of the geological memory of the landscape, it may be referred to a granite landscape (Migoń, 2006).

This contribution presents an example of Janštejn castle ruins. This geocultural site has been described in terms of geomorphological processes and landforms (including the use of advanced visualisation methods), and evaluated by using the geomorphosite concept. Based on the SWOT

analysis, threats and opportunities were identified as a starting point for the further research and activities oriented towards the sustainable geotourist and geoeducational use.

Methods

The basis for this study is a review of existing literature (Tabuer, 1987 and Czech Geological Survey, 2026 for regional settings, Migoń, 2006 for granitic landscape frameworks, Natural Monument Institute, 2026 for historical aspects) and a detailed geomorphological mapping and field work. The visualisation of the castle structure and its surroundings was geodetically surveyed using 3D terrestrial laser scanning (Leica ScanStation C10) connected to the Global Navigation Satellite System (GNSS) (Leica Viva NetRover GS08 receiver connected to the network of permanent GNSS stations of the Czech Republic, CZEPOS, in RTK (real-time kinematics) mode). All this served as a basis for the assessment of the heritage values and SWOT analysis.

Results

The site of interest is located approximately 21 km southwest of Jihlava (Vysočina Region, Czechia), 1.2 km SW of Nová Ves (Figure 1). A rocky outcrop with castle ruins rises from the western slope of a flat ridge at elevations of 694–702 m near the 723.5 m elevation point “U hradu”.

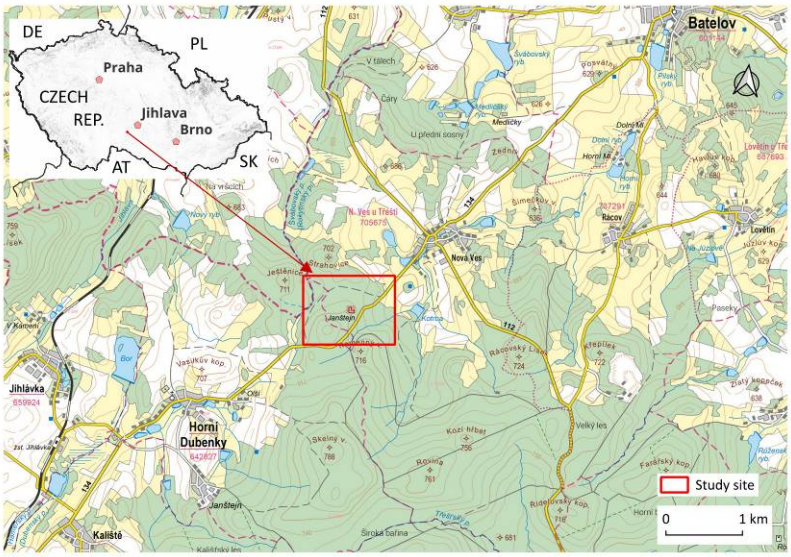

Fig. 1: Situation map displaying the position of the study site within Czechia. (Data sources: Base topographic map ČR 1 : 50 000, Czech Office for Surveying, Mapping and Cadastre).

The bedrock of the study area consists of granular biotite granite (Mrákotín type) from the Moldanubian Plutonic Complex (Czech Geological Survey, 2026). Geomorphologically, the area is characterized by a diversity of landforms that have been formed by a range of geomorphological agents and processes. Thus, the relief may be considered as polygenetical (Kirchner et al., 2025). The following morphogenetic landforms may be identified: 1) Structural-denudational, especially structurally-denudational rock wall (a remnant of a more extensive formation, constituting a rocky elevation that arose after the removal of tropical weathering deposits from the basal weathering surface), and boulder accumulations (remnants of a weathering mantle), 2) Cryogenic (frost cliffs, cryoplanation terrace, cryoplanation plateau, debris accumulations), 3) Gravitational (weathered and lose rock faces, niches, resulting in the formation of debris), 4) Anthropogenic, especially historical settlement features and military defensive structures (embankments, moats or ramparts), modifications of natural outcrops and block accumulations during the construction of the castle. Figure 2 displays the typical cryogenic landform and main cultural aspect of the site (the ruin of tower of Janštejn castle). The longitudinal section (created by use of Laser Scanner) is displayed on Figure 3.

Fig. 2: Frost cliffs affected by weathering (left), Janštějn castle ruins (right). Photo: authors.

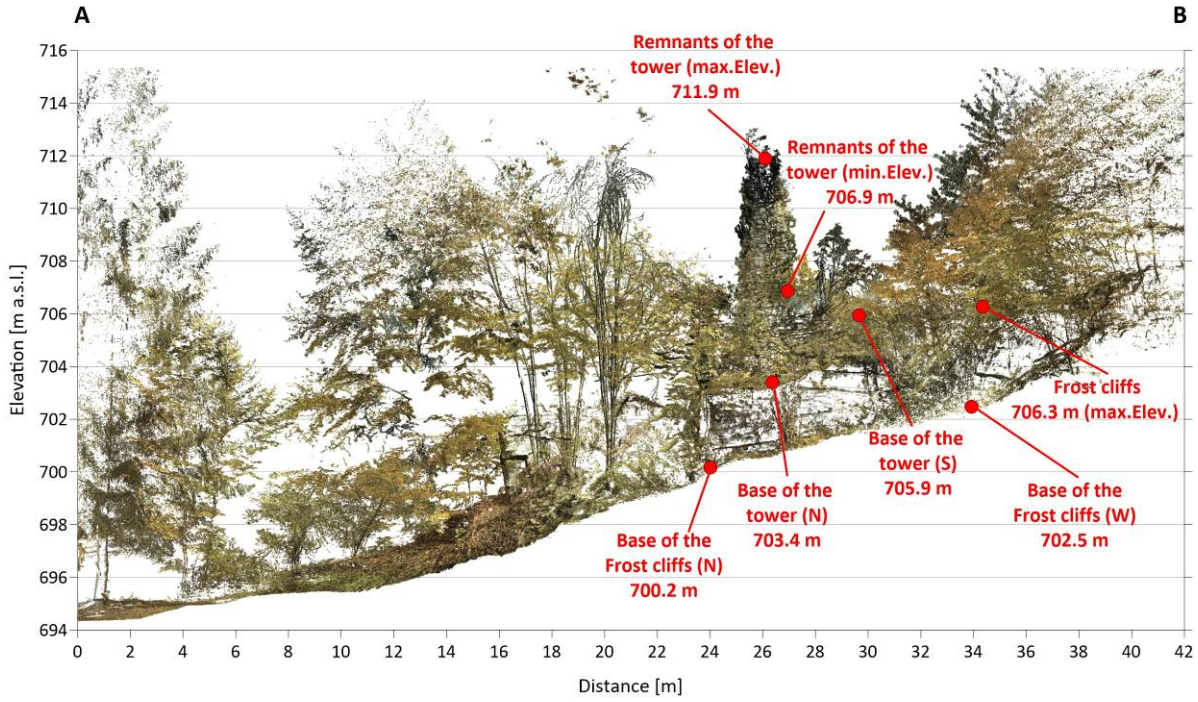

Fig. 3: Longitudinal section (AB) of the frost cliffs with remnants of Tower S–J (azimuth 178.8°W)

In order of identifying and documenting the key heritage values, a “geomorphosites” approach was used. The assessment of geocultural sites is based on the cultural landscape approach (Reynard and Giusti, 2025), it reflect the geoheritage and cultural heritage links (Pijet-Migoń and Migoń, 2022), and the geosite assessment criteria (Brilha, 2016). It is accompanied by SWOT analysis. A brief evaluation of particular heritage values follows: 1) Representativeness: the main landforms represent typical features resulting from the long-term geomorphological evolution (granitic landscapes, cryogenic processes), 2) Integrity: The rock wall has been modified by cryogenic and anthropogenic processes, so its state of preservation is more or less average. The cryogenic landforms can be considered well-preserved, 3) Interpretative value: The site shows the typical phenomena of granitic landforms, although the visibility is limited and the landforms are remodelled, so the interpretative value is average. Cryogenic and anthropogenic landforms are considered typical examples, their pedagogical and interpretative value is very high, 4) Paleogeographical importance: The geomorphological processes and phenomena reflect the long-term geomorphological evolution of the wider region (the formation of a levelled surface during the Paleogene, cryogenic processes associated with cold periods in the Quaternary), the paleogeographic importance is high, 5) Aesthetic value: The site appears to be somewhat hidden and does not stand out prominently in the landscape. However, the

spatial structure is interesting, with rock outcrops alternating with remnants of old masonry, complemented by anthropogenic landforms. Aesthetically, the site can be considered “picturesque,” but it is not particularly unique, 6) Cultural value: The castle ruins hold the status of Cultural Monument with archaeological and historical importance. The cultural value quite high, not only thanks to the presence of ruins, but also thanks to the presence of anthropogenic landforms, or the use of local rock material as building stone.
Based on the detailed fieldwork and heritage values assessment, the SWOT analysis was elaborated, including the identification of threats and opportunities of a rational use of the geocultural site (Table 1).

Tab. 1: SWOT analysis of Janšejn geocultural site

Strenghts	**Weaknesses**
- The geo-phenomena (especially cryogenic landforms) are representative, clearly visible, and easily recognizable - The site is of high cultural (archaeological and historical) significance - A close relationship between geoscientific and cultural values	- The site is not a unique or exceptional (within the broader region) - There is a lack of information on the biota and its relationship to geodiversity features - Due to the reshaping of the relief by cryogenic processes, older landforms (typical of granite landscapes) are less easily recognizable
Opportunities	**Threats**
- Leveraging the close connections between geoscientific and cultural values for multi- and transdisciplinary education (Earth sciences, history…) - The development of sustainable forms of tourism (especially geotourism) - More detailed geomorphological and archaeological research can contribute to further increasing the overall value of the site	- Active processes at the site (slope instability, deterioration of the castle walls) may pose a risk both in terms of the site’s overall degradation and in terms of its potential future use for geotourism and education - Risks at the site associated with a potential increase in visitor numbers need to addressed regarding the tourism infrastructure and safety

Conclusion

The Janštejn castle is a typical example of geocultural site which may be defined as a site where geodiversity and culture are closely interconnected and they influence each other. Indeed, the geological resources and geomorphological setting (presence of significant outcrops as suitable platform for constructing the castle, possibility of use the local stone) played a substantial role in the sites history. On contrary, the anthropogenic activities also influenced the geodiversity: the rock outcrops were modified during the construction, new landforms appeared, and the material was moved.
The detailed literature review, field work (including the use of advanced visualisation methods), and use of geomorphosite assessment approaches enabled the identification, documentation, and evaluation of the heritage values. Based on this, the preliminary analysis of threats and opportunities were identified. This will serve for a further rational use of the site that may be used also by local stakeholders, including the municipalities, schools, or Vysočina National Geopark. In further research, we plan to conduct a more detailed analysis and assessment of the site’s potential for education and the development of sustainable forms of tourism, as well as a more detailed identification, analysis, and assessment of threats and risks.

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Souhrn
Příspěvek představuje geokulturní lokalitu Janštejn jako typický příklad lokality, kde dílčí složky geodiverzity (horniny moldanubika, kryogenní a antropogenní tvary reliéfu jako např. tory, sklaní stěny, balvanová more, hradní příkopy, valy) ovlivňují a jsou ovlivňovány kulturními, historickými nebo archeologickými aspekty. Lokalita byla podrobně popsána, zmapována a zhodnocena z hlediska jejího potenciálu pro rozvoj udržitelného turismu a vzdělávání. Dále byly identifikovány potenciální hrozby a rizika, která mohou negativně ovlivnit hodnoty lokality a rovněž bylo diskutováno její udržitelné využívání.

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CLIMATE DEVELOPMENT IN THE BESKYDY MOUNTAINS

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Abstract
The area of the Beskydy Mountains covered in this article is 2,412 km², and the average elevation is 557 meters above sea level. The selected area covers only 3% of the territory of the Czech Republic.
The climate is changing worldwide, and the Beskydy Mountains are no exception. Given that the elevation range of the mountain range is 1,000 m, we calculated the characteristics of the Beskydy Mountains for individual years and months from 1874 to the present using available data. For precipitation totals, average air temperature, and new snowfall totals, we obtained 150-year time series, from which we are able to analyze trends and identify historical extremes in this region. Based on our knowledge of the past and present, we can better prepare for and adapt to the future climate, which influences and will increasingly influence most of our activities.

Key words: air temperature, precipitation total, trend, weather station, Bílá

Introduction

For the purposes of describing the climate of the Beskydy Mountains, we define the Beskydy in this context as the area comprising the Silesian and Moravian-Silesian Beskydy, the Hostýn-Vsetín Highlands, the Javorníky Mountains, and the Podbeskydská Uplands. We defined the boundary by selecting the area where the landscape rises from the plain to the hills as the Beskydy Mountains. This created a closed polygon for calculating characteristics in a GIS (Geographic Information System) environment. The area defined in this way (Fig. 1) covers 2,412 km² and has an average elevation of 557 m above sea level. The highest point is Lysá hora, and the lowest point lies at an elevation of 264 m above sea level. The area represents approximately 3% of the Czech Republic's total land area.
For the defined area of the Beskydy Mountains, we derived spatial characteristics of air temperature, total precipitation, and new snowfall over the past 150 years. Based on meteorological data from the Bílá station, we further assessed the long-term trends in snow cover and conditions for winter recreation, including a forecast for the 2025/2026 season.
We also outlined the potential climate development in the Beskydy region up to the year 2100 based on the regional ALADIN-CLIMATE/CZ model (ALARO configuration, 2.3 km resolution, Brožková et al. 2019) as part of the PERUN project (PERUN 2022). Two emission scenarios were evaluated: SSP2-4.5 and SSP5-8.5 (IPCC, 2021). Due to space constraints, we present only a portion of the results.

Materials and methods

Long-term meteorological data series from the CLIDATA climatological database of the Czech Hydrometeorological Institute were used to calculate the areal characteristics.
The analysis included data from 24 standard stations, 8 snow gauge stations, 40 supplementary stations, and approximately 105 rain gauge stations. Data from neighboring regions in the Czech Republic, Poland, and Slovakia were also utilized. Monthly and annual characteristics of air temperature, total precipitation, and new snowfall were analyzed for the period 1874–2025 (approximately 130 years for snow). Spatial characteristics were derived using interpolation methods that account for the influence of orography, particularly the local linear regression (LLR) method and ClidataDEM (Stříž 2008).

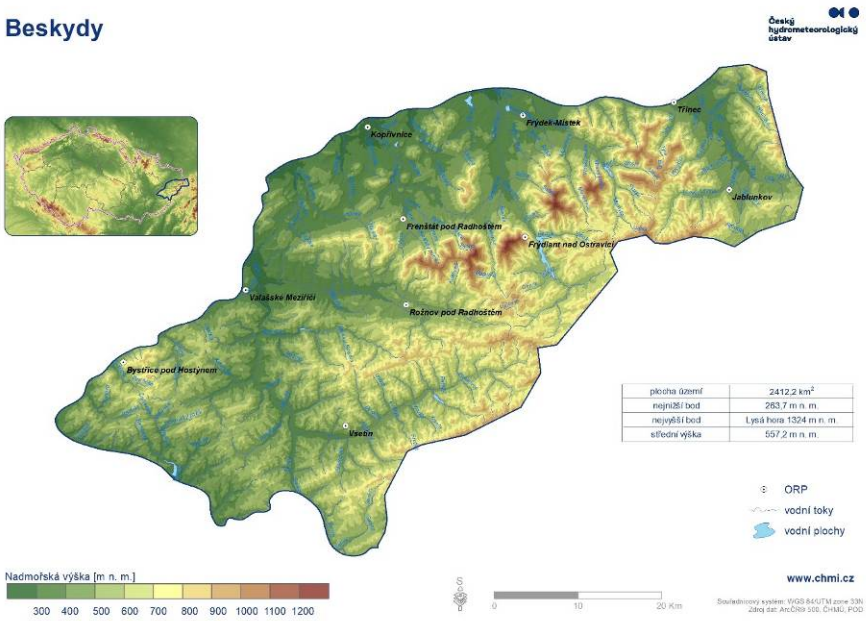

Fig. 1: Map of the Beskydy region.

Results

The average annual air temperature in the Beskydy Mountains over the past 152 years has shown an upward trend of 0.118 °C per decade. Over the entire study period, it has increased by 1.8 °C. The 1901–1930 temperature norm had an annual air temperature of 6.5 °C, the 1931–1960 and 1961–1990 norms were both 6.7 °C, and the 1991–2020 norm was 7.7 °C (Fig. 2). For the years 2021–2025, the average annual temperature is 8.5 °C (Fig. 3).

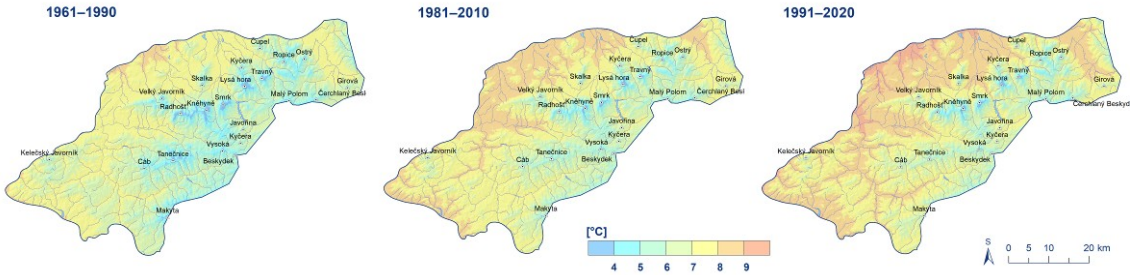

Fig. 2: Long-term averages of air temperature in the Beskydy Mountains for the periods 1961–1990, 1981–2010, and 1991–2020.

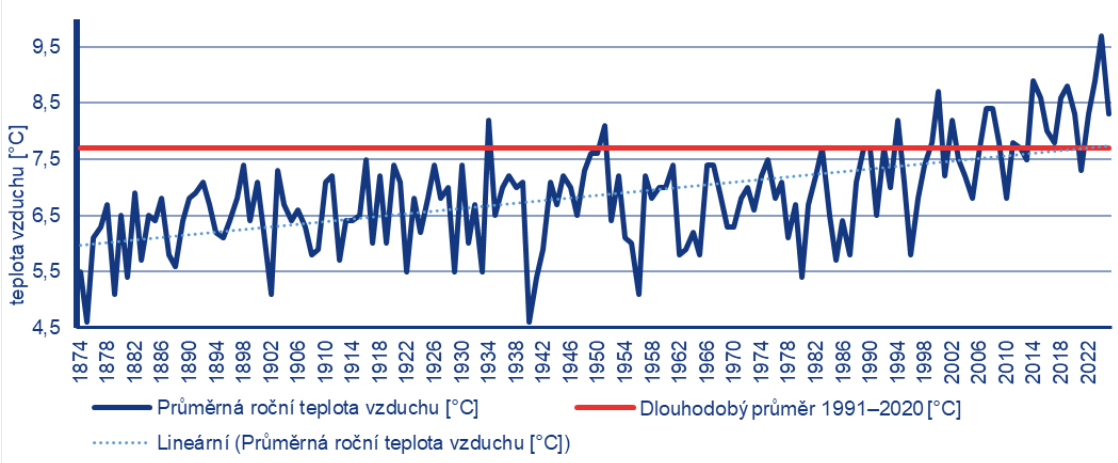

Fig. 3: Average annual air temperature calculated for a defined area of the Beskydy Mountains, compared with the 1991–2020 normal period and the linear trend.

Figure 4 below shows that, according to both the SSP2-4.5 and SSP5-8.5 socioeconomic scenarios, the trend of rising air temperatures in the Beskydy Mountains will continue. According to model simulations based on the medium emissions scenario SSP2-4.5, average air temperatures in the Beskydy Mountains are expected to rise by 2.2 °C by the end of the 21st century compared to the current climate (1991–2020). Under the pessimistic scenario SSP5-8.5, the increase is as high as 4.7 °C.

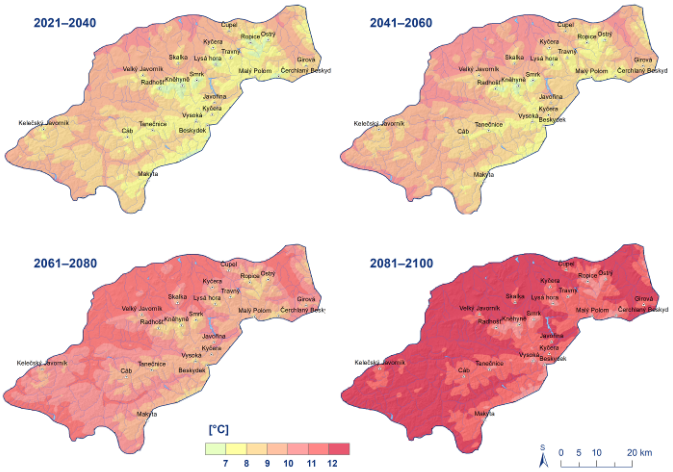

Fig. 4: Average annual air temperature in the Beskydy Mountains for the SSP5-8.5 scenario and individual 20-year periods

Annual precipitation totals show a slight downward trend of 5.5 mm per decade. Individual reference periods have annual averages ranging from 986 to 1,086 mm.
Regarding possible future trends, the SSP2-4.5 scenario does not predict any significant changes in precipitation by 2100, while the SSP5-8.5 scenario shows an increase in precipitation totals in all 20-year periods (Table 1).
The total amount of new snow in the Beskydy Mountains has shown a declining trend over the past 130 years (1896–2025) of 1.9 cm per decade. The average annual snowfall was 206 cm for the period 1901–1930, 222 cm for the period 1931–1960, 220 cm for the period 1961–1990, 197 cm for 1991–2020, and just 140 cm for the last five years (2021–2025).

According to a compiled data series from meteorological stations in Bílá in the Beskydy Mountains, covering various measurement locations (720–770 m a.s.l.) for the period since 1900, the long-term winter total of new snowfall (September–May) ranged from 283 to 286 cm during 1901–1990, 296 cm during 1991–2020, and only 169 cm in the last five years. The trend is decreasing at a rate of 2.5 cm per 10 years.
Maximum total snow cover depths at Bílá during winter seasons show a decreasing trend of 3.1 cm per 10 years. The average winter maximum for the period 1901/1902–1930/1931 was 95 cm, for the period 1931/1932–1960/1961 it was 90 cm, for the period 1961/1962–1990/1991 it was 81 cm, for the period 1991/1992–2020/2021 it was 74 cm, and for the last five winters, 2021/2022–2025/2026, only 51 cm. The highest total snow cover to date was 198 cm in the winter of 1943/1944, and the lowest to date, only 23 cm, was in the winter of 2019/2020.
Given the aforementioned trend in air temperature, it can be assumed that the nature of precipitation will also change, as evidenced by other regional characteristics for individual elevation zones in the Beskydy Mountains (Table 1). As air temperatures rise, particularly minimum winter temperatures, snowfall will decrease in favor of rainfall. For example, results based on the SSP5-8.5 scenario predict snow cover only at elevations above 600 m a.s.l. (Fig. 5).

Tab. 1: Regional characteristics for elevation zones in the Beskydy Mountains according to the SSP5-8.5 scenario.

		Altitude (m n. m.)					
Element	Period	pod 400	401–600	601–800	801–1000	1001–1200	nad 1201
Minimum annual air temperature (°C)	2021–2040	5,2	4,5	3,8	3,4	3,0	2,6
	2041–2060	5,5	4,9	4,2	3,8	3,3	3,0
	2061–2080	6,8	6,1	5,5	5,1	4,7	4,4
	2081–2100	8,6	8,0	7,4	7,0	6,6	6,4
Average annual precipitation (mm)	2021–2040	889	982	1132	1239	1318	1374
	2041–2060	906	1007	1156	1263	1343	1400
	2061–2080	997	1096	1262	1383	1478	1543
	2081–2100	988	1092	1263	1379	1466	1533
Average annual snow cover height (cm)	2021–2040	1	2	5	6	8	9
	2041–2060	2	4	8	11	14	15
	2061–2080	1	2	4	5	7	7
	2081–2100	0	1	2	2	3	3

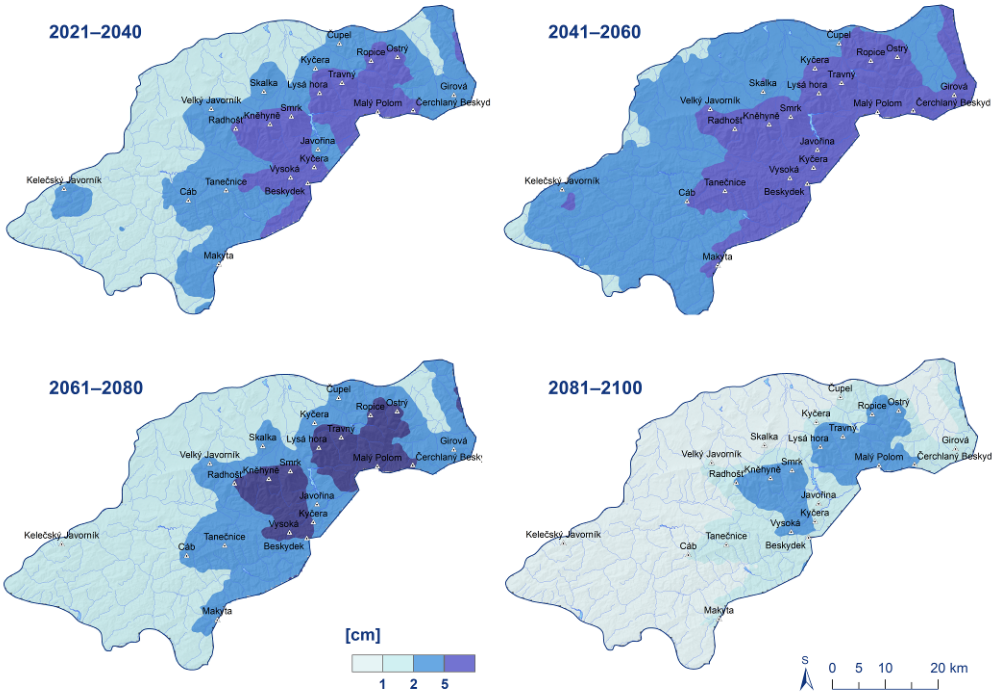

Fig. 5: Average annual snow depth (cm) in the Beskydy Mountains for the SSP5-8.5 scenario and individual 20-year periods.

Discussion

The last winter season (2025/2026) at Bílá in the Beskydy Mountains offered good skiing conditions. The first snowfall resulting in a snow cover was recorded on November 17; it snowed almost daily until

November 26, and the snow cover remained until December 3, reaching a maximum depth of 14 cm. From November 17 to December 3, 2025, sub-freezing minimum air temperatures were suitable for snowmaking. Between December 4 and 11, daytime air temperatures remained above freezing. From December 12 to February 21, minimum air temperatures were below freezing on most days.
After the Christmas holidays, it began snowing again during a cold spell, and a significant snowpack was recorded, peaking at 55 cm on January 12. By the end of January, there was still nearly 20 cm of natural snow, which melted before mid-February; however, it snowed again in mid-February and remained on the ground until the end of the month. Natural snow appeared on the ground during a cold snow episode at the end of March.
Continuous snow cover was recorded from December 28, 2025, to February 11, 2026, and then from February 15 to 23, 2026. From March 25 to 31, 28 cm of new snow fell, and the snow cover persisted into early April, with a maximum of 12 cm on March 27. In the first half of March, maximum air temperatures ranged between 6 and 11 °C. Conditions for downhill skiing were excellent at least until mid-March. The actual 2025/2026 season at the Bílá Ski Resort began around November 29, 2025, with full operations starting in mid-December 2025 and the season ending on March 23, 2026. The resort was not open all day every day (limited operations at the beginning and end of the season). The full season (most slopes) lasted from December 20, 2025, to March 15, 2026, offering approximately 85–90 days of quality skiing.
This winter also offered ideal conditions for cross-country skiing. There are four cross-country trails in and around Bílá. The approximately 15 cm of natural snow required for good trail conditions was recorded from December 28, 2025, through early February 2026.

Conclusion

The average annual air temperature in the Beskydy Mountains over the past 150 years has shown an upward trend of 0.118 °C per decade. While it was 6.5 °C during the period 1901–1930, it has reached 8.5 °C in the last five years (2021–2025). Annual precipitation totals show a slight downward trend of 5.5 mm per 10 years. Between individual normal periods, annual totals generally range from 986 to 1,086 mm. Year-to-year variability is considerable, with no statistically significant trend; however, a shift in the distribution of precipitation throughout the year toward more intense episodes is evident. The total amount of new snow in the Beskydy Mountains has shown a decreasing trend over the past 130 years (1896–2025) of 1.9 cm per 10 years; the seasonal snow total for 1991–2020 was 197 cm, and for 2021–2025, only 140 cm. An analysis of future climate trends in the Beskydy Mountains based on outputs from the ALADIN-CLIMATE/CZ regional climate model confirms that projections of future climate trends correspond to trends already observed in long-term meteorological data series, particularly the rise in air temperature and the decline in snow cover.

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Souhrn
Rozloha Beskyd, o nichž pojednává tento článek, činí 2 412 km² a průměrná nadmořská výška je 557 metrů. Vybraná oblast pokrývá pouze 3 % území České republiky.
Klima se mění po celém světě a Beskydy nejsou výjimkou. Vzhledem k tomu, že výškový rozsah pohoří je 1 000 m, vypočítali jsme na základě dostupných údajů charakteristiky Beskyd pro jednotlivé roky a měsíce od roku 1874 do současnosti. Pro úhrny srážek, průměrnou teplotu vzduchu a úhrny nového sněhu jsme získali 150leté časové řady, z nichž jsme schopni analyzovat trendy a identifikovat historické extrémy v této oblasti. Na základě našich znalostí minulosti a současnosti se můžeme lépe připravit na budoucí klima a přizpůsobit se mu, které ovlivňuje a bude stále více ovlivňovat většinu našich činností.

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COMPARISON OF MULTISPECTRAL DATA FROM UAV AND SATELLITE IMAGERY FOR MONITORING THE VEGETATION STATUS OF GOLF COURSES

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Abstract
Recreational areas such as golf courses represent a specific type of landscape element whose maintenance requires intensive vegetation management, particularly in terms of irrigation, fertilization, and regular turf maintenance. Considering the environmental impacts of these activities, there is an increasing need for methods that enable more efficient and environmentally sustainable management of such areas.
This contribution focuses on the use of multispectral data for monitoring the vegetation condition of turfgrass areas on a golf course and compares different sources of remote sensing data. Specifically, data acquired from an unmanned aerial vehicle (UAV) DJI Mavic 3M and satellite systems Sentinel-2 and Planet are analyzed. The acquired imagery was processed into orthophotos and multispectral layers, from which selected vegetation indices (e.g., NDVI and GNDVI) were calculated.
The analysis focuses on comparing spatial resolution, level of detail, and the ability to identify spatial variability in vegetation condition among the different data sources. The results show that UAV imagery provides highly detailed information on local vegetation changes, while satellite data enable regular monitoring of vegetation development over a broader temporal scale. The combination of both approaches therefore represents a suitable tool for supporting the sustainable management of recreational areas, optimizing irrigation regimes, and reducing the excessive use of fertilizers and other environmental inputs.

Key words: UAV; multispectral imaging; vegetation indices; recreational landscape; golf courses; sustainable turf management; Sentinel-2; Planet; remote sensing

Introduction
The management of many golf courses is currently undergoing a fundamental transformation. Traditional uniform maintenance is gradually being replaced by a modern concept known as “precision turfgrass management” (Carlson, 2022). This approach utilizes advanced technologies to accurately map the condition of playing surfaces and subsequently apply water and fertilizers in a targeted manner. As a result, resources are not wasted on healthy turf but are directed exclusively to problem areas that genuinely require intervention (Straw, 2020).
Targeted application of inputs thus represents a response to increasing environmental sustainability demands while also generating significant economic savings due to its efficiency (Carlson, 2022; Caturegli, 2016).
A key prerequisite for implementing this concept in practice is the application of remote sensing methods. Zhang (2019) highlights the irreplaceable role of multispectral imaging in this context, as it enables the detection of vegetation stress before visible symptoms appear. The analysis of vegetation indices such as NDVI, GNDVI, and NDRE allows for precise quantification of vegetation vitality. The diagnostic potential of this approach has been confirmed by Caturegli (2016) and Zhang (2019), who demonstrated a strong correlation between vegetation indices, nitrogen content in plants, and overall turf health.
Based on these findings, considerable attention is currently devoted to selecting the optimal data acquisition platform. Golf course managers typically choose between unmanned aerial vehicles (UAVs) and satellite systems. The aim of this study is to compare the usability of UAV, PlanetScope, and Sentinel-2 data for efficient golf course management in accordance with the concept of precision turfgrass management.

Methods
The research was conducted at the Prague City Golf Zbraslav course, which represents a typical example of intensively managed sports turf with high demands for irrigation and fertilization. The total area of the eighteen-hole course is 1.81 km² (Figure 1A). The comparison of remote sensing data outputs (UAV, PlanetScope, Sentinel-2) was carried out at the level of hole no. 14 (Figure 1B), where two sub-areas were defined: green and fairway. It is assumed that the different management of these areas results in varying requirements for irrigation, fertilization, and maintenance intensity.

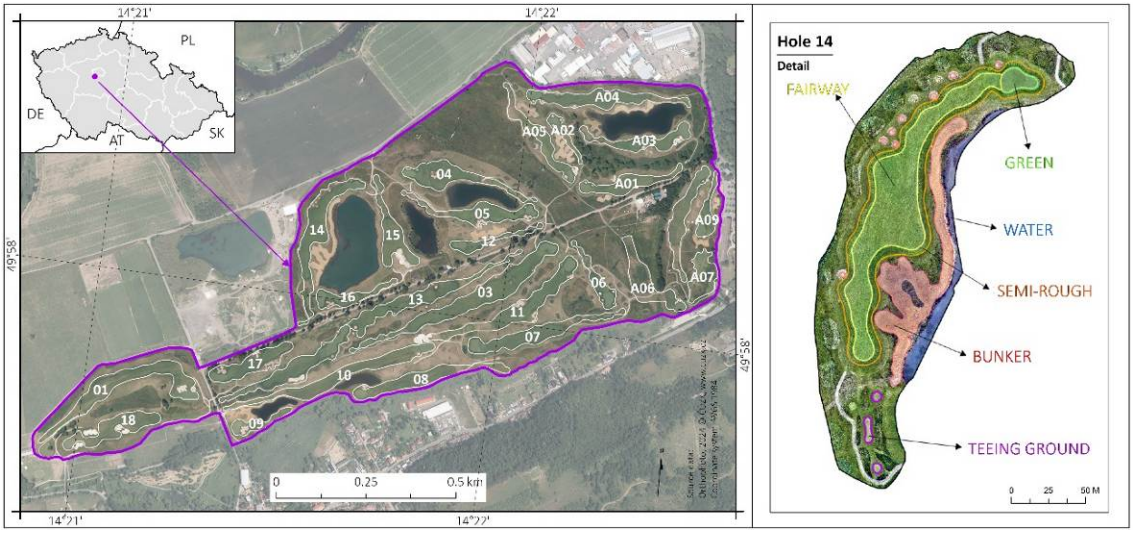

Fig. 1: Location of the study area

Overview and parameters of input data:

i) **Unmanned aerial vehicle (UAV):** Data were acquired on 23 October 2025 using a DJI Mavic 3M at an altitude of 120 m. The system is equipped with an RGB camera and four multispectral sensors. The resulting ground sampling distance (GSD) is 3.23 cm/pixel for the visible spectrum and 5.53 cm/pixel for multispectral bands (Green, Red, Red Edge, and NIR).

ii) **Sentinel-2 satellite (Copernicus):** As a representative of freely available data, an image acquired on 21 October 2025 was used. The system provides a spatial resolution of 10 m in key visible and near-infrared bands, while selected red-edge bands and derived indices have a resolution of 20 m.

iii) **PlanetScope constellation:** A representative of commercial satellite systems, PlanetScope imagery from 21 October 2025 was used, with a spatial resolution of 3 m/pixel. The unit price of archival data ranges approximately between 1.80–2.25 USD/km². However, the minimum purchase requirement is 250 km², resulting in a total acquisition cost exceeding CZK 13,000 for a single order.

Satellite data were selected to temporally correspond with UAV flights. Due to orbital parameters and cloud cover conditions, the closest available cloud-free images were used to ensure a valid comparison.

Raw UAV data were processed into orthophotos using DJI Terra software. Subsequent analysis and comparison with satellite imagery were performed in ArcGIS Pro 3.6.2. The GNDVI (Green Normalized Difference Vegetation Index), utilizing near-infrared (NIR) and green bands, was selected to assess turf vitality due to its high sensitivity to chlorophyll content and its correlation with nitrogen concentration in biomass.

Results and Discussion

The analysis confirmed significant differences in spatial resolution (GSD) among the evaluated platforms. UAV imagery (3.23–5.53 cm/pixel) enabled precise detection of local turf defects and irregularities in input distribution. PlanetScope data (approximately 3 m/pixel) captured coarser variability across fairways. The spatial resolution of Sentinel-2 (10–20 m/pixel) proved to be limiting for precision turf management purposes (Figure 2).

The analysis also identified areas requiring more intensive intervention as well as zones in optimal condition. Locations with GNDVI values below the average of a given sub-area can be classified as priority zones for agronomic intervention. Conversely, areas with above-average index values indicate sufficient nutrient and water saturation, eliminating the need for uniform input application.

Conclusion

This study evaluated the applicability of remote sensing methods for precision turfgrass management. The results confirm that UAV technologies provide the most reliable identification of local areas requiring increased management attention. PlanetScope imagery with a spatial resolution of 3 m/pixel produces significantly more generalized values, and its application therefore requires a dedicated economic evaluation (cost versus information value compared to UAV data).

The use of Planet SkySat data should also be considered. Its spatial resolution of 50 cm/pixel represents a suitable compromise between highly detailed UAV imagery and coarser PlanetScope

data. Sentinel-2 imagery was found to be not suitable for high-resolution turfgrass management applications due to insufficient spatial detail.

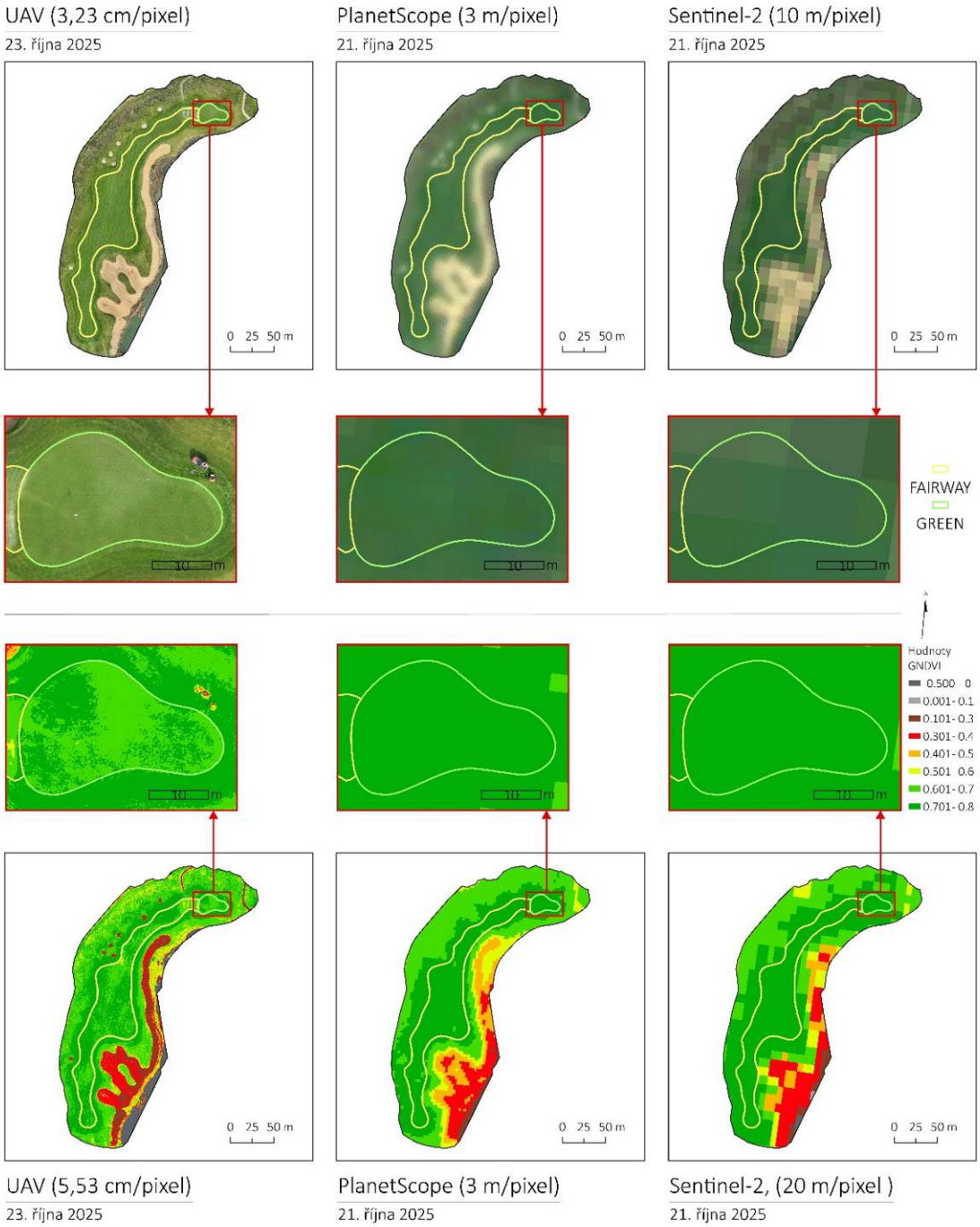

Fig. 2: Comparison of spatial resolution of data sources

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Souhrn
Rekreační oblasti, jako jsou golfová hřiště, představují specifický typ krajinného prvku, jehož údržba vyžaduje intenzivní management vegetace, zejména pokud jde o zavlažování, hnojení a pravidelnou údržbu trávníku. S ohledem na environmentální dopady těchto aktivit roste potřeba metod, které umožňují efektivnější a environmentálně udržitelnější správu takovýchto ploch. Tento příspěvek se zaměřuje na využití multispektrálních dat pro monitorování stavu vegetace travnatých ploch na golfovém hřišti a porovnává různé zdroje dat dálkového průzkumu Země. Konkrétně jsou analyzována data získaná z bezpilotního letounu (UAV) DJI Mavic 3M a satelitních systémů Sentinel-2 a Planet. Pořízené snímky byly zpracovány do ortofotomap a multispektrálních vrstev, ze kterých byly vypočteny vybrané vegetační indexy (např. NDVI a GNDVI). Analýza se zaměřuje na porovnání prostorového rozlišení, úrovně detailu a schopnosti identifikovat prostorovou variabilitu stavu vegetace mezi různými zdroji dat. Výsledky ukazují, že snímky z UAV poskytují vysoce detailní informace o lokálních změnách vegetace, zatímco satelitní data umožňují pravidelné monitorování vývoje vegetace v širším časovém měřítku. Kombinace obou přístupů proto představuje vhodný nástroj pro podporu udržitelného managementu rekreačních oblastí, optimalizaci režimů zavlažování a snížení nadměrného používání hnojiv a dalších environmentálních vstupů.

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COMPOSITIONAL APPROACHES OF HERBACEOUS PLANT COMMUNITIES IN A UNIVERSITY CAMPUS LANDSCAPE

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Abstract
The paper addresses compositional principles in the design of herbaceous beds and grass–herbaceous plant communities within a university campus environment. The aim of the study is to highlight the possibilities of using ornamental herbaceous plants in the formation of aesthetically valuable, functional, and ecologically stable vegetation elements in an academic setting. In the design of the planting beds, fundamental landscape architectural principles were applied, particularly composition, rhythm, colour harmony, plant height gradation, and seasonal dynamics of vegetation. Attention was also paid to the adaptability of the selected species to local site conditions, their ecological requirements, and maintenance demands. The selection of plant material focused on species and cultivars with high ornamental value throughout the growing season, while considering their phenology, growth habit, and mutual compatibility within the overall composition. The design also reflects the need to enhance biodiversity and support ecological functions of greenery within the urbanised environment of a university campus, and addresses mowing strategies. The outcome of the study is a design of compositionally balanced herbaceous plant communities that contribute to improving the visual quality of university space while creating opportunities for educational and research activities, including monitoring plant growth, development, and adaptation to specific site conditions.

Key words: herbaceous plant communities; planting design; landscape architecture; urban biodiversity; campus landscape

Introduction

Woody and herbaceous plants used in urban environments play a significant role in enhancing the resilience and adaptive capacity of cities to the impacts of climate change (Kuczman et al., 2024; Hus, Paganová, Raček, 2021), particularly through the mitigation of the urban heat island effect. At the same time, appropriately designed and managed green spaces represent a key tool for achieving sustainable development goals (Tóth, Slobodníková, 2025; Hus, Saková, 2025; Bellérová, Hus, 2025). In this context, there is an increasing need for new approaches to planning sustainable and ecologically functional urban spaces that integrate the use of trees, shrubs, and herbaceous plants. In Europe, herbaceous vegetation has long been considered an important element in enhancing the ecological stability of urban environments, including their resilience to climate change (Sjöman, Bellan, Hitchmough, 2015; Pomatto, 2023). At the same time, growing attention is being paid to the potential of meadow communities and perennial plantings, which enable a reduction in the maintenance costs of urban green spaces while providing positive environmental effects, including support for biodiversity (Caser, 2022; Hitchmough, 2009). The use of meadow flowers, including perennial species, in degraded urban areas also contributes to increased biodiversity and environmental awareness among residents (Jiang, Yuan, 2017). In addition to wildflower meadows, flower beds represent another preferred solution, significantly enhancing the aesthetic value of urban green spaces. Their advantage lies in their applicability even in smaller areas, such as roundabouts or vegetated strips along roads, where the use of meadow vegetation is less suitable. Under such conditions, Colombo et al. point out the risk that meadow vegetation may be perceived by the public as unmanaged and aesthetically less attractive, particularly after the completion of the life cycle of annual species. In contrast, flower beds combining ornamental and native perennials allow for the maintenance of continuous soil cover and, through variability in forms and colors, support pollinator presence (Hus, Saková, 2025; Hus, Pástorová, 2025). The use of perennial plantings in public spaces has become the subject of intensive professional discussion in recent years. Contemporary approaches to vegetation design primarily focus on economically efficient solutions with low maintenance requirements. A key aspect is the selection of species suitable for specific site conditions and the realistic consideration of long-term management and maintenance costs. This trend is closely linked to a period of stagnation or decline in

funding for public green spaces, which has motivated landscape architects and green space managers to seek cost-effective and sustainable approaches to creating dynamic, seasonally variable, and biologically valuable urban vegetation. In practice, this has led to a broader application of ecologically oriented plantings composed with regard to the ability of species to thrive under the natural conditions of a given site, rather than relying on traditional approaches based on intensive environmental modification to meet the requirements of selected species. Such an ecologically based approach enables a transition to less intensive management regimes, resulting in reduced maintenance costs and increased overall sustainability of vegetation elements in urban environments (Hitchmough, Woudstra, 1999). Despite these benefits, the implementation of flower plantings also has certain limitations. These include, in particular, the time required for project preparation and the selection of appropriate plant material, as only a thorough analysis of the growth characteristics of individual species and their interactions allows for the creation of stable and long-term functional vegetation compositions. After implementation, a time lag must be expected before achieving maximum ornamental effect, especially in the case of slow-growing species. Another limiting factor is that certain groups of perennials (e.g., bulbous and tuberous plants) exhibit only a short-term ornamental effect, which may be perceived negatively by users of public spaces. However, this drawback can be mitigated through appropriate species selection and compositional design (Korenkova, Shiryaeva, Naumkin, 2022). The present paper focuses on the presentation and analysis of compositional principles applied in the design of herbaceous planting beds and grass–herbaceous plant communities within a university campus environment (Porvazník, Bakay, Miklášová, 2025). The main objective of the study is to analyze and interpret the potential of ornamental herbaceous plants in creating aesthetically valuable, functional, and ecologically stable vegetation elements in an academic setting, with an emphasis on their application in the context of contemporary sustainability requirements and climate change adaptation.

Materials and method

The conventional approach to the design of public spaces is based on long-established principles and practices that primarily emphasize aesthetic qualities and adherence to traditional compositional rules. However, this approach often overlooks broader ecological contexts and sustainability principles, which are currently regarded as essential in shaping urban environments. Over the past decade, several landscape architectural interventions have been implemented within the campus of the Slovak University of Agriculture in Nitra, with a particular emphasis on the application of herbaceous plantings. These interventions represent practical examples of a shift from traditional approaches towards vegetation-oriented solutions that reflect contemporary requirements for ecological stability and functional diversity of urban green spaces. At the same time, they serve as a means of presenting effective adaptation measures to the general public, particularly in the context of flood risk reduction and the mitigation of the adverse effects of climate change through planting design—specifically, through diverse, species-rich herbaceous compositions. The campus of the Slovak University of Agriculture in Nitra was subjected to a systematic analysis, on the basis of which selected vegetation modifications dominated by perennial plantings were identified and typologically classified. Different types of herbaceous communities were distinguished according to site conditions, species composition, and spatial arrangement.

Results

Within the area of the Slovak University of Agriculture in Nitra, several types of perennial planting beds were identified, which are characterized by different internal arrangements and variable species composition, which reflects differences in spatial location and site-specific conditions affecting their growth and development.

A/ Representative planting beds in front of the main building

In 2019, representative perennial planting beds with a total area of approximately 900 m² were established within the lawn areas of the representative space in front of the assembly hall of the Slovak University of Agriculture in Nitra. Linear planting beds were designed within the university parterre as a vegetation element accompanying users as they transition from the street space towards the assembly hall. The individual bed segments are complementary in form and sufficiently spacious to allow the plant community, composed of species used in the mixture, to function sustainably and provide year-round visual interest within this type of space.

year of establishment: 2019

site conditions: sunny exposure

plant community: a xerophytic plant assemblage providing year-round effect, with a pronounced spring aspect created by bulbous species and early spring perennials: (*Allium* 'Purple Sensation', *Helleborus niger*)

B/ Group understory planting beds located between the pavilions of the main building
In 2023, extensive lawn areas located between the blocks of the main building of the Slovak University of Agriculture in Nitra were transformed into perennial plantings established beneath the understory of existing mature trees, as well as under conditions of pronounced shading caused by the surrounding built environment enclosing the site on three sides. The locality is additionally characterized by a rain shadow effect, resulting in a significant reduction in incident precipitation. Within stands of deciduous broadleaved woody species, vertical differentiation of root systems between woody plants and herbaceous species occurs, enabling their coexistence across different soil horizons. However, a limiting factor for the persistence of understory herbaceous communities, particularly in dense tree groupings, is insufficient light availability. During the leafless period, approximately 50% of solar radiation reaches the soil surface, creating favorable conditions for the development of early spring ephemeroids. A key phenological feature of these communities is the spring aspect, characterized by intensive flowering of species prior to canopy leaf-out, such as *Corydalis cava*. Conversely, another group of species is adapted to reduced light conditions during the growing season following canopy closure, forming the so-called summer aspect of the herbaceous understory.
year of establishment: 2023
site conditions: shading from surrounding buildings; tree understory
plant community: species adapted to long-term shade and periodic soil desiccation (so-called "dry shade" conditions)

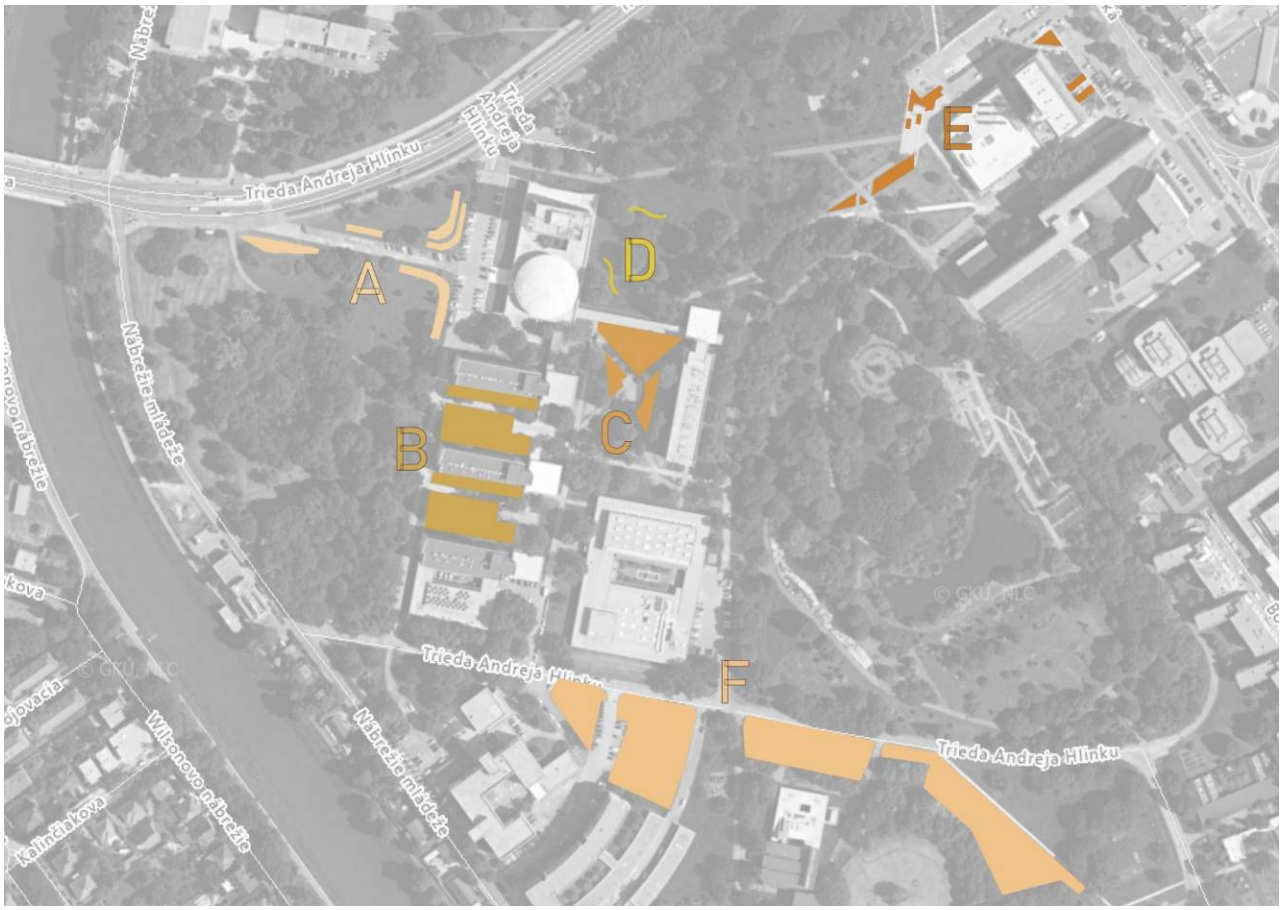

Fig. 1: Map of the campus of the Slovak University of Agriculture in Nitra indicating areas where perennial herbaceous planting elements were implemented (Hus, 2026).

C/ Perennial planting beds within the inner courtyard of the main building
A semi-enclosed space between Pavilion CH, the connecting corridor, and Pavilions A, Z, and T was transformed into a relaxation area complemented by urban furniture and a network of pathways. At the

same time, the original lawn areas were replaced with perennial planting beds covering a total area of 2800 m^2. The site, which includes these perennial plantings, is exposed to high visitor intensity.
The designed herbaceous community, intended for areas with partial light as well as shading caused by trees or surrounding buildings, consists of drought-tolerant species. The site is not equipped with automatic irrigation, and the plants are subjected to water deficit, particularly during the summer period.
year of establishment: 2023
site conditions: shading from surrounding buildings; tree understory; sunny exposure
plant community: species adapted to long-term shade and periodic soil desiccation (so-called “dry shade” conditions)

D/ Linear plantings of bulbous and tuberous species established within lawn areas
Bulb planting strips were established within lawn areas in the vicinity of the assembly hall of the Slovak University of Agriculture in Nitra. From a compositional perspective, they were designed in organic forms, creating a contrast with the rational and geometric character of the surrounding architecture. The spring aspect of the plantings is composed of two genera of bulbous plants – Narcissus and Crocus. Flowering occurs from March to the first half of April. Following flowering and the senescence of the above-ground plant parts, the area is subsequently incorporated into the standard lawn mowing regime.
year of establishment: 2021
site conditions: sunny exposure, semi-shaded conditions under tree canopies
plant community: bulbous and tuberous plant species flowering in March and April: *Narcissus*, *Crocus*

E/ Representative perennial planting beds in the university campus in front of the dormitory with a pronounced spring effect
The planting composition is complemented by woody species, specifically Amelanchier spp. and a shrubby form of Acer campestre, which contribute to the spatial structure and functional diversity of the design. The planting scheme is conceived as open and loosely arranged, with the use of dominant species forming the structural framework of the plant community. A pronounced spring aspect is ensured by the inclusion of bulbous plants of the genus Narcissus, which, when planted at high density, create a visually continuous, nearly monodominant effect during the period from March to April.
year of establishment: 2024
site conditions: sunny exposure
plant community: light-demanding xerophytic species

F/ Biodiverse grass–herbaceous communities
A project focused on the application of grass–herbaceous communities in an urban environment was implemented. As part of the project, 18 original flowering meadow mixtures were established over an area of approximately 1.5 ha. These stands serve as both demonstration and experimental plots. The project enables the monitoring of establishment processes, management practices, and the development of meadow communities under intra-urban conditions, while also facilitating the identification of limitations and risks associated with their implementation. The mixtures consist of species capable of adapting to urban environmental conditions and exhibiting resilience to periods of drought.
year of establishment: 2024
site conditions: sunny exposure
plant community: grass–herbaceous communities, annual and perennial herbaceous species

Conclusion
The study confirms that herbaceous plant communities, when designed with respect to compositional principles and site-specific conditions, represent an effective tool for enhancing the ecological, functional, and aesthetic quality of university campus environments. The use of perennial and grass–herbaceous plantings contributes to increased biodiversity, improved microclimatic conditions, and reduced maintenance demands. The case of the Slovak University of Agriculture in Nitra demonstrates the potential of university campuses as model spaces for the application of sustainable and ecologically oriented planting strategies that also support education and research activities. However, successful implementation requires careful species selection, detailed planning, and consideration of long-term management. Herbaceous planting design can thus be regarded as a progressive approach contributing to the development of resilient and sustainable urban landscapes.

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Souhrn
Článek se zabývá kompozičními principy při navrhování trvalkových záhonů a travnatě-trvalkových společenstev v prostředí univerzitního kampusu. Cílem studie je poukázat na možnosti využití okrasných trvalkových rostlin při vytváření esteticky hodnotných, funkčních a ekologicky stabilních vegetačních prvků v akademickém prostředí. Při navrhování výsadbových záhonů byly uplatněny základní principy krajinářské architektury, zejména kompozice, rytmus, barevná harmonie, gradace výšky rostlin a sezónní dynamika vegetace. Pozornost byla věnována také přizpůsobivosti vybraných druhů místním podmínkám, jejich ekologickým požadavkům a nárokům na údržbu. Výběr rostlinného materiálu se zaměřil na druhy a kultivary s vysokou okrasnou hodnotou po celou vegetační dobu, přičemž byla zohledněna jejich fenologie, růstový habitus a vzájemná kompatibilita v rámci celkové kompozice. Návrh také odráží potřebu posílit biologickou rozmanitost a podpořit ekologické funkce zeleně v urbanizovaném prostředí univerzitního kampusu a zabývá se strategiemi sečení. Výsledkem studie je návrh kompozičně vyvážených společenstev bylin, která přispívají ke zlepšení vizuální kvality

univerzitního prostoru a zároveň vytvářejí příležitosti pro vzdělávací a výzkumné aktivity, včetně sledování růstu, vývoje a adaptace rostlin na specifické podmínky daného místa.

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CULTURAL HERITAGE CONSERVATION AND SUSTAINABLE TOURISM IN NIGERIA: PERCEIVED KNOWLEDGE, PROBLEMS, AND POLICY DIRECTION

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Abstract
The study explored sustainable tourism for conserving cultural heritage in Nigeria, thereby preserving various cultural geographies, historical sites, and rich traditions and customs. We deliberated on sustainable tourism as a realistic pathway to protecting immaterial cultural assets while nurturing socio-economic progress. The study gathered and utilized primary data with a well-structured questionnaire survey of 120 visitors of the tourist center Osun-Oshogbo Sacred Nigeria, which belongs to local communities. The study found that about 90% of stakeholders agreed that sustainable tourism can effectively preserve cultural heritage sites. Moreover, 75% of the respondents ranked Nigeria's cultural heritage conservation efforts as very essential, although showing very low familiarity (36%) and visitation to cultural heritage sites. However, the environmental problems and challenges threatening sustainable tourism in Nigeria were acknowledged as urban encroachment and pollution (26.67%), scarcity of funding and or coordination amongst the diverse government and non–government agencies (37.5%), and Insecurity (36.7%), among others. Furthermore, the survey disclosed that more than 60% of participants identified weak policy enforcement, underfunding, and over-commercialization as major challenges. The research confirmed that both community engagement and policy adjustments are necessary for enhanced and sustainable conservation of Osun-Oshogbo, and Nigeria in general.

Key words: Community-Based Tourism, Cultural Heritage Conservation, Heritage Preservation, Policy and Governance, Stakeholder Participation, Sustainable Tourism

Introduction

Nigeria is known for its cultural vibrancy, which embraces 250 ethnic groups through their various traditions and languages, nature, and festive customs and historical sites (Choi, 2010). Nigeria's remarkable cultural diversity creates a living cultural tapestry that emerges through its lively celebrations and traditional customs. The cultural wealth of Nigeria permeates daily life through musical energy, historical depth, and friendly interactions among its people (Bandelj, 2011).

The entire nation tells its story through diverse traditions, which create a welcoming atmosphere that makes Nigeria a place where cultural heritage remains precious. However, it continues to bring people together (Amalu et al., 2020). The cultural heritage of Nigeria includes the sacred beauty of Sukur Cultural Landscape and Osun-Osogbo Grove alongside the dynamic energy of Durbar and the festive spirit of the New Yam Festival, which represent the core values of Nigerian national identity (Loulanski, 2011). These cultural sites serve as links between our individual and collective heritage (Nzeda Tagowa, 2010).

Sustainable tourism has become a purposeful approach to addressing problems in cultural heritage preservation over the last few years. This method protects cultural sites, keeps them alive for future generations, and makes them accessible to everyone. Sustainable tourism allows communities to maintain their historical sites by creating welcoming spaces for visitors, thereby fostering economic growth and protecting indigenous sites. People will sustain their cultural heritage by keeping their historical narratives alive, which shape their identity. Sustainable tourism exists to safeguard both natural and cultural resources while creating economic and social benefits (Gill-Robinson, 2007, Abdullahi et al., 2023, Olagunju, 2024).

This research aims to solve current sustainability issues by studying the potential of sustainable tourism to protect Nigerian cultural heritage. The research aims to identify obstacles to implementing sustainable tourism, evaluate its advantages for heritage protection, and develop plans to safeguard Nigerian cultural assets for future generations.

Material and methods

The research design comprises various methods that connect quantitative and qualitative techniques to achieve not only desired but also high-quality results. The qualitative research method uses observational breakdowns and in-depth discussions to collect detailed stakeholder insights into sustainable tourism and heritage conservation strategies. The quantitative component helps this study by using structured surveys to collect numerical data, which estimates current perspectives, recognizes meaningful problems, and evaluates possible opportunities for sustainable tourism growth.

A representative sample of 120 participants was selected to achieve diverse perspectives about cultural heritage conservation through sustainable tourism. The study used semi-structured questionnaires with both closed- and open-ended questions to collect quantitative and qualitative data on sustainable tourism practices and heritage conservation initiatives from visitors, locals, and tourism operators.

The research employed a mixed-methods analysis, integrating quantitative methods with qualitative techniques. The questionnaire data were subjected to descriptive statistical analysis for frequency/percentage calculations and visualization. Researchers used a thematic analysis to identify patterns in questionnaire and observational data, which they grouped into main themes: policy implementation barriers, environmental impacts, and community engagement. The research compared Nigerian findings with global best practices to identify specific areas for improvement.

Results and Discussion

The The study analyzed three demographic variables: age, gender, and education level. Most respondents were between 18 and 44 years old, which were 92% of the sample. The gender distribution was 57.5% male and 42.5% female.

The findings revealed that 46.67% of respondents agreed that communities actively engaged in tourism management experienced increased preservation of cultural sites. Many community members confirmed their involvement in traditional festivals and in guiding tourists at cultural heritage locations/sites.

Our results show that 54.17% of all stakeholders agreed that sustainable tourism helped protect heritage sites, indicating strong consensus on its role in conservation. Tourists (26.67%) specifically sought authentic cultural experiences, indicating that their motivations closely aligned with cultural values. Government officials (19.17%) identified weak policy enforcement as the main institutional challenge that prevented effective preservation.

A satisfactory percentage of participants (52%) reported familiarity with cultural heritage sites, with average interpretation among local residents. Comprehending the public's understanding of heritage sites is important because awareness influences both visitation rates and conservation support. Approximately 37% actually stood in the affirmative with familiarity, indicating an emphatic attribute base among the studied inhabitants' part. Exclusively, 12% of respondents reported being unfamiliar with cultural heritage sites, indicating that a small number of residents lacked knowledge of these paramount cultural assets.

The results show that most respondents (about 56%) had previously visited at least one cultural heritage site in Nigeria. This finding implied a notably high level of public engagement with cultural heritage locations. However, about 44% of respondents indicated that they had not visited any heritage sites; accordingly, a crack in experiential frontage among a marked portion of the population.

This level of acquaintance indicates that while many Nigerians identify with and admire their cultural heritage, there is a need for more focused education and promotion programs to deepen public engagement and understanding, particularly to move individuals from moderate to advanced levels of familiarity.

Our results indicate that a large majority of respondents (75%) ranked Nigeria's cultural heritage conservation efforts as essential. In comparison, 22.5% judged them vital, and only a small bit (2.5%) viewed them as not essential. These outcomes highlight strong shared support for the demand for practical heritage conservation. The increased ratio of respondents who felt conservation efforts as crucial displays across-the-board backing for protecting cultural reserves. Regarding the respondents' perceptions of the importance and effectiveness of efforts being made to conserve Nigeria's cultural heritage, It sought to understand whether the public views conservation initiatives as a priority and how strongly they believe these efforts contribute to preserving national identity and cultural pride.

The survey findings showed that poor government policies and lack of funding were the most cited threats, identified by 50.8% of respondents. Other significant dangers included vandalism and neglect (34.2%), pollution (23.3%), deforestation (22.5%), and urbanization (18.3%). Elements such as climate modification and natural risks, over-tourism, and unbridled access were also cited, though to a lesser extent.

Assessing perceptions/views of effectiveness is important for identifying gaps between conservation policies and actual outcomes on the ground. The survey results indicated that most respondents (50.0%) were unsure if the current conservation efforts were practical. Only 24.2% of participants felt the efforts were not practical, while 25.8% were confident in their effectiveness.
These findings suggest a general dissatisfaction with Nigeria's current situation of cultural heritage conservation. A high ratio of negative responses indicated concerns about weak policy enforcement, including inadequate funding, inferior infrastructure, and a shortage of community involvement in decision-making. The study results further indicate that an overwhelming majority of respondents (90%) agreed that tourism can effectively and efficiently improve the preservation of Nigeria's cultural heritage. Understanding public opinion on this connection is vital, as sustainable tourism is often seen as a fundamental strategy for heritage conservation.
The survey responses revealed that the most important strategy was community involvement in tourism management (42.5%). Other key strategies included increasing awareness and education on cultural heritage conservation (40.0%), encouraging eco-friendly and responsible tourism practices (37.5%), and establishing public-private partnerships for funding heritage sites (32.5%). Smaller proportions also support stricter government regulations (20.8%) and limiting the number of tourists at sensitive sites (Table 1).

Tab. 1: Views on sustainable tourism strategies for cultural heritage conservation

ANSWER	RESPONSES	RATIO
Community involvement in tourism management	51	42.5%
Gate fee for visitors	20	16.7%
Stricter government policies and regulations	25	20.8%
Public-private partnerships for funding heritage	39	32.5%
Limited number of tourists on sensitive heritages	15	12.5%
Eco-friendly and responsible tourism practices	45	37.5%
Awareness and education	48	40.0%

These results indicate that respondents strongly favor strategies/approaches that empower or support local communities/societies, promote responsible tourism behavior, and ensure shared responsibility between public and private sectors. The findings reveal a mixed perception: while half of the respondents recognized some level of community participation, a considerable proportion doubted its existence or was unaware of it. This implies that although measures to entertain communities exist, they may not be overall or visible enough. Supporting community participation through greater decision-making power, training, and equitable benefit-sharing is essential to foster a stronger sense of ownership and responsibility toward heritage conservation.
The results indicated that the leading factor was training and education on heritage conservation (55%), followed closely by government and NGO support for community-led conservation projects (about 49%). Other important motivators included financial incentives for local communities (39%) and increased employment opportunities in heritage tourism (44%). Only about 16% implied greater participation in policymaking processes.
The research findings demonstrated that building community capacity through education and offering tangible socioeconomic benefits is seen as paramount for encouraging/supporting active involvement. Additionally, institutional support from both the government and non-governmental organizations is critical to empowering local communities. The results highlight that meaningful participation must go beyond symbolic gestures; communities need the fundamental skills, resources, and opportunities to fully engage in heritage conservation efforts.
Our results show participants' opinions on the problems affecting the economic impact of using tourism to conserve heritage. Undersupply of funds for conservation activities" was the most frequently noted challenge, with 63 respondents (52.5%) citing it as a notable problem. This suggests that a lack of allocation makes it more demanding to support and facilitate cultural heritage assets, which in turn diminishes their capability to benefit from tourism. Sixty-one respondents (50.8%) selected poor infrastructure and accessibility, including roads, airfields, and even hotels, as the second-highest challenge. This indicates that inadequate transportation system, poor site amenities, and limited accessibility impact tourists' ability to visit and enjoy places of interest, thereby reducing their potential financial benefits. Fifty respondents (41.7%) highlighted "low tourist awareness and curiosity," indicating a lack of marketing, education, or advertising initiatives that highlight the pleasures and importance of cultural heritage sites. Meaningful problems were also recognized as "poor government

aid" (37.5%) and security crises (36.7%). These insinuate that inadequate legislative frameworks, a dearth of political will, and safety concerns deter both conservation investments and tourism.
The study results show that increasing government funding for site maintenance (59.2%) is the top priority, reflecting urgent infrastructure and preservation needs (Table 2). Improved security/accessibility (55%) and better tourism marketing (50%) were also significant, aligning with findings on Nigeria's challenges with neglect and low tourist engagement. Public-private partnerships (29.2%) and gate fees (16.7%) scored lower, suggesting stakeholders favor direct government intervention over revenue-dependent models. These results reinforce the Sustainable Tourism Development Theory, balancing economic, social, and environmental needs, and mirror respondents' demands.

Tab. 2: Initiatives that can improve the economic benefits of cultural heritage conservation

ANSWER	RESPONSES	RATIO
Increased government funding	71	59.2%
Better marketing and tourism promotion	60	50.0%
Improved security and accessibility	66	55.0%
Community involvement in tourism management	47	39.2%
Public-private partnerships for site development	35	29.2%
Introduction of gate fees	20	16.7%

Conclusion

Our study aims to solve current sustainability issues by studying the potential of sustainable tourism to protect Nigerian cultural heritage. This research reveals how sustainable tourism can help develop Nigeria's cultural heritage by promoting its historic sites, cultural events, and creative traditions. The analysis showed that sustainable tourism establishments, which combine environmental conservation with socio-cultural aspects and economic inclusivity, successfully develop both tangible heritage items, such as old monuments and museums, and intangible heritage elements, such as oral traditions and craftsmanship.
The case of the Osun-Oshogbo Sacred Grove and the Sukur Cultural Landscape showcases how community-run ecotourism projects can save heritage sites while generating economic benefits for local people. Eco-Friendly enterprises can preserve cultural sites and create jobs and income opportunities for the locals and adjacent communities through activities such as ecotourism, handicraft sales, and visionary initiatives.
The study results emphasize that integrated policy-driven actions are a key tool to sustainable tourism and effective conservation of its heritage. Moreover, the study identified challenges, including weak enforcement and budget insufficiency that hinder the effectiveness of conservation efforts. This integration of economic and cultural development supports a more comprehensive approach to heritage conservation, where the protection of cultural assets goes hand in hand with improving the livelihoods of local communities.

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Souhrn

Cílem naší studie je řešit současné problémy v oblasti udržitelnosti prostřednictvím zkoumání potenciálu udržitelného cestovního ruchu při ochraně nigerijského kulturního dědictví. Tento výzkum

ukazuje, jak může udržitelný cestovní ruch přispět k rozvoji nigerijského kulturního dědictví prostřednictvím propagace historických památek, kulturních akcí a tvůrčích tradic. Analýza prokázala, že subjekty zabývající se udržitelným cestovním ruchem, které spojují ochranu životního prostředí se sociokulturními aspekty a ekonomickou inkluzivitou, úspěšně rozvíjejí jak hmotné památky, jako jsou staré památníky a muzea, tak prvky nehmotného dědictví, jako jsou ústní tradice a řemeslná výroba.
Případ posvátného háje Osun-Oshogbo a kulturní krajiny Sukur ukazuje, jak mohou ekoturistické projekty řízené komunitou zachránit památky a zároveň přinést ekonomické výhody místním obyvatelům. Ekologicky šetrné podniky mohou chránit kulturní památky a vytvářet pracovní místa a příjmové příležitosti pro místní obyvatele a sousední komunity prostřednictvím aktivit, jako je ekoturistika, prodej řemeslných výrobků a vizionářské iniciativy.
Výsledky studie zdůrazňují, že integrované opatření založené na politice jsou klíčovým nástrojem pro udržitelný cestovní ruch a účinnou ochranu jeho dědictví. Studie navíc identifikovala výzvy, včetně slabého vymáhání a nedostatečného rozpočtu, které brání účinnosti snah o ochranu. Tato integrace ekonomického a kulturního rozvoje podporuje komplexnější přístup k ochraně dědictví, kde ochrana kulturních statků jde ruku v ruce se zlepšováním životních podmínek místních komunit.

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CYCLING ROUTES AS RECREATIONAL CONNECTIONS BETWEEN THE CITY OF NITRA AND ITS SURROUNDING LANDSCAPE

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Abstract
Cycle routes are an important recreational equipment of the landscape, whether urban or rural and open landscape. They provide active relaxation, but also the opportunity to learn, try new things, and discover new places. Their equipment is very important, not only in terms of construction, but also to provide the comfort of the users. The placement of rest areas, view points, or interesting elements—artistic or educational are essential for their attractiveness. The Paper provides an overview of the cycling network around Nitra and the possibilities for connecting interesting points, supplemented by the interventions of colleagues from the Institute of Landscape Architecture, whether it be rest areas or visual-interactive elements. The Paper presents as an example a student proposal for the design of the Water company garden in Nitra, which aims to open up its space to users and cyclists in the surrounding area.

Key words: Landscape architecture, intervention to the landscape, leisure activities, cycle paths, Nitra region

Introduction

The specific function of cycle paths is not only the transport but also recreational use (Kliková, 2025). There are 36.3 km of marked bike paths in Nitra in the immediate vicinity of the city, and about 21 cycle routes with total length up to 100 km (including the wider area – Zobor, Dražovce, Párovské Háje) (Source 1 (2025). Nitra's true recreational potential stems not only from the city's bike trails, but especially from their connection to the countryside surrounding the city. The cycle roads can be a key element in the development of sustainable tourism, the support of local communities (Mišovičová, Pucherová, 2024), the expansion of opportunities for recreational and educational activities (Bihuňová, Zajícová, 2025), and the integration of recreational elements and greenery into the landscape (Čibik, 2023; Bellerová et al. 2025). The vegetation elements that line the cycle trails create a linear green feature in the landscape, promote biodiversity, and serve as a significant visual characteristic of the environment (Tóth, 2022; Kuczman et al., 2024). Cyclists' expectations for the cycleway environment and the supportiveness of the environment for cyclists' activities induce affordances to be actualised from inside-out (cyclist to cycleway) and outside-in (cycleway to cyclist) (Qi et al., 2021).

Material and methods

The area in question is located in the northwestern part of the city, between the Nitra River and the Dobrotka Stream. A major landmark is Sihoť City Park, located within walking distance.
The area of the Waterworks garden is located within the premises of the West Slovak Waterworks Company. It is situated on the outskirts of the city of Nitra. The site is located approximately 200 meters northwest of the regulated channel of the Nitra River. The Dobrotka Stream flows near the site, alongside which runs a bike path leading to the Dražovce district. Access to the site is possible via the bypass (Road No. 51 and R1a). The Sihoť City Park is located 500 meters from the site, and the historic city center is approximately 1.5 km away.
The ZBGIS map portal was used as the basis for determining the dimensions and drafting the design. Additionally, a geodetic survey document provided by the Western Slovakia Water Company was utilized. Current orthophoto mosaics, together with cadastral mapping, provided insight into the current land use of the study area. Additionally, base maps from the following portals were used: OpenStreetMap and Googlemaps.
The tree inventory and terrain survey were done in 2025. The data were recorded in a table summarizing the current condition of the trees.

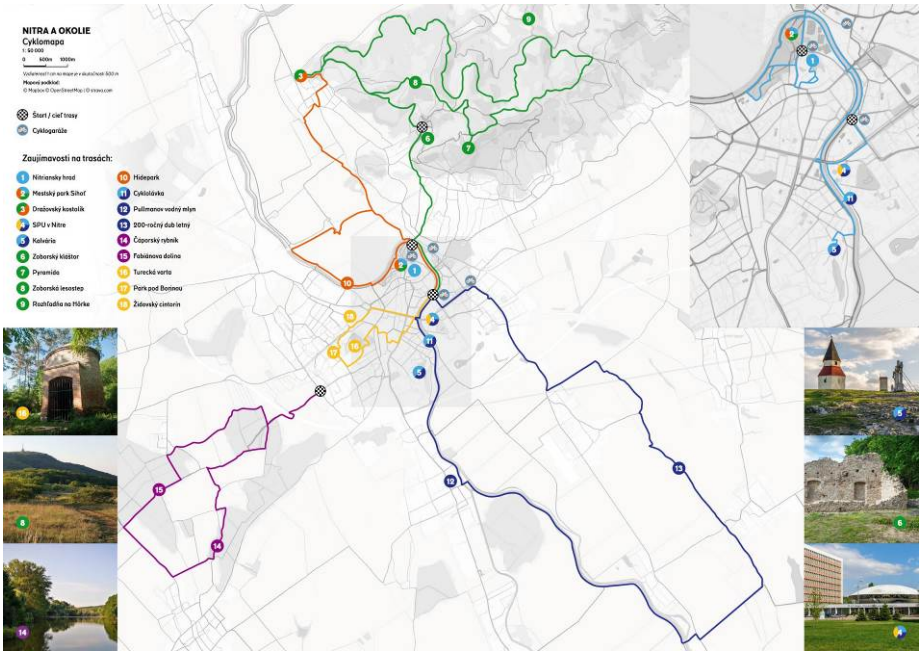

Fig. 1: Map of marked cycling routes in Nitra and its surrounding (Source: https://www.nitra.eu/8649/cyklotrasy)

Fig. 2: Localisation of the Water company garden in Nitra, with connection to the city park and cycling route

Fig. 3: Current situation of the Water company garden with the inventory of the greenery

A total of 21 tree species were inventoried, with the most common *Fraxinus excelsior* (6 pieces), *Salix x fragilis* (4 pieces), *Populus nigra, Juglans regia* (3 pieces), *Cerasus avium* (2 pieces), *Populus alba, Rhamnus catharticus, Robinia pseudoacacia* (1 piece). 20% of the inventoried trees were young trees, 65% mature trees, and 15% senescent trees.

Results

The area of the garden was divided into 3 zones: a social zone, a park zone, and a natural zone. Each zone has a specific character and is defined by its degree of openness, vegetation composition, and proposed street furniture and equipment. Through this division, the space is conceived as a gradient—a transition from an urbanized to a natural environment. The overall form is inspired by the natural flow of water—specifically, the vibration and shape of a water droplet upon hitting the surface. This motif is translated into the shaping of the main circulation routes and spatial structures. The design also employs metaphorical language—water as a bearer of life, movement, and technological value—thereby creating a strong conceptual framework with an emphasis on symbolism and education.

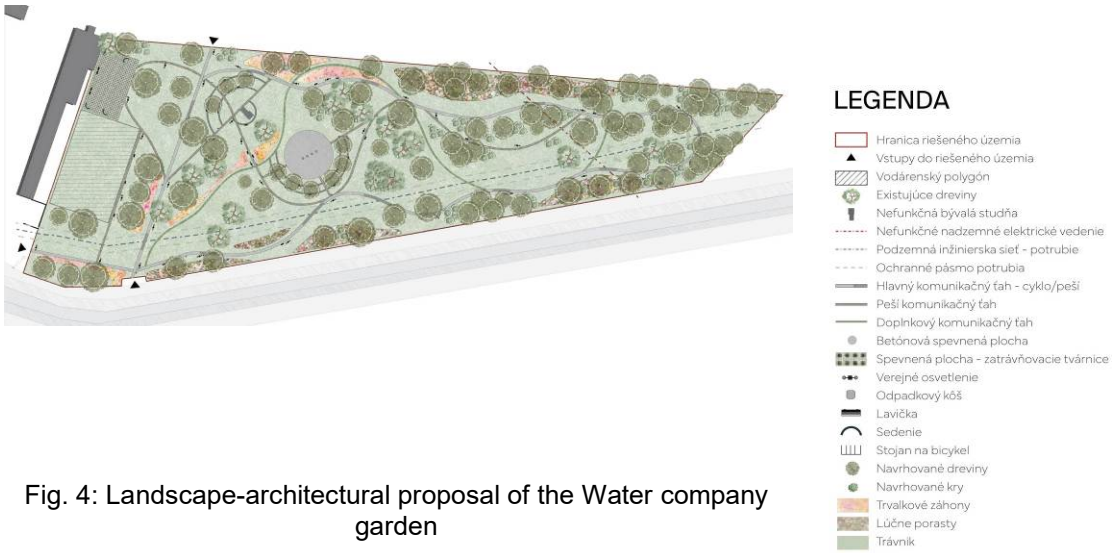

Fig. 4: Landscape-architectural proposal of the Water company garden

The concept also integrates a rain garden element, serving as a technological and ecological component for rainwater retention. Another significant feature is the proposed lookout point/well, which has the potential to become an iconic element of the design. The drawing clearly illustrates the hierarchy of circulation relationships, the balanced placement of functional areas, and the logic of the routing.

The proposed trees are: *Acer campestre ´Elsrijk´* - 13 pc, *Tilia cordata ´Winter orange´* - 19 pc, *Tilia platyphyllos* – 7 pc, *Acer platanoides ´Drummondii´* - 6 pc, *Quercus robur ´Fastigiata´* - 6 pc, *Carpinus betulus* – 6 pc, *Sorbus domestica* – 7 pc, *Fagus silvatica* – 7 pc, *Liriodendron tulipifera* – 6 pc, *Celtis australis* – 8 pc, *Malus ´Everest´* - 8 pc.

Discussion and Conclusion

The landscape architecture design for the Waterworks Garden in Nitra presents a comprehensive solution for transforming an unused industrial site into an ecologically functional space open to the public. The design reflects the principles of sustainability, inclusion, and environmental education. The landscape-architectural design is not only a landscape intervention but also a vision for the development of urban peripheries through greenery and water.

The revitalization of the site would help make the local cycle path—which connects the city Nitra with the Drazovce district—more attractive. There are already interventions along this route in the form of land art elements /AMFI/ (Čibik, 2023) and public gathering spot – fire place (Bellérová et al., 2025). The city of Nitra is gradually planting accompanying vegetation along the cycle paths, but places for rest and relax have not yet been built at acceptable distances.

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Souhrn
V Nitře a jejím bezprostředním okolí se nachází 36,3 km značených cyklostezek a v širším okolí města až 100 km. Projekt krajinářské architektury pro Vodárenskou zahradu v Nitře představuje komplexní řešení přeměny nevyužívaného průmyslového areálu na ekologicky funkční prostor otevřený veřejnosti. Návrh odráží principy udržitelnosti, inkluzivity a environmentální výchovy. Finální návrh není pouze krajinářským zásahem, ale také vizí rozvoje městských okrajových částí prostřednictvím zeleně a vody.

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DEGREE LEVEL AS DIFFERENTIATING FACTOR IN ENVIRONMENTAL SENSITIVITY IN RECREATIONAL USE OF NATURAL ENVIRONMENTS

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Abstract

Recreational use of natural environment represents an environmentally sensitive area that requires responsible behavior and well-developed environmental sensitivity. The level at which individuals perceive the environmental context of recreation may be associated with their degree level in higher education; therefore, the aim of study was to identify differences in perceptions of environmental challenges and emerging trends in nature-based recreation between bachelor's and master's degree students. The research sample consisted of 1,178 university students (bachelor's, N = 518; master's, N = 660). Assessments of differences relied on chi-square test with Cramér's V, followed by multivariable ordinal logistic regression adjusted for gender, age, and type of higher education institution. Analysis of response distributions using the chi-square test showed significant differences ($p < .01$) between bachelor's and master's students across all analyzed items (χ^2; small effects - Cramér's V). Differences involved perceptions of environmental pressure on areas, the environmental challenges associated with the recreational use of nature, and emerging trends in physical activity. After adjustment for control domains, master's students showed approximately 60% higher odds of rating these aspects more than bachelor's students. Degree level influenced perceptions of environmental context of recreation. Strengthening environmental education at the bachelor's level may promote sustainable recreational behavior in natural environments.

Key words: Higher education, environmental behavior, outdoor recreation, university students.

Introduction

Recreational use of natural environments has become an important issue in higher education because outdoor activity offers benefits for health and well-being while creating pressure on fragile ecosystems. Among university students, engagement with outdoor recreation is linked to well-being effects and contact with green and natural settings (Puhakka, 2021).

Educational programs that integrate physical activity in natural environments can strengthen environmental knowledge, attitudes, and responsible behavior, showing that recreation can serve as pathway to sustainability education (Santos-Pastor et al., 2022). Recent research emphasizes that connection to nature should be built in higher education as part of sustainability strategy and awareness building (Kleespies & Dierkes, 2023); however, environmental awareness and citizenship are not distributed across students, and differences in perception are reported in higher education contexts (Migl et al., 2023). These findings suggest that higher education can shape environmental literacy and students' sensitivity to ecological consequences of leisure behavior. Because bachelor's and master's students differ in curriculum exposure, academic maturity, and learning experience, degree level may represent factors in how they perceive environmental pressure, environmental challenges, and emerging trends related to recreation in natural environments (Ewert et al., 2005).

This study aims at identifying differences in perceptions of environmental challenges and emerging trends in nature-based recreation between bachelor's and master's degree students.

Materials and Methods

The study included 1,178 university students from Slovak higher education institutions. The sample comprised 518 bachelor's students (44.0%) and 660 master's students (56.0%). Distribution of gender remained balanced, with 584 males (49.6%) and 594 females (50.4%).

Data collection used questionnaire focused on environmental aspects of physical activity in natural environments. The analysis targeted five items (Questions 1, 2, 3, 4, and 5), each scored on five-point Likert scales. The items examined respect for environmental restrictions in nature, perceived

contribution of outdoor physical activity to environmental burden, perception of university students' outdoor activity as an environmental challenge, perception of new trends in nature-based activity, and support for environmental education linked to physical activity in nature.
Descriptive statistics summarized sample characteristics via absolute and relative frequencies (*n*, *%*). For each selected item, response distributions across Likert categories underwent comparison between bachelor's and master's students. Chi-square tests of independence (χ^2) evaluated group differences, and Cramér's *V* quantified effect size. Because the analysis included five parallel tests, Holm correction adjusted *p*-values for multiple comparisons.

Tab. 1: Characteristics of study sample according to study level (*N* = 1,178)

Variable	Bachelor's degree	Master's degree	Sample
N	518	660	1,178
% of sample	44.0%	56.0%	100%
Male, *N* (%)	272 (52.5%)	312 (47.3%)	584 (49.6%)
Female, *N* (%)	246 (47.5%)	348 (52.7%)	594 (50.4%)

Ordinal logistic regression then estimated the association between study levels and response levels. Proportional odds model with logit link produced adjusted odds ratios (aORs) and 95% confidence intervals. Study level (master's vs. bachelor's) served as the main predictors, while gender, age category, and type of higher education institution entered the model as covariates. Holm correction adjusted regression *p*-values across the five analyzed items. Statistical significance followed α =.05. Interpretation considered significance and effect magnitude.

Results

Comparison of bachelor's and master's students showed significant differences across all five analyzed items in chi-square analysis, even after Holm correction (Table 2). Effect sizes remained small, with Cramér's *V* ranging from .114 to .158. Perceptions of new trends in outdoor physical activity showed the most evident between-group differences (Q4; χ^2 = 29.469, *p_adj* = 3.14 × 10^-5, *V* = 0.158), followed by support for environmental education related to physical activity in nature (Q5; χ^2 = 24.189, *p_adj* = .0003, *V* = .143) and perceived contribution of outdoor activity to environmental burden (Q2; χ^2 = 20.881, *p_adj* = .0010, *V* = .133).
For Q1, both groups reported high respect for environmental restrictions in nature, although master's students showed more favorable distributions. Combined proportions of "mostly respect" and "always respect" reached 87.6% among bachelor's students and 92.7% among master's students. For Q2, bachelor's students selected "I cannot assess" (56.4% vs. 43.6%), whereas master's students indicated that outdoor activities rather or strongly contribute to environmental burden (31.0% vs. 21.6%). For Q3, master's students viewed university students' physical activity in nature as environmental challenges ("rather yes" + "definitely yes": 40.0% vs. 31.3%). For Q4, they perceived new trends in outdoor activity ("strongly perceive" + "very strongly perceive": 32.7% vs. 24.3%), while bachelor's students reported low awareness of such trends. For Q5, support for including environmental education in higher education remained high in both groups, but the response "definitely yes" appeared more among master's students (20.0% vs. 11.6%).
In the adjusted ordinal logistic regression model, significant differences after Holm correction remained only for Q3 and Q4. Compared with bachelor's students, master's students showed higher odds of reporting higher scores for perceptions of environmental challenges (*aOR* = 1.60, *95% CI* 1.28 - 2.00, *p_adj* = .0002) and perception of new trends (*aOR* = 1.65, *95% CI* 1.33 - 2.06, *p_adj* = 4.04 × 10^-5). No adjusted differences emerged for Q1, while Q2 and Q5 showed only non-significant trends in favor of master's students.

Tab. 2: Comparison of bachelor's and master's students across questions

Q	Patterns	χ^2	p_adj (χ^2)	V	aOR	95% CI	p_adj (OLR)
Q1	Respects in both groups	15.484	.0076	.115	1.03	.81-1.30	.8307
Q2	Bc. unable to assess; Mgr. perceived burden	20.881	.0010	.133	1.24	.99-1.55	.1109
Q3	Mgr. viewed activity as an envr. challenge	15.191	.0076	.114	1.60	1.28-2.00	.0002
Q4	Mgr. perceived new outdoor trends	29.469	3.14 × 10^-5	.158	1.65	1.33-2.06	4.04 × 10^-5
Q5	Mgr. showed support for envr. education	24.189	.0003	.143	1.29	1.03-1.61	.0745

Discussion

The study indicates that degree level functions as differentiating factors in how university students perceive the environmental context of recreation in natural environments. Although students at both study levels expressed positive orientations toward outdoor physical activity, master's students often recognized environmental burden, environmental challenge, and emerging trends in natural recreation. This pattern suggests that academic progression may strengthen not only environmental knowledge, but interpretive sensitivity toward the ecological implications of recreation. Such an interpretation aligns with research emphasizing the role of higher education in developing environmental awareness and ecological literacy (Kukkonen et al., 2018; Kleespies & Dierkes, 2023; Akay & Akçaova, 2025).

An important result concerns respect for environmental restrictions. Both groups reported high levels of compliance with rules such as following marked trails and respecting protected areas, and the adjusted model did not identify significant degree-level effects for this item. This outcome suggests that basic pro-environmental norms may already hold stable places among university students regardless of study level. Differences appeared in items requiring reflective judgment, in particular, those related to environmental challenge and awareness of new recreation trends. Degree level, therefore, may influence higher-order interpretive aspects of environmental sensitivity more than simple rule acceptance. Available findings suggest that environmental attitudes, awareness, and responsible behavior in nature do not inevitably progress in tandem (Migl et al., 2023).

In particular, strong adjusted effects emerged at perceiving outdoor physical activity as environmental challenges and recognizing new trends such as trail running, gravel cycling, and outdoor fitness. These results carry practical importance because contemporary recreation diversifies and expands into ecological sensitive spaces. Students who perceive these trends may better understand their environmental consequences, including trampling, crowding, habitat disturbance, and cumulative pressure on natural areas. Current literature on outdoor education and sustainability supports this interpretation, emphasizing that direct experience in nature can strengthen environmental sensitivity when accompanied by structured educational framing (Santos-Pastor et al., 2022; Nguyen-Dinh-Dinh & Zhang, 2025).

Another result concerns perceived environmental burden. Bachelor's students selected the response category expressing uncertainty, whereas master's students acknowledged that outdoor activity contributes to environmental pressure. This contrast may indicate gaps in environmental interpretations at earlier stages of study. Bachelor's programs may present physical activity in nature through leisure, health, or performance perspectives, while ecological consequences receive less explicit emphasis. Available research suggests that university environments, campus landscapes, and outdoor education initiatives can enhance students' recognition of environmental values when ecological literacy becomes an educational goal (Huang et al., 2023).

Support for environmental education linked to physical activity in nature remained high in both groups, although the adjusted effect did not retain significance after correction. Even so, the descriptive pattern points to somewhat stronger endorsement among master's students. This tendency implies that academic maturity may increase receptiveness to sustainability-oriented content. Institutions (i.e., university), therefore, should not assume that contact with nature alone develops environmental sensitivity. Outdoor participation needs curricular and extracurricular support that links recreation with reflection on environmental burden, responsible conduct, and changing forms of contemporary outdoor activity. Evidence from higher education research points in same directions, showing that nature-based experience contributes most when paired with explicit educational aims (Puhakka, 2021; Morales-Baños et al., 2023).

Conclusion

Degree level shaped students' environmental sensitivity in recreational use of natural environments. Master's students demonstrated awareness of environmental burden, recreational challenges, and emerging outdoor activity trends than bachelor's students, indicating that academic progression may strengthen ecological interpretation of recreation. These findings highlight the need to integrate sustainability-oriented outdoor education earlier in higher education curricula, in particular, the bachelor's level. Strengthening such educational approaches may foster responsible behavior, deeper ecological literacy, and better recognition of environmental impacts associated with leisure in nature, supporting broader findings on environmental values and educational influence (Huang et al., 2023; Morales-Baños et al., 2023).

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Souhrn
Studie se zaměřuje na rekreační využívání přírodního prostředí jako oblast vyžadující odpovědné jednání a rozvinutou environmentální senzitivitu. Cílem bylo zjistit rozdíly ve vnímání environmentálních výzev a nových trendů v rekreaci v přírodě mezi studenty bakalářského a magisterského stupně. Výzkumný soubor tvořilo 1 178 vysokoškolských studentů. Analýzy prokázaly statisticky významné rozdíly ve všech sledovaných položkách, přičemž studenti magisterského stupně hodnotili environmentální souvislosti rekreace citlivěji než studenti bakalářského studia. Výsledky naznačují, že stupeň vysokoškolského vzdělání ovlivňuje environmentální percepci rekreačních aktivit. Posílení environmentálního vzdělávání v bakalářském studiu může podpořit udržitelnější chování v přírodním prostředí a přispět k odpovědnějšímu využívání přírody během volnočasových aktivit.

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DESIGN OF CREATING AN EDUCATIONAL TRAIL SELEC – INOVEC

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Abstract
Educational trails represent a specific form of environmental interpretation of the landscape. These are thematically designed routes in a natural or cultural environment, which are an important tool of environmental education, especially in protected areas. The aim of the work was a practical design of the educational trail Selec – Inovec. The design consists of the proposal of the route, the content design and the placement of information boards as well as the design of additional recreational mobiliary. The proposed educational trail is situated in the area of interest of the Považský Inovec mountain range. It is linear with a total length of 5.607 km; on the route a total of 13 stops are proposed, which contain 11 information boards thematically focused on the area of natural attractions, history and forestry activity, 3 rest areas, as well as other necessary recreational mobiliary. The educational trail should serve as an element of forest pedagogy for the forestry entity managing the given area when working with the public.

Key words: Recreation, educational trail, recreational infrastructure, informational board

Introduction

In addition to their main production function, forests also fulfill a number of non-production functions, within which the social demand is increasing also for recreational and educational functions of the forest. In this context, environmental education is gaining increasing importance, the aim of which is to shape a positive relationship of humans to nature and to support responsible behavior toward the environment.
Such a function is fulfilled precisely by educational forest trails; these are thematically focused routes that allow visitors to acquire knowledge directly in the natural environment, which increases their understanding and memorability of information.
The aim of the work was the design of the educational trail Selec – Inovec thematically focused on local natural attractions and forestry activity.

Materials and methods

The area of interest is localized in the cadastral territory of the municipality of Selec, which is located in the foothills of the Považský Inovec, south of the regional city of Trenčín at a distance of 15 kilometers. In the area of interest we can find several natural attractions:

- "natural monument Selecké stone sea" on an area of 4.83 ha with the 5th level of protection, which originated by frost weathering of quartzite rock, which created a scatter of boulders. The stone sea is formed from Triassic quartzites of the Lúžňany formation; it is composed of white gray-white to white quartzites with the presence also of heavy minerals (zircon, tourmaline, rutile) (https://app.geology.sk/gm50/);
- "nature reserve Považský Inovec" on an area of 35.42 ha with the 5th level of protection, part of this area is on the UNESCO World Heritage list;
- "natural monument Selecký stream" on an area of 4.53 ha with the 4th level of protection; it is a preserved mountain stream together with tributaries and bank vegetation;
- the peak Hradisko (732 m a.s.l.), where there are remains of fortification of a former Slavic hillfort, especially ramparts of the hillfort;
- the forest railway Trenčín – Selec, which served for the transport of harvested timber from the Považský Inovec mountain range to the sawmill in Trenčín; the route started in Trenčín, passed through Soblahov, Mníchovská Lehota, Trenčianska Turná up to Selec. It was operated in the period 1912–1937; its total length was 38.5 km; to this day several parts are preserved, such as the track body, stone and concrete bridge pillars and culverts or cuttings in the terrain (https://www.juce.sk/rozne/uzkorozchodna-zeleznica/63-urz1).

The methodology of the work consisted in terrain reconnaissance, by which the area of interest was mapped from the point of view of the occurrence of natural attractions and existing recreational use,

which was the basis for the design of the educational trail route, namely from the point of view of directional and elevation alignment, spatial arrangement, character of the surface or existence of objects of recreational use.
Using a GPS locator, the selection of suitable places for the placement of educational-information boards or other tourist mobiliary was recorded. The directional and elevation solution of the route was designed using the map portal Zbgis (https://zbgis.skgeodesy.sk/), where the placement of individual educational-information boards and rest areas was also designed.
At the rest areas, the necessary recreational mobiliary was designed; the technical design of individual objects of recreational mobiliary or educational-information boards was elaborated in the environment of the software AutoCAD 2000. Finally, the content and graphic design of individual panels of the educational-information boards was designed.

Results
The design of the directional solution of the educational trail Selec – Inovec (Fig. 1) is localized in the subunit Vysoký Inovec belonging to the Považský Inovec mountain range, characterized by intensive tourist use with a rich network of marked tourist routes (approx. 373 km).
The route passes through several tourist routes and cycling routes, which are clearly marked in the terrain in accordance with the standard STN 01 8025.

Fig. 1: The map of the area with the proposed educational hiking trail

The route design begins behind the village of Selec in the valley of the Krželnický stream behind the forester's lodge in the locality Konrút with a starting point with a parking area in front of a historical stone railway bridge at an elevation of 442.2 m a.s.l.
The first section leads along the red cycling magistral Around Považský Inovec (No. 044, length 128 km) up to the summit station of the former local ski lift at stationing 1.144 km; this section goes along the body of the former narrow-gauge forest railway (Trenčín – Selec).
From there it connects to the green tourist route (No. 5111 Nové Mesto nad Váhom – Mníchová Lehota, length 29.3 km) and continues along it below the hill Hradisko up to the locality Haranty, where there is a junction of 8 roads together with a timber loading site; there is also a tourist signpost "Za sokolou skalou" (647 m a.s.l.).
From this place the route connects to the blue cycling route (No. 2313 Kálnica – Chata pod Inovcom – Dubodiel, length 40 km) and leads up to the end of the educational trail, which is located below Chata pod Inovcom at an elevation of 788.4 m a.s.l., with the possibility of further continuation along the red cycling route (No. 0705 Hlohovec – Inovec – Trenčín, length 83.95 km). The proposed route has a linear character; its length is 5,607 m, elevation gain 346.2 m.
The route passes through a forest complex with several nice viewpoints, where 3 rest areas were also designed. The average slope of the proposed route is 6.17%; the elevation profile of the route (Fig. 2) is moderately demanding, it begins with a flat section up to the summit station of the former local ski lift; from here it continues with the steepest ascent of the route (slope 14%) with a length of approx. 1 km and further continues up to the end of the route in a gentle ascent with the exception of three short descending sections.
The proposed route has an earthen or gravel surface without more significant erosion damage and without the need for terrain modifications; it is of sufficient width allowing movement or meeting of pedestrians and cyclists.

Fig. 2: Longitude profile of trail

To this was adapted the proposal of the content of individual educational–information boards. A total of 11 boards are proposed, an introductory welcome board placed at the starting point of the trail with the basic characteristics of the educational trail and a further 10 thematically focused boards (Tab. 1). Their placement in the terrain was based both on the selection of suitable locations for their placement and also from the point of view of the content of individual boards for their practical visualization directly in the terrain.

Tab. 1: Thematic content of educational information boards

No.	Thematic focus	Stationing (km)
0	Welcome to the educational trail Selec – Inovec	0.000
1	History and present of the forest railway Trenčín – Selec	0.037
2	Municipality Selec / behavior in the forest	1.107
3	Artificially created communities of European larch (Larix decidua)	2.074
4	Natural communities of European beech (Fagus sylvatica)	2.232
5	Decline and dieback of ash trees	2.265
6	Selecké stone sea	2.883
7	Forest transportation network	3.438
8	Forest protection	4.440
9	Forest and water	4.480
10	History of Forest Enterprise Inovec s.r.o.	5.607

Educational–information boards will be made of wood; supporting posts will be made of beams 150 × 150 mm; the structure will be covered with a wooden gable roof; the panel base with dimensions 1400 × 1200 mm will be made of wooden boards and on it the actual board filling made of plastic–aluminum composite will be attached, which will be protected against weather conditions by lamination; they will be installed into the terrain on concrete footings using steel profiles.
The graphic visualization of the educational–information board is solved by dividing its area into 4 zones (Fig. 3):

1. serial number of the stop with stationing,
2. thematic title of the educational–information board,
3. text part of the addressed issue,
4. image part of the addressed issue.

Fig. 3: Layout of educational information board

Given that no recreational mobiliary equipment is located on the proposed route, 3 rest areas were designed:

- km 1.144 – designed at the upper station of the cableway of the former ski resort with a nice view of the municipality of Selec,
- km 3.438 – designed at the junction in the locality Haranty,
- km 4.127 – expanded open space in a bend of the forest road with a nice view of the White Carpathians and the municipality of Trenčianske Stankovce.

These rest areas will be equipped with a wooden shelter (square ground plan 4100 × 4100 mm) with a gable roof, installed on concrete footings, in which simple wooden seating for 10 people with a table and benches (length = 3000 mm) made of half-round timber is designed.
Their part will also be a masonry stone fire pit (Ø 700 mm), a wooden trash bin and a simple bicycle stand made of round timber (Ø 400 × 4000 mm) with carved grooves for inserting a wheel for 5 bicycles.
On the route of the educational trail there is also a spring (km 4.480), at which its roofing and modification of water outflow is proposed.

Discussion

At present, we do not have in Slovakia any regulation or guideline in the form of a binding technical regulation for the construction of educational trails. There are only manuals for a broader professional and lay public (https://naucnechodniky.eu/, Bizubová, Ružek, Makýš, 2001; Pachinger et al., 2016; Burkovský, Králiková, 2015; Růžička, 2012), from which we also proceeded when creating the design of our educational trail.
The design of the educational trail Selec – Inovec was also created in cooperation with the local forest manager of the area of interest and should have practical implementation as a tool of forest pedagogy; therefore it is thematically focused mainly on forestry activity.
In this way we would like to positively influence the perception of the lay public on forest management, which should always have priority over its recreational and tourist use.
Sometimes it happens that misunderstanding of the priority of land management by its visitors leads unnecessarily to the creation of friction, non-respect of instructions and guidelines issued by managers or forest owners, which is to the detriment of both sides.

Conclusion

The basic goal of an educational trail is to use the visitor's stay in nature also for their reflection and education from knowledge and information made accessible along the route of the educational trail.

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Souhrn

Naučné stezky představují specifickou formu environmentální interpretace krajiny. Jedná se o tematicky koncipované trasy v přírodním nebo kulturním prostředí, které jsou významným nástrojem environmentálního vzdělávání zejména v chráněných územích.
Cílem práce byl praktický návrh naučné stezky Selec – Inovec. Návrh spočívá v návrhu trasy, obsahovém návrhu a rozmístění informačních tabulí, jakož i návrhu dalšího rekreačního mobiliáře.
Navrhovaná naučná stezka je situována v zájmovém území pohoří Považský Inovec. Je liniového charakteru o celkové délce 5,607 km; na trase je navrženo celkem 13 zastávek, které obsahují 11 informačních tabulí tematicky zaměřených na oblast přírodních atraktivit, historie a lesnické činnosti, 3 odpočinková místa, jakož i další nezbytný rekreační mobiliář.
Naučná stezka by měla sloužit jako prvek lesní pedagogiky pro lesnický subjekt obhospodařující dané území při práci s veřejností.

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DESIGN AND ESTABLISHMENT OF HERBACEOUS PLANTINGS IN RURAL ENVIRONMENTS AND THEIR CONTRIBUTIONS TO PUBLIC SPACE QUALITY

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Abstract
Rural public spaces in Slovakia have undergone significant transformations in recent decades, often disrupting their traditional character and landscape identity. Appropriately designed vegetation represents an important tool for restoring the aesthetic, ecological, and cultural values of rural settlements. This study focuses on the role, functions, and potential applications of herbaceous plantings in rural environments and highlights their ecological, aesthetic, and social benefits. The paper also identifies common shortcomings in the management of rural greenery, including the absence of conceptual planning, the use of unsuitable plant assortments, and insufficient professional involvement in the design of public spaces. It presents a categorization of greenery within the built environment and discusses the specific characteristics of working with perennials and annual plants. In addition, suitable species for different site conditions are recommended, with particular emphasis on the use of local and traditional taxa. Herbaceous plantings contribute significantly to increasing biodiversity, supporting natural ecosystems, improving rainwater retention, and strengthening the identity of rural landscapes. The study ultimately emphasizes the importance of a professional and context-sensitive approach that respects local environmental conditions and cultural specificities to create sustainable, functional, and visually high-quality rural public spaces.

Key words: herbaceous plant communities; planting design; landscape architecture; urban biodiversity; rural environments

Introduction

Vegetation represents a key tool in spatial formation, extending beyond mere ground coverage to actively influence spatial structure, legibility, and use. Through planting design, space can be differentiated, movement can be guided, and visual relationships can be established. Thus, planting design integrates both aesthetic and spatial-forming functions (Vinczeová, Tóth, 2025; Kuczman et al., 2024; Tóth, Slobodníková, 2025).

Inspiration derived from natural plant communities, such as meadows, steppes, and prairies, is common in contemporary design practice. However, inappropriate application may result in homogeneous and visually monotonous compositions. For this reason, it is essential to apply principles of scale, rhythm, and contrast, which ensure visual variability and long-term attractiveness of plantings (Hus, Pástorová, 2025; Bellérová, Hus, 2025; Rózová, Pástorová, Kuczman, 2023). The design of vegetation elements is based on a comprehensive methodological approach, including site and user analysis, spatial composition design, definition of functional elements, and selection of appropriate plant species. Emphasis is placed on respecting ecological conditions, functional requirements, and the overall sustainability of the solution (Dunnett, Hitchmough, 2007; Dunnett, 2019; Rózová, Turanovičová, Tóth, 2020). Contemporary approaches to planting establishment reflect the need for environmentally sensitive solutions, including minimizing soil disturbance, utilizing organic materials, and supporting natural processes. Such plantings contribute to the stability of urbanized ecosystems.

Plantings also fulfill important aesthetic and psychological functions. Their acceptance by the public is crucial for long-term sustainability; therefore, user preferences must be considered. Nature-based plantings offer dynamism and support biodiversity, whereas traditional compositions provide a higher degree of legibility and order (Oudolf a Kingsbury, 2013; Baroš a Martinek, 2018; Hillová, et al., 2016; Hus, Saková, 2025). The contemporary concept of “enhanced nature” integrates ecological and aesthetic principles through vegetation layering, the use of native species, and the promotion of natural dynamics within plant communities (Dunnett, 2019). Lindemann-Matthies and Brieger (2016) state that, in addition to wildflower meadows, flower beds are among the preferred measures for enhancing the aesthetic value of urban green spaces. These elements can significantly contribute to the visual attractiveness of the environment, particularly in urbanized areas. Moreover, flower beds can be effectively implemented in small-scale sites (e.g., roundabouts or green strips along roads), where the use of wildflower meadows is less suitable. It is also important to note that the public may

perceive spontaneously growing vegetation as aesthetically unmaintained and less attractive, especially at the end of the life cycle of annual species. In contrast, flower beds combining ornamental and native perennials can ensure stable ground cover even in limited spaces. Their morphological and color diversity further enhances their attractiveness to pollinators. Additionally, year-round ground cover provided by ornamental perennials suppresses weed growth, thereby contributing to reduced maintenance and vegetation management costs (Pomatto, 2023). The aim of the paper was to propose and analyse various scenarios for the application of herbaceous vegetation elements in rural environments with respect to different spatial uses.

Materials and method

The methodological approach was focused on the design and application of measures (scenarios) aimed at enhancing the aesthetic and ecological quality of rural spaces. Within this framework, vegetation elements with the potential to enrich the rural landscape through visually attractive and ecologically functional components were identified and analysed. The methodological procedure was based on the selection of appropriate planting types and vegetation elements, with emphasis placed on their compositional, ecological, and functional characteristics. During their application, particular attention was given to the preservation of regional landscape character, the promotion of biodiversity, and the restoration of traditional forms of greenery typical of rural environments.

The methodological framework included the following types of vegetation elements:

- group-composed perennial beds,
- loose mixed perennial plantings,
- monocultural perennial plantings,
- annuals established by direct sowing,
- traditional annual flower beds,
- flowering meadows,
- solitary trees,
- combinations of woody plants and herbaceous species.

In the design of vegetation plantings, general design principles were applied in combination with the morphological and growth characteristics of plants. The key factors influencing the resulting composition included plant height, colour, structure, and vegetation dynamics. The implementation of these elements was evaluated in terms of their contribution to enhancing the aesthetic value of the environment as well as strengthening the ecological stability of the area. The methodology was based on nature-based design principles and integrated both traditional and contemporary approaches to the creation of vegetation elements in rural landscapes.

Results

The practical part of the study focuses on specific vegetation measures that enhance public spaces through the integration of appropriate green infrastructure elements. These include a set of design proposals consisting of herbaceous plants, woody species, and their combinations, all of which provide significant ecological and aesthetic benefits for rural landscapes. The proposed measures also reflect the current needs and development opportunities of rural environments in the 21st century.

Group-composed perennial bed

This represents a long-term vegetation element based on a predefined planting scheme that enables the creation of a structured and deliberate composition. The planting consists of multiple plant species arranged in larger, clearly defined groups. Their combination results in a strong and visually distinctive effect.

Loose mixed perennial bed This type also represents a long-term vegetation element, with the aim of approximating a naturalistic planting character. The composition is species-rich and emphasizes diversity. During implementation, a fixed planting plan is not strictly required, as the designer may arrange plants intuitively, combining solitary species with group plantings, ground-cover species, scattered individuals, as well as bulbous and tuberous plants.

Monocultural perennial planting This type of planting consists of a single plant taxon, resulting in a simple and visually calm composition. The overall effect depends on whether the planting is designed as point-based or large-scale. This approach is less demanding in terms of design and implementation; however, over time it may appear monotonous and can lead to rapid visual saturation.

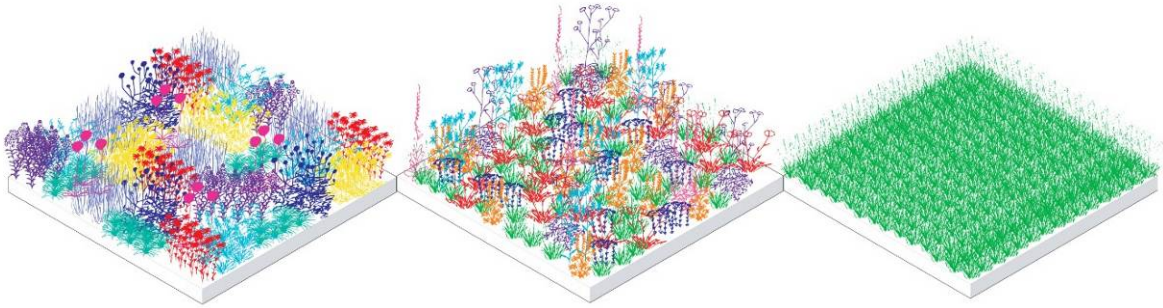

Fig. 1: Possible applications of perennial plants in rural environments in different compositional arrangements- group-composed perennial bed (left), loose mixed perennial bed (in the middle), monocultural perennial planting (right)(Pilarčík, 2025).

Annual bed established by direct sowing This represents a short-term vegetation measure composed of dicotyledonous flowering herbs without the presence of grasses, characterized by a strong visual effect. It serves as an alternative to traditional annual beds established through planting. Its advantages include a dynamic, naturalistic appearance, simple and rapid establishment even on lower-quality soils, and relatively low maintenance requirements.

Traditional annual bed Annual beds are renewed each year and represent a short-term vegetation element within the overall composition. True annuals complete their life cycle within a single growing season and die after flowering. In contrast, tender perennials (so-called “false annuals”) do not naturally die but are unable to survive winter conditions in temperate climates. The final appearance of these beds varies depending on the design concept, establishment technique, and level of maintenance.

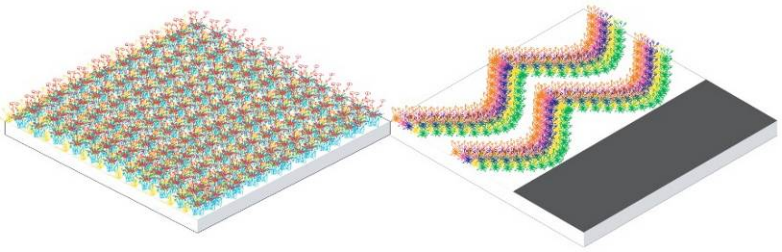

Fig. 2: Use of annual herbaceous plants in rural landscape design- annual bed established by direct sowing (left), traditional annual bed (right) (Pilarčík, 2025).

Grasses

Grasses represent the most extensive and commonly used green surface in public spaces. Several types can be distinguished depending on their function and intended use. During summer months, lawns exhibit significantly lower surface temperatures compared to impervious surfaces, thereby contributing to the reduction of urban heat. They also enable natural water retention, infiltration, and evapotranspiration, which improves local microclimatic conditions.

Flower meadow This type of vegetation consists predominantly of grasses with varying proportions of herbaceous species, particularly botanically valuable taxa. It is commonly used to simulate natural or semi-natural meadow communities and contributes to increased biodiversity as well as the enhancement of the natural character of the landscape.

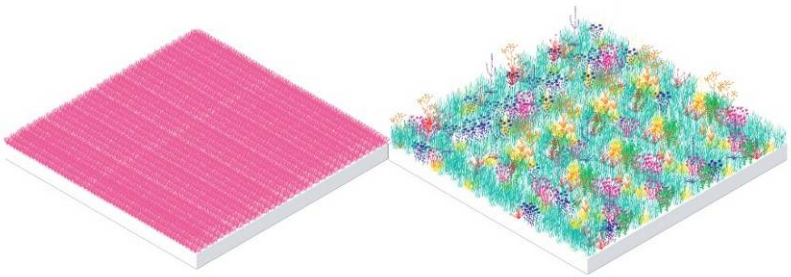

Fig. 3: Use of a herb community- grasses (left), flower meadow (right) (Pilarčík, 2025).

Planting in mobile containers Containers designed for planting can take various forms and allow for the use of a wide range of herbaceous and woody species, including their combinations. Depending on the selected plant material, these vegetation elements may be temporary, perennial, or movable. They represent a functional technical solution that enables the introduction of greenery in locations where conventional planting is not feasible.

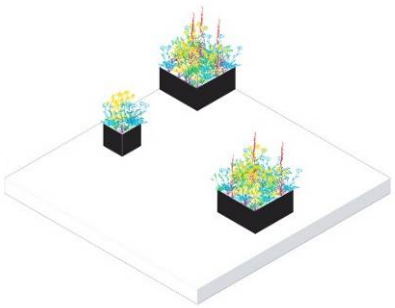

Fig. 5: Use of herbaceous plants in combination with technical elements- mobile containers (Pilarčík, 2025).

Discussion

Herbaceous plantings represent a current and relevant approach to greenery management in rural environments, both in central and peripheral areas. Village centres, as the most frequently visited and intensively used spaces, are required to meet specific aesthetic and functional standards while also providing representative and recreational environments (Balko, 2017; Čibik, 2024). The increasing concentration of users in limited public spaces places growing demands on the quality of these areas. Consequently, green public spaces must offer a high level of aesthetic experience and functional value (Oudolf, Gerritsen, 2013). Herbaceous plantings based on plant communities primarily focus on ground coverage and the selection of species to create a coherent composition. However, this approach needs to be extended by incorporating spatial design considerations. Plantings should not merely fill empty spaces but actively shape, structure, and define spatial identity (Dunnett, 2019). Therefore, the objective of design should extend beyond visual appearance to the creation of an authentic spatial atmosphere. In the design of herbaceous plantings, their aesthetic function must be carefully considered, as it often represents the primary motivation for their implementation (Baroš, Martinek, 2018). Plant combinations should not be random; instead, they should be deliberately selected to reflect user preferences while maintaining rhythm and compositional unity (Oudolf, Kingsbury, 2013). In this way, planting design creates not only a visual effect but also an emotional connection between people and space. For these reasons, it is essential that vegetation measures are systematically implemented in rural public spaces. They contribute not only to improving the quality of life of residents but also to enhancing the visual character of rural environments and strengthening their connection with the surrounding landscape. Vegetation thus plays a key role in shaping public space—not merely as a complement to architecture, but as an active and defining element. In conclusion, herbaceous plantings can be considered an effective tool for addressing the challenges of contemporary rural planning, with the potential to significantly improve the quality, identity, and ecological as well as social value of rural settlements.

Conclusion

Herbaceous plantings represent an effective tool for improving the quality of rural public spaces in Slovakia by enhancing their ecological, aesthetic, and social functions. The study confirms that appropriately designed vegetation can contribute to biodiversity support, microclimate regulation, and the restoration of local landscape identity. At the same time, it highlights the importance of a systematic and professional approach that integrates ecological conditions, spatial composition, and user needs. The application of context-sensitive and nature-based design principles is essential for creating sustainable, functional, and visually coherent rural environments.

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Souhrn
Venkovské veřejné prostory na Slovensku prošly v posledních desetiletích významnými proměnami, které často narušily jejich tradiční charakter a krajinnou identitu. Odborně navržená zeleň představuje důležitý nástroj pro obnovu estetických, ekologických a kulturních hodnot venkovských sídel. Tato studie se zaměřuje na roli, funkce a možné využití bylinných výsadeb ve venkovském prostředí a zdůrazňuje jejich ekologické, estetické a sociální přínosy. Článek také identifikuje běžné nedostatky v péči o venkovní zeleň, včetně absence koncepčního plánování, používání nevhodných druhových skladeb a nedostatečného zapojení odborníků do navrhování veřejných prostor. Představuje kategorizaci zeleně v zastavěném prostředí a diskutuje specifické charakteristiky práce s trvalkami a jednoletými rostlinami. Dále doporučuje druhy vhodné pro různé podmínky stanovišť, se zvláštním důrazem na využití místních a tradičních taxonů. Bylinné výsadby významně přispívají ke zvyšování biodiverzity, podpoře přírodních ekosystémů, zlepšování zadržování dešťové vody a posilování identity venkovské krajiny. Studie nakonec zdůrazňuje význam profesionálního a kontextově citlivého přístupu, který respektuje místní environmentální podmínky a kulturní specifika, s cílem vytvořit udržitelné, funkční a vizuálně kvalitní venkovské veřejné prostory.

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DESIGNING A RECREATIONAL GREENWAY IN A FORMER RAILWAY CORRIDOR: THE RADOŠINKA CYCLING ROUTE

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Abstract
This paper presents a landscape architectural design proposal for a regional cycling route in the Radošinka microregion in western Slovakia. The project explores the potential transformation of a former railway corridor between Zbehy and Radošina into a recreational greenway connecting the cities of Nitra and Piešťany. The aim is to develop a sustainable cycling corridor that supports everyday mobility and recreational use while simultaneously enhancing the landscape accessibility of the surrounding rural environment. The study is based on a comprehensive landscape analysis focusing on settlement structure, landscape character, visual relationships and existing mobility networks within the predominantly agricultural landscape of the microregion. Based on these analyses, the proposal defines the main cycling route primarily outside major roads and complements it with thematic cycling loops linking individual municipalities, landscape landmarks and cultural heritage sites. Attention is given to the design of rest areas, viewpoints and small-scale landscape architectural elements that integrate the cycling route into the open landscape and strengthen regional identity. The design approach emphasises a sensitive relationship between recreation and landscape protection, ensuring that the proposed infrastructure respects the visual structure, ecological values and character of the rural landscape. The project demonstrates how the reuse of abandoned infrastructure corridors can support sustainable recreation, landscape protection and regional development.

Key words: rural landscapes; landscape accessibility; landscape architecture; sustainable mobility; green infrastructure

Introduction

Contemporary landscape architecture increasingly addresses the need to reconcile mobility demands with environmental sustainability (Fornal-Pienak and Bihuňová, 2022) and the preservation of rural landscape character (Schüppel and Staudte, 2025; Štemberová et al., 2025). In this context, cycling infrastructure has emerged as a key component of sustainable mobility systems, offering an environmentally friendly, economically accessible and socially inclusive alternative to motorised transport (Tóth et al., 2014; Čibik et al., 2019). Beyond its transport function, cycling also plays an important role in recreation, public health and regional development, contributing to improved quality of life and stronger connections between settlements and their surrounding landscapes (Bechera et al., 2022; Hus, 2024). In many European regions, including Slovakia, the development of cycling infrastructure remains uneven, particularly in rural areas where everyday mobility is still largely dependent on car transport. At the same time, these regions often contain underutilised or abandoned transport corridors—such as former railway lines—which represent significant spatial and structural potential for transformation into greenways. The adaptive reuse of such corridors enables the creation of continuous, safe and legible routes that can serve both functional and recreational purposes while minimizing new land consumption (Čibik et al., 2022; Bellérová and Hus, 2025; Karzhauov et al., 2025). The Radošinka microregion in western Slovakia presents a typical example of a predominantly agricultural landscape with dispersed settlements, limited transport alternatives and a strong cultural and natural identity (Králik, 2025). Its flat terrain and linear structure defined by the Radošinka stream provide favourable conditions for cycling. However, the absence of a coherent cycling network restricts both everyday mobility and the recreational use of the landscape. At the same time, the railway corridor between Zbehy and Radošina offers a unique opportunity for the development of a continuous cycling connection linking the regional centres of Nitra and Piešťany. Cycling routes in rural landscapes are not merely technical infrastructures; they are landscape architectural interventions that influence spatial perception, accessibility and the overall experience of the territory. Well-designed routes can connect cultural landmarks, enhance visual relationships, support biodiversity and contribute to the identity of a region (Paganová and Kuczman, 2022; Kuczman and Paganová, 2022). They can also activate underused spaces and support community engagement, reflecting broader socio-spatial dynamics in landscape design (Miklášová et al., 2022; Čakovská et al., 2019). As

highlighted in previous research, cycling infrastructure delivers economic, ecological and social benefits, including reduced emissions, support for local tourism and improved public health outcomes (Hus et al., 2021; Kristiánová and Štěpánková, 2012). This paper builds upon a comprehensive landscape architectural study and presents a design proposal for a recreational greenway utilising the former railway corridor in the Radošinka microregion (Králik, 2025). The aim is to develop a multifunctional cycling route that integrates sustainable mobility with landscape protection and recreational use. The proposal is informed by an in-depth analysis of the spatial structure, landscape character, visual axes and existing mobility networks, and it seeks to create a coherent system of main and complementary routes that enhance accessibility while respecting the ecological and visual qualities of the rural environment. By demonstrating the potential of railway-to-greenway transformation, the study contributes to broader discussions on sustainable infrastructure, landscape regeneration and the role of design in shaping resilient rural territories.

Material and methods

The study is based on a landscape architectural design approach combining spatial analysis, field research and conceptual design methods. It focuses on the Radošinka microregion in western Slovakia (Nitra Self-Governing Region, districts of Nitra and Topoľčany). The territory forms part of the Danubian Lowland and the floodplain system of the Váh River basin. The landscape is predominantly agricultural, with a flat to gently undulating relief shaped by the Radošinka stream. The study area includes ten cadastral territories. The primary materials consisted of spatial and analytical data describing the natural and cultural landscape structure of the territory, including topographic and orthophoto maps, land use and vegetation data, transport infrastructure networks, cadastral and settlement structure data, as well as relevant planning documents and technical standards. Field surveys were carried out to verify current landscape conditions, identify visual relationships, assess the quality of existing infrastructure and document cultural and natural landmarks within the microregion. The methodological framework consisted of several consecutive steps: 1) landscape analysis; 2) mobility and infrastructure assessment; 3) identification of potential corridors; 4) design principles and routing strategy; 5) landscape architectural design.

Results

The proposed transformation of the former railway corridor between Zbehy and Radošina into a cycling greenway proves to be a feasible strategy for improving mobility and recreation in the Radošinka microregion. The corridor enables a continuous, safe and legible main cycling route connecting Nitra and Piešťany, while avoiding high-traffic roads. The design defines a hierarchical network consisting of a primary route and secondary thematic loops linking municipalities, cultural landmarks and landscape features, thereby significantly enhancing landscape accessibility. The flat relief and agricultural character of the territory were identified as key advantages for cycling development, while the current lack of infrastructure was confirmed as a major limitation. An important outcome is the integration of landscape architectural elements, including rest areas, viewpoints and small-scale interventions, which transform the route into a multifunctional recreational corridor. The proposal respects visual structure, ecological values and regional identity, demonstrating that the reuse of abandoned infrastructure can support sustainable mobility, tourism and rural development.

Discussion

The results confirm the potential of former railway corridors as effective spatial frameworks for the development of cycling greenways in rural landscapes. Similar to findings on the reuse of underutilised spaces and sustainable land strategies (Čibik et al., 2022; Bellérová and Hus, 2025; Karzhauov et al., 2025), the proposed transformation of the Zbehy–Radošina corridor provides a continuous and safe route while minimising new land consumption. The integration of a hierarchical network and landscape architectural elements supports previous research emphasising the role of design in enhancing landscape accessibility, identity and user experience (Paganová and Kuczman, 2024; Kuczman and Paganová, 2024). At the same time, the study highlights the need for context-sensitive approaches that balance recreational use with the protection of ecological and visual landscape values, as noted in broader discussions on rural landscape planning and sustainability (Fornal-Pienak and Bihuňová, 2022).

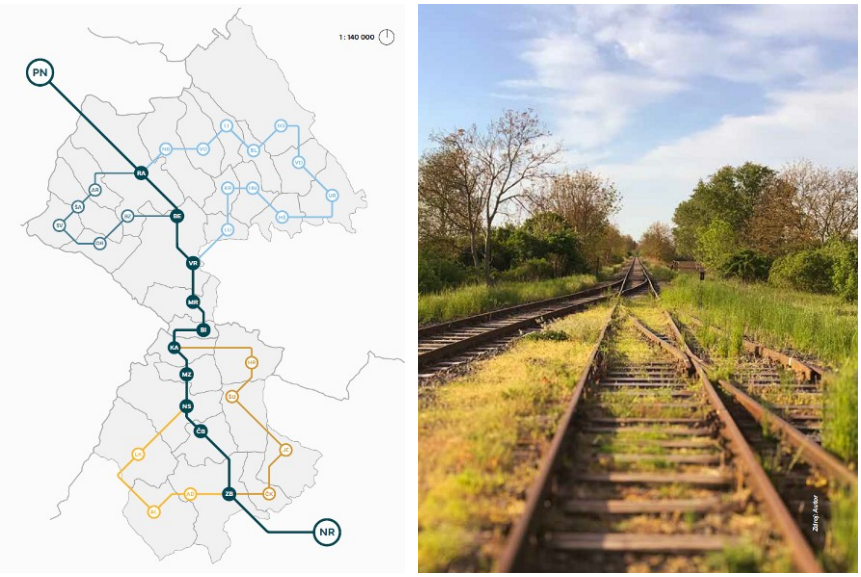

Fig. 1: The proposed cycle route from Nitra to Piešťany (left), partly to be implemented on an abandoned railway corridor (right) (Source: Králik, 2025).

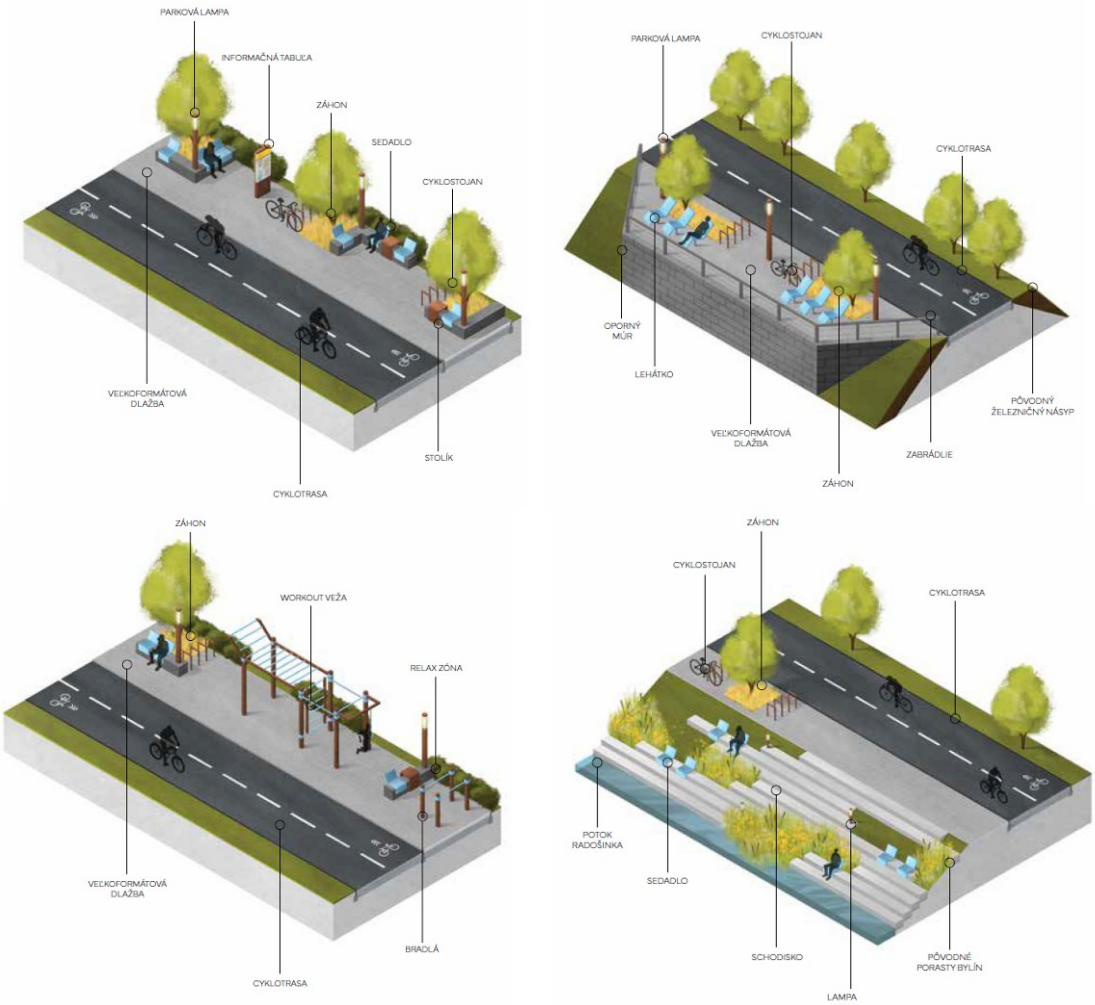

Fig. 2: Different site-design typologies along the cycle route (Source: Králik, 2025).

Conclusion

The study demonstrates that the reuse of the former railway corridor in the Radošinka microregion offers a viable solution for developing a sustainable cycling greenway. The proposed design enhances mobility, landscape accessibility and regional identity while respecting ecological and visual values. It highlights the potential of abandoned infrastructure as a catalyst for sustainable rural development.

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Souhrn
Článek představuje návrh cyklistické zelené stezky v mikroregionu Radošinka, který vychází z přeměny bývalého železničního koridoru. Projekt spojuje udržitelnou mobilitu s ochranou krajiny a vytváří souvislou trasu doplněnou tematickými okruhy a prvky krajinářské architektury. Návrh zlepšuje dostupnost, rekreační potenciál a posiluje regionální identitu v převážně zemědělské krajině.

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DESIGNING LANDSCAPE FRAMES AND PROCESSES – CONTEMPORARY DILEMMAS IN THE AGE OF CLIMATE CHANGE

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Abstract
Human attitudes towards nature and trees have evolved from fear, humility, and respect, through triumph and nonchalance, to concern for the future. Contemporary cities, in the age of climate change, should develop in accordance with the concept of "sustainable development," which is understood, among other things, as actions that reconcile the well-being of nature with human needs, with the well-being of future generations in mind.
Generally speaking, we distinguish three design trends in contemporary landscape architecture: conceptual (artistic), functional, and ecological. Unfortunately, it often happens that nature-based solutions or actions under the banner of biodiversity protection are based on form, placing a strong emphasis on aesthetics in the traditional sense and harmony. In this article, the author presents several important assumptions that should guide the actions of designers pursuing the mission of adapting to and mitigating climate change. The foundation for effective action is understanding the processes occurring in the ecosystem and the role and position of humans in nature.
The aim of the work is to present models of dynamic landscape shaping (DLS) with particular emphasis on vegetation typical of floodplains in the Vistula River valley in the city of Warsaw. The research results allowed us to formulate guidelines for the proper shaping of plant landscapes in river valleys in urban space, which has practical use in urban planning and landscape architecture.

Key words: Dynamic landscape shaping, biodiversity, ecological design, adaptation to climate change, river valley.

Introduction

Conventional landscape design paradigms have become insufficient in the context of contemporary social, economic, and climatic challenges. In response, landscape architecture has shifted from conceptual, form-oriented approaches toward ecological design focused on protecting phytocoenoses, enhancing biodiversity, and strengthening ecosystem services. Current design concepts increasingly adopt a systemic, landscape-based perspective that integrates ecological, social, and economic interdependencies, treating the landscape as a social-ecological system (Parks & Liao 2022).
A key expression of this shift is the concept of Nature-Based Solutions (NbS), defined as actions that use ecosystem processes to address environmental and societal challenges while supporting biodiversity and human well-being (Cohen-Shacham et al. 2016; Sowińska-Świerkosz & García 2024). NbS offer an alternative to “gray” infrastructure by embedding natural processes into spatial planning and design.
Within a functionalist paradigm, shaping natural systems is understood as supporting and regulating ecological processes—such as energy and matter flows—through long-term monitoring, targeted interventions, maintenance, and, where appropriate, deliberate non-intervention (Beatley 2016). In this context, design should not aim at achieving a fixed climax state, but rather at managing dynamic processes. Succession depends on periodic disturbances (e.g., grazing, cutting), which are essential for maintaining biodiversity (Sikorski & Rosłon-Szeryńska 2011). However, in urban environments, uncontrolled processes may lead to undesirable outcomes, such as the dominance of expansive synanthropic species (Rosłon-Szeryńska & Sikorski 2011; Fortuna-Antoszkiewicz et al. 2018).
Understanding succession mechanisms is therefore fundamental to process-based ecological design. Classical ecological theory distinguishes two primary models: the deterministic (Clementsian) model, which assumes a predictable progression toward a stable climax (Clements 1916), and the individualistic (Gleasonian) model, emphasizing species-specific responses and the absence of a fixed endpoint (Gleason 1926). While the former supports restoration-oriented design, it is often criticized for oversimplification (Pickett et al. 1987), whereas the latter underlines the need for flexibility and acceptance of variability.
Contemporary ecology integrates these perspectives through mechanistic models that highlight species interactions and environmental conditions, including facilitation, tolerance, and inhibition (Connell & Slatyer 1977), as well as disturbance-based and mosaic dynamics (Pickett et al. 1987).

The aim of this paper is to present a model for designing dynamic ecological processes in naturally valuable urban areas, using river valleys as a case study. The approach is based on vegetation dynamics and succession theory, interpreting succession as a process leading to relative, dynamic stability of phytocoenoses, shaped by internal and external factors and contributing to ecosystem resilience.

Material and methods.

An ecological approach was adopted, incorporating the theory of vegetation dynamics and succession mechanisms. The study is based on the premise that succession represents a phytocoenosis's pursuit of relative stability—a dynamic and flexible process, shaped by internal and external factors, that enhances ecosystem resilience.

Pilot research was conducted using the Golędzinów Nature Park project, located within the Natura 2000 site of the middle Vistula River Valley in Warsaw (Poland) (fig. 1). The research comprised three stages, based on long-term environmental monitoring, including analyses of vegetation cover transformations and physiographic conditions.

Fig. 1: Golędzinów Park in the Vistula Valley. Aerial view.

Scenarios of predicted vegetation development were elaborated, accounting for both natural and anthropogenic processes. These projections were grounded in an analysis of historical and current succession mechanisms observed in the Golędzinów area over the past century. The proposed design interventions aim to stimulate or initiate desirable ecological processes, support the sustainability of climax communities, and restore degraded systems.

The study applied key criteria for assessing vegetation variability, with particular emphasis on succession processes and human impact, including management practices such as mowing, tree removal, and land-use changes.

Results

Characteristics of the study area, conditions, and natural and landscape transformations

The study area is located within the floodplain of the Vistula River Valley, between the Gdański Bridge and Gen. S. Grota-Roweckiego Bridge, within the Natura 2000 Central Vistula Valley Special Bird Protection Area. Its formation has been shaped by fluvial processes and anthropogenic activity. The Golędzinów floodplain developed on sandy and organic sediments within former meandering oxbow systems.

Over the last century, the area has undergone significant transformations, enabling the identification of future landscape dynamics under climatic and urban pressures. Before World War II, large parts of the area were waterlogged, with extensive sandbanks and active river branches. Subsequent cut-offs formed oxbow lakes, some of which still retain water periodically or permanently. Riparian communities originally dominated the area.

Fig. 1. shows a orthophotomap from 1935 with the marked and current boundaries of the Vistula River shoreline and treeline. Visible zones of sandbanks in the northern and central parts indicate the later development of less fertile meadows and grasslands. The southern areas, wooded and underwater in 1935, are now covered with riparian shrubs, reed beds, and fresh floodplain meadows. Sandy coastal banks remaining from the pre-war period Area underwater in the pre-war period Oxbow lake

connected to the Vistula River in the 1930s and early 1940s. Current boundary of Golędzinów Park between the Puck Coast earthwork and the Vistula shoreline.
Until the 1980s, natural succession led to the expansion of riparian vegetation, later disrupted by the establishment of family allotment gardens (fig. 2). Three clusters of riparian trees are visible, left within the allotment gardens. Riparian trees in a striped arrangement are visible in the Vistula riverbank zone. These sites indicate the historical continuity of phytocoenoses. The remaining area has seen development changes, including modification of the inland shoreline and the formation of islands, the transformation of riparian forests into pastures and meadows, followed by the cultural cultivation of allotment gardens, and ultimately the restoration of meadow phytocoenoses.
In 2014, a high river level was visible in this area. Thanks to deposited sediments, riparian forest stands are regenerating. This is the period of liquidation of allotment gardens. The successional development of riparian communities is closely linked to the physiographic conditions of the area (including terrain, geomorphology, water-soil, and microclimate conditions). The drifting spatial arrangement of emerging clusters of trees and shrubs shapes the shape of the Vistula oxbow lake, and their persistence and further development is conditioned by the flood movements of the Vistula flood wave and the direction of valley ventilation.
Remnants of natural phytocoenoses persisted in oxbow depressions and along the river. Since the early 2000s, following the removal of allotments, renaturalization processes have intensified, including the regeneration of riparian shrubs and the restoration of floodplain meadows (2014–2016).
Fig. 4. Shows contemporary land transformations with secondary succession. The present landscape is typical of urban river valleys, dominated by floodplain meadows (*Molinio-Arrhenatheretea*) with synanthropic and non-native species, and riparian forests (*Salici-Populetum*). However, it has cultural features resulting from the presence of ornamental plants (including trees) from former allotment gardens.

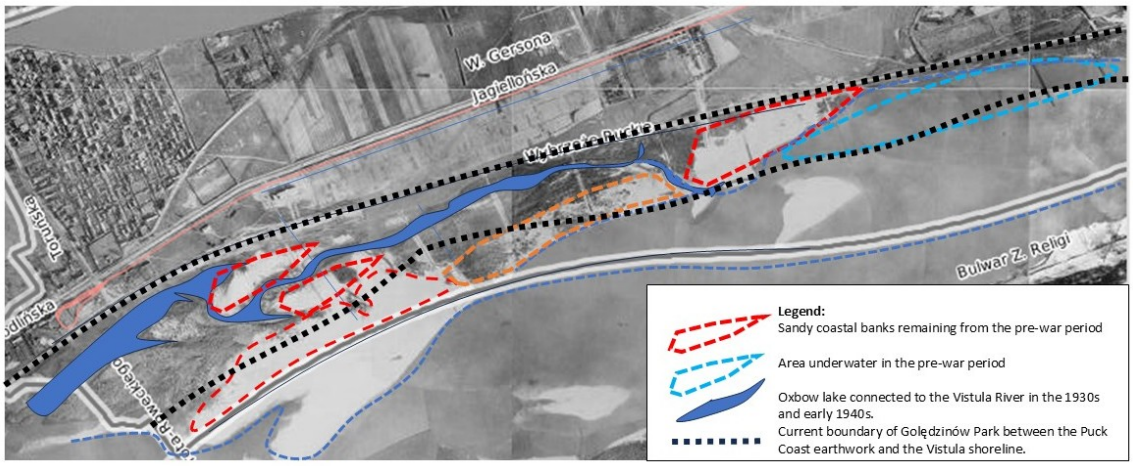

Fig. 2: Orthophotomap of the area from 1935, showing the boundaries of the riverbank and its numerous oxbow lakes. Shallow areas are visible in the northern and central parts.

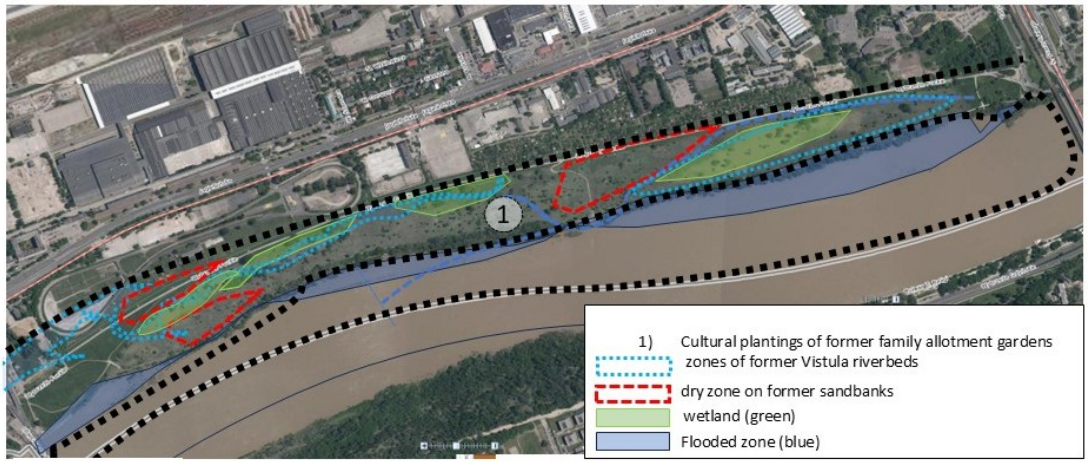

Fig. 3: Orthophotomap of the area developed with allotment gardens from the 1980s and 1990s, with the marked and current boundaries of the Vistula River shoreline and treeline layout.

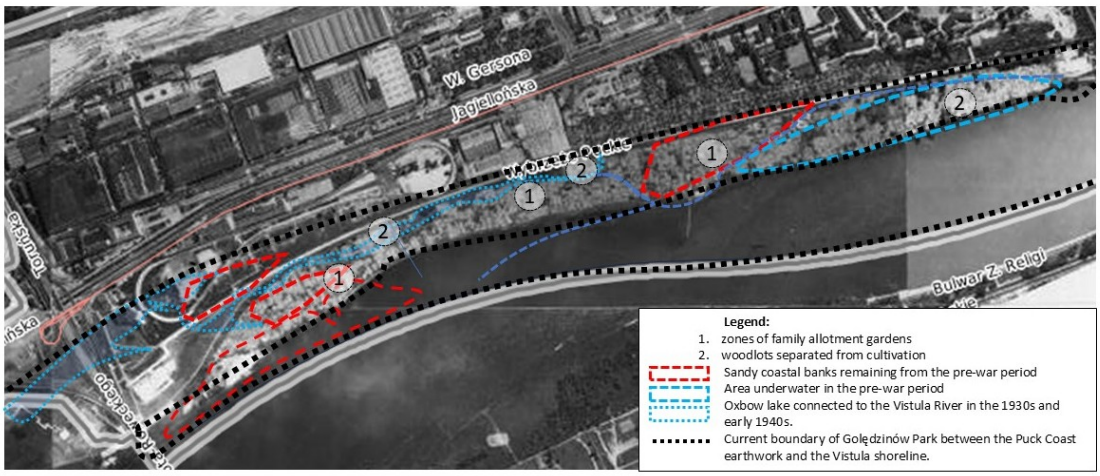

Fig. 4: Orthophotomap of the area during the Vistula River's high water level in 2014. Flooded zone (blue), wetland (herb), and in the oxbow lake basin (red).

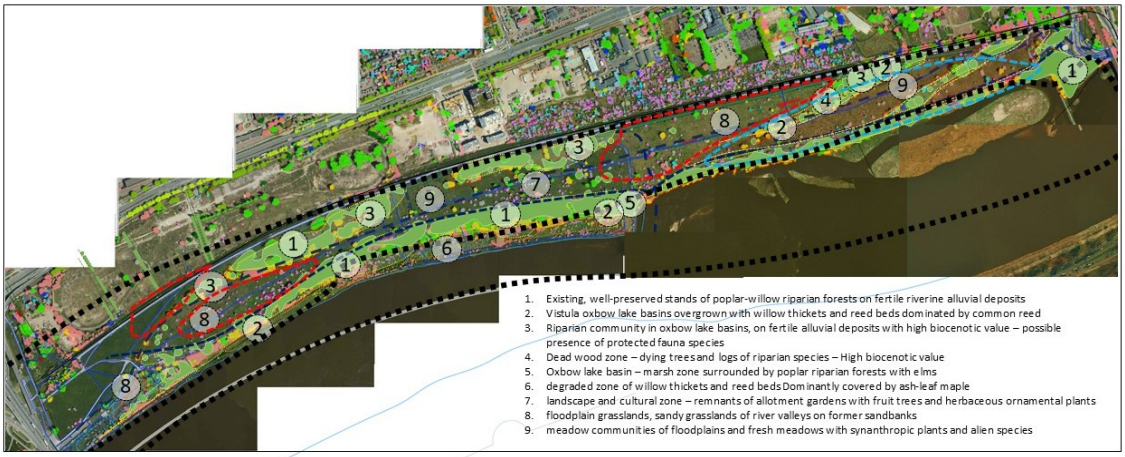

Fig. 5: Contemporary land transformations with secondary succession.

Conclusions from the analyses and design assumptions

The study adopts an ecological approach grounded in vegetation dynamics and succession theory, treating succession as a dynamic process leading to relative ecosystem stability and resilience. The research framework consisted of three stages: (1) long-term monitoring and physiographic analysis, (2) development of scenarios of vegetation transformation under varying levels of human intervention, and (3) evaluation of predicted changes leading to habitat protection concepts.

The spatial structure of vegetation is strongly determined by fluvial processes and human activity. Based on historical and current succession patterns, forecasts of phytocoenotic transformations were developed. Design interventions aim to stimulate desirable ecological processes, support climax communities, and restore degraded systems through targeted actions, maintenance, or controlled non-intervention, supported by monitoring.

Key assumptions include: maintaining strip-like riparian forests along the river; restoring willow shrub communities on riverbanks; enabling secondary succession in former oxbow zones following allotment removal; halting succession of semi-natural meadows through active management; and allowing succession of aquatic communities towards terrestrial forms under eutrophication and climate change pressures.

The developing landscape and spatial structure of the vegetation are closely linked to the river's fluvial processes (linear character, drifting tree clusters, and belt-like tree plantings) and human activity (open meadows, scattered tree and shrub plantings). It is important to consider that animals (including birds and small mammals) and wind will be significant architects of the emerging plant structures and species composition of the "Golędzinów" Natural Park.

Guidelines and Recommendations for Habitat Protection

For well-preserved riparian forests (*Salici-Populetum*), management focuses on monitoring and supporting natural generational and seasonal dynamics. In floodplain meadows, succession towards forest and the spread of invasive species should be controlled through mowing regimes, adapted to

phenological cycles. Early mowing of goldenrod-dominated patches and later mowing of species-rich meadows are recommended, along with biomass removal, seed dispersal support, and optional liming under low flood frequency conditions.
In former oxbow areas, passive management (cessation of mowing) combined with removal of invasive species (e.g., *Acer negundo*, *Solidago canadensis*) is intended to stimulate secondary succession and natural regeneration of native riparian species. Aquatic and semi-aquatic habitats are expected to undergo gradual terrestrialization due to eutrophication and altered hydrological regimes.
In degraded riparian communities, regenerative succession is supported through the gradual removal of invasive species and promotion of native regeneration via natural dispersal mechanisms. Selected specimens of non-native trees may be retained for cultural and landscape value.
Deadwood retention and natural tree senescence are recommended, with safety ensured through spatial planning and selective pruning near paths. Regular inspection of structurally sensitive trees is required. The design of paths and infrastructure aims to minimize human disturbance while enabling controlled observation, thereby supporting biodiversity conservation.

Conclusion

The study demonstrates a design approach focused on shaping dynamic ecological processes rather than static plant compositions. By integrating long-term environmental monitoring, succession theory, and scenario-based forecasting, the proposed model enables adaptive management of urban riverine landscapes.
The results confirm that vegetation structure and landscape form are emergent properties of interacting natural and anthropogenic processes. Design interventions should therefore act as catalysts of desirable ecological dynamics—supporting resilience, enabling regeneration, and guiding succession trajectories—rather than imposing fixed spatial forms.
This process-oriented approach provides a transferable framework for sustainable landscape design, particularly in ecologically sensitive and dynamically changing environments such as urban floodplains.

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Souhrn
Postoj člověka k přírodě a stromům se vyvíjel od strachu, pokory a úcty přes pocit nadvlády a lhostejnost až k obavám o budoucnost. Současná města by se v době klimatických změn měla rozvíjet v souladu s konceptem „udržitelného rozvoje“, který se mimo jiné chápe jako opatření, jež sladí blaho přírody s lidskými potřebami, a to s ohledem na blaho budoucích generací.
Obecně lze v současné krajinářské architektuře rozlišit tři designové trendy: koncepční (umělecký), funkční a ekologický. Bohužel se často stává, že řešení založená na přírodě nebo opatření pod záštitou ochrany biologické rozmanitosti vycházejí z formy a kladou silný důraz na estetiku v tradičním smyslu a harmonii. V tomto článku autor představuje několik důležitých předpokladů, které by měly vést k činům projektantů usilujících o přizpůsobení se klimatickým změnám a jejich zmírnění. Základem účinného jednání je pochopení procesů probíhajících v ekosystému a role a postavení člověka v přírodě.
Cílem práce je představit modely dynamického formování krajiny (DLS) se zvláštním důrazem na vegetaci typickou pro nivy v údolí řeky Visly ve Varšavě. Výsledky výzkumu nám umožnily formulovat pokyny pro správné formování rostlinných krajin v říčních údolích v městském prostoru, což má praktické využití v urbanismu a krajinářské architektuře

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DEVELOPMENT OF BUSINESS EVENTS IN DESTINATION KOŠICE BASED ON COOPERATION WITH THE SLANSKÉ HILLS REGION

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Abstract
The article summarizes the successful cooperation between neighboring Destination managment organisations and the destinations of Košice and Prešov, whose main goal is to develop sustainable tourism in the Slanské Hills sub-destination and at the same time expand Košice's offer as a destination for business events. The connection and development of nature and incentive tourism with the congress segment strengthens the competitiveness of the region.

Key words: MICE, incentive activities, geological area, unique experiences, marketing, overturizmus

Introduction
The phenomenon of overtourism in the Košice and Prešov Regions does not constitute a uniform problem of evenly distributed excessive visitor pressure, as observed in destinations that dominate global tourism flows. Rather, it represents a structural phenomenon of selective overcrowding in a limited number of localities, occurring alongside the persistent long-term underutilisation of the majority of the territory. This constitutes a spatial asymmetry of tourist demand, with direct implications for the quality of the visitor experience, the integrity of natural and cultural heritage, and the effectiveness of regional tourism development.
Overtourism refers to a condition in which the number of visitors to a given destination exceeds its carrying capacity, ecological, infrastructural, or social, resulting in a deterioration of residents' quality of life, damage to natural and cultural heritage, and, paradoxically, a decline in the quality of the experience for tourists themselves (UNWTO, 2018).
The most pronounced example of this concentration is the High Tatras, where transport, environmental, and infrastructural pressures converge, with traffic congestion and trail overcrowding during peak seasons negatively affecting both biodiversity and visitor experience. Experts and regional stakeholders consistently identify the redistribution of visitor flows towards alternative destinations as a key measure in sustainable destination management.
The core challenge facing both regions lies not in the absolute volume of visitor arrivals, but in the uneven spatial distribution of tourist flows. Demand remains concentrated on a narrow set of iconic destinations, principally the High Tatras, Slovak Paradise, and Spiš Castle, while territories with considerable natural and cultural-historical potential, such as the Slanské Hills, the Čergov Mountains, the Vihorlat Hills, and the Šariš region, remain largely peripheral to both domestic and international visitors. This is further compounded by the dominance of day-trippers, who do not utilise local accommodation or catering facilities, thereby minimising the economic contribution of their visit to local communities.
In this context, a key finding is the potential for linking the urban cultural environment of Košice with the natural and cultural assets of the wider region, and in particular the sub-destination of the Slanské Hills. To date, the Slanské Hills have not been formally defined as a distinct tourism sub-destination, and this extensive territory encompasses as many as 89 municipal units across the Košice and Prešov Regions. Tourism stakeholders have long identified a persistent absence of systematic support, coordinated activity, effective inter-institutional cooperation, and coherent marketing communication within this area.
Tourism, and in particular its MICE segment (Meetings, Incentives, Conferences, Exhibitions), also referred to as business events, represents a significant instrument of economic development for both the city and the region. In comparison with leisure tourism, it generates higher added value, longer average length of stay, and a greater utilisation of local services. The Košice destination possesses both the prerequisites and the infrastructure necessary for the development of business events. Analytical outputs indicate, however, that the destination's potential remains underexploited, particularly with regard to the diversification of the tourism offer and the more effective integration of the city with its wider regional surroundings. A fragmentation of the tourism product and an insufficient productisation of incentive and post-congress activities have been identified, which is further reflected in the relatively short average length of stay among visitors.

In response to this identified need, a cooperative initiative was established in 2025 by three destination managemenet organisations (hereafter DMOs): Visit Košice, Región Šariš, and Horný Zemplín. This initiative opened a professional dialogue with territorial stakeholders and subject-matter experts.

Materials and methods

This article builds upon existing strategic, analytical, and marketing documents produced by Visit Košice DMO, as well as on the findings of market research studies aimed at assessing the readiness of the Košice destination to host business events for both domestic and international clients. The analysis presented in this article draws primarily on a qualitative case study derived from the operational practice of Visit Košice DMO, and on specialist strategic studies and action plans developed through collaboration between DMOs and the Technical University of Košice.

Results

Visit Košice DMO has been actively engaged in the development of business events within the city of Košice since 2024. Together with Bratislava and the High Tatras, Košice ranks among the principal areas in which business events is currently expanding. The city possesses several key prerequisites for the development of the MICE segment and for attracting international business events clients. It benefits from a strong cultural identity, a rich portfolio of urban and regional attractions, a high standard of supporting services, and a favourable geographical position within Central and Eastern Europe. At the same time, however, the destination faces challenges typical of secondary MICE destinations — a fragmented tourism offer, limited capacity for large-scale events, and the absence of a unified strategic framework.

In response to a published call for cooperative projects issued by the Ministry of Tourism and Sport of the Slovak Republic, a joint project was submitted in 2025 by three cooperating DMOs with the aim of supporting the development of business events and incentive tourism offerings. The project was successfully completed and resulted in the production of several significant documents authored by both domestic and international experts, assessing the development potential of the Košice destination in the field of business events, and of the Slanské Hills sub-destination as a rich and largely undiscovered area with considerable potential for the development of leisure and incentive offerings in support of the broader growth of business events. One of the first activities undertaken within the cooperative project was a survey examining international perceptions of Košice as a potential destination for the organisation of business events. Among the positive findings regarding the perception of Slovakia, culture and nature emerged as key differentiating factors described as a *clear distinction from major congress cities*, thereby confirming the strategic rationale for focusing on the development of the Slanské Hills sub-destination, an area that remains comparatively lesser-known alongside the iconic cultural and natural attractions of eastern Slovakia.

The Slanské Hills constitute a volcanic mountain range in eastern Slovakia, extending from Prešov to the border with Hungary and forming part of the Carpathian volcanic arc. The area is of particular appeal due to its natural attractions, most notably the only geyser in Slovakia, as well as its technical and historical landmarks, including the Opal Mines, the only such mines in Europe, complemented by a dense network of hiking trails.

One of the key outputs produced in 2025 is the Action Plan for the Development of the Slanské Hills sub-Destination. The Action Plan serves as an operational strategic instrument for the systematic development of the sub-destination, with the overarching objective of transforming the area into an attractive and sustainable tourism destination. The plan is structured around two complementary pillars — tourism infrastructure development and product and service development. It identifies priority areas for intervention aimed at enhancing the attractiveness of the territory, improving accessibility, and diversifying the tourism offer across different visitor segments.

In the area of tourism infrastructure development, the document analyses the existing network of hiking and cycling trails, categorised by difficulty and functional significance, and identifies the need for their extension and interconnection through several new sections. A separate area of concern is the insufficiency of accommodation and catering facilities, compounded by the low digital visibility of existing establishments. Proposed measures include the development of a central booking portal, the opening of mountain huts through partnership arrangements, the introduction of self-service refreshment facilities, and support for new gastronomic outlets, including seasonal formats.

With regard to transport infrastructure, the document addresses the improvement of access roads and parking facilities, and proposes the integration of cycling with public transport through increased bicycle capacity, the introduction of cycle buses, and the digitalisation of reservation systems.

In the area of product and service development, the document proposes the creation of four thematic tourism routes integrating the natural, historical, and cultural assets of the territory. These products are oriented towards geotourism, industrial heritage, and cultural-historical interpretation (including concepts such as the Nostalgic Geotour, Salt Road, Wealth of the Earth, and Land of Extinct Volcanoes) and are designed to address the needs of diverse visitor segments. The development strategy further encompasses the creation of new attractions, including recreational facilities, visually distinctive photo points, and innovative experiential and educational elements. Additional emphasis is placed on event development and support for local producers, building on existing initiatives and introducing new concepts oriented towards health and wellbeing tourism, educational experiences, and cultural and artistic events set within the natural environment.
From a MICE and incentive tourism perspective, the current situation represents a significant underutilised potential. Conference and incentive participants possess both the time and financial capacity for supplementary activities, and research consistently indicates a growing preference for experiential and authentic engagement among the higher-income, higher-education profiles characteristic of this segment. International visitors tend to perceive Košice as a discovery destination offering authentic experiences beyond mainstream tourist circuits — a competitive advantage that nonetheless demands high standards of interpretation and service. This reinforces the strategic case for developing thematically coherent products that communicate the narrative connection between Košice and the Slanské Hills, rather than presenting isolated attractions.
Visitors increasingly expect a curated destination narrative rather than a catalogue of sights, a trend of particular relevance for incentive programmes, where memorability and team cohesion are primary objectives (Kršák, 2025). Full implementation of the Action Plan is expected to enhance the competitiveness of the Slanské Hills relative to other Slovak regions and adjacent cross-border destinations.

Discussion
Business event organisers typically favour destinations with international air connectivity and diversified service infrastructure — criteria that Košice, as the regional centre of eastern Slovakia, fully satisfies. A key comparative advantage lies in its proximity to the Slanské Hills sub-destination, where transfer distances from the city centre are comparable to those routinely undertaken within larger European congress cities, effectively extending the destination perimeter without additional logistical burden.
This gives rise to a complementary model in which Košice provides the congress infrastructure while the Slanské Hills contribute authentic incentive potential, enhancing the destination's differentiation in the business events market. The MICE segment requires short transfers, a compelling narrative, and a curated programme scenario, together these constitute a marketable product rather than a mere service offering, and a destination capable of delivering all three can compete effectively regardless of its international profile. This synergistic model also carries direct economic implications, as extended lengths of stay and increased overnight visits generate multiplier effects of particular relevance for eastern Slovakia, a region characterised by structural economic disparities relative to the western part of the country.

Conclusion
The deliberate diversification of tourist flows towards less-visited yet attractive localities in the immediate vicinity of Košice and Prešov represents not merely a marketing objective, but also an instrument of spatially balanced and environmentally responsible tourism development in the region. The Košice and Prešov Regions face a specific form of uneven tourism development, in which visitor demand is concentrated on a limited number of iconic destinations while extensive territories with considerable potential remain chronically underutilised. In this context, the Slanské Hills sub-destination constitutes a strategic development opportunity, a territory of authentic natural, cultural, and historical value situated in immediate proximity to the established MICE centre of Košice.

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Souhrn
Článek se zabývá územní asymetrií turistické poptávky v Košickém a Prešovském kraji, kde se návštěvnost soustřeďuje na úzký okruh ikonických lokalit (Vysoké Tatry, Slovenský ráj, Spišský hrad), zatímco rozsáhlá území s vysokým přírodním a kulturně-historickým potenciálem zůstávají nevyužitá. Zvláštní pozornost je věnována subdestinační oblasti Slanské vrchy, která navzdory svému potenciálu dosud chyběla jako samostatně definovaná a koordinovaně propagovaná destinace. Vychází z případové studie spolupracujících organizací Visit Košice, Región Šariš a Horný Zemplín, které v roce 2025 realizovaly projekt zaměřený na rozvoj business events a incentivní nabídky. Jeho výstupem je Akční plán rozvoje subdestinační oblasti Slanské vrchy, který pokrývá turistickou infrastrukturu, rozvoj produktů a dopravní dostupnost. Výsledky poukazují na synergický potenciál propojení Košic jako zavedeného centra MICE se Slanskými vrchy jako přírodním a zážitkovým zázemím. Diverzifikace turistického toku do méně známých lokalit tak představuje nástroj nejen marketingového, ale i environmentálně odpovědného rozvoje cestovního ruchu na východním Slovensku.

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DEVILS AND ANGELS IN CZECH TOPONYMS

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Abstract
The article aims to explore spatial distribution and relationships between toponyms in the Czech Republic between place names inspired by the themes of hell and devils on the one hand, and contrasting names derived from God, angels, and heaven on the other.
The key hypothesis verified was that local names derived from hell or the devil frequently indicate interesting geomorphological formations and dynamic relief and are generally more often used for natural objects and local names of land and forest areas, while names derived from God, angels, and heaven are mainly used for smaller man-made structures or buildings. The text is accompanied by examples of notable objects with interesting names closely related to tourism, recreation, or nature conservation.

Key words: place name; geomorphological landforms; tourism; hell; heaven

Introduction

Toponyms reflect a diverse range of landscape forms, from landownership patterns and homesteads to specific topographical contours and local folklore. Such cultural imprints persist within collective memory and cartographic records for centuries (Bijak, 2021; Halas, Kallabová, 2026). This study explores the interrelations between two antithetical thematic categories: on the one hand infernal place names derived from the devil, hell, and the Satan (Kubalíková et al., 2025) and divine or Christian-rooted names such as God, angels, and heaven on the other one (Daníčková, Bajer, 2019; Reeves, Otterstrom, 2019). These contrasting semantic worlds are applied extensively to both anoikonyms (landforms, natural features or agricultural plots) and oikonyms (settlements, buildings, and administrative districts) (Kirchner & Kubalíková, 2015; Kubalíková et al., 2025).
We specifically test the hypothesis that "diabolical" place names often correlate with prominent geomorphological features and rugged topography. Furthermore, we posit that while names associated with hell and the devil are predominantly linked to natural features and rural tracts, names derived from God and angels are more frequently associated with anthropogenic structures and small-scale architecture.

Materials and methods

The spatial distribution of toponyms within the Czech Republic was evaluated using the Geonames database, provided by the Czech Surveying and Cadastral Office. Geonames[1] serves as the primary geographic authority for the Czech Republic, with a level of detail corresponding to the 1:10,000 Base Map (BM 10). It is managed as a seamless, nationwide dataset and is a core component of the national geodetic infrastructure.
To ensure data integrity, the dataset required methodological refinement. While many features are unique, linear objects (such as watercourses or valleys) often appear as multiple entries. To avoid redundancy, each feature was reduced to a single name and a unique location. This is already handled methodologically by the database itself, as objects of a multiple nature do not have a location field filled in the attribute table, with the exception of one representative point per each feature.
Keywords were extracted using the *Select by Attributes* function in ArcGIS, employing SQL syntax with the “LIKE” operator. The query targeted the “name” attribute, accounting for case sensitivity and various morphological derivations of the selected stems.
The first thematic group comprised Czech toponyms containing the terms (or derivatives of): *‘čert’*, *‘čertovský’*, *‘ďábel’*, *‘ďábelský’*, *‘peklo’*, *‘pekelský’*, *‘rarach’*, *‘lucifer’*, and *‘rohatý’*. In contrast, the

[1] https://geoportal.cuzk.gov.cz/(S(unt3l5ikspaxkgv5culurwz1))/Default.aspx?mode=TextMeta&side=Geonames&metadataID=CZ-CUZK-GEONAMES-V&menu=261

second category consisted of names stemming from the concepts: *'bůh'*, *'božský'*, *'anděl'*, *'andělský'*, *'nebe'*, and *'nebeský'*. These terms represent standard Czech and don't encompass regional dialects. For cross-linguistic applications, these lexemes would need to be adapted to the specific linguistic corpora of the target language.

Results

Within the group of toponyms derived from the words čert (devil) and peklo (hell), the Geonames database identified a total of 953 features across the Czech Republic. Of these, 660 features were classified as anthropogenic. Most of these man-made toponyms referred to local agricultural and forest tracts, parts of municipalities, ponds, paths, and basic settlement units. Conversely, the number of buildings with names derived from the devil or hell was notably low (a total of 16 buildings).

A relatively high number of names associated with devils or hell were recorded for natural features (293), which were often geomorphologically significant. There is a frequent occurrence of toponyms for hills, peaks, and mountains, as well as names for isolated boulders, rock formations, ravines, valleys, caves, ridges, and slopes (Tab. 1). Furthermore, there is a significant proportion of "diabolical" toponyms associated also with hydrographic features, specifically brooks, small wells, springs, and waterfalls.

The most common names for the first group of toponyms studied included: *Peklo, V pekle, Čertův potok, Čertův kámen, Čertova rokle, Čertův mlýn, Na pekle, Pekelský potok, Pekla, Čertův vrch, Čertova skála, Nad peklem, U pekla, Pekelský rybník, Čertův důl, Čertova hora, Čertova díra, Čertova hráz, Čertova stráň, Čertova brázda, Čertova pláň, Čertova stěna*.

Tab. 1: Categories of natural landforms in both groups of toponyms under study

	Derived from	
Feature category	devil, hell	God, angel, heaven
Ridge, crest	7	
Cave	9	
Lake	1	
Hill, peak, mountain	84	15
Isolated boulder, rock, rocks	64	3
Promotory	1	
Brook	36	5
Spring	8	9
Peat bog	1	
Gorge	26	
Mountain pass	1	
Rock formation	5	
Small well	20	6
Slope, hillside, scree	6	1
Valley	20	1
Waterfall	4	
Total	293	40

The second group of toponyms, derived from the words *bůh* (God), *božský* (divine), *anděl* (angel), *andělský* (angelic), *nebe* (heaven), and *nebeský* (heavenly), comprised a total of 1,199 features in the Czech Geonames database. This category was heavily dominated by anthropogenic features, with 1,159 records identified as of 2025. Within this group, buildings and structures accounted for 1,159 entries, consisting primarily of churches, chapels, and small-scale sacral architecture. A significant portion of these anthropogenic toponyms also describes local names for agricultural plots, forest tracts, municipal districts, urban areas, and occasionally ponds.

In contrast to the first group, only 40 natural features were identified among toponyms derived from the terms God, angel, and heaven (Tab. 1). These included specific geomorphological relief features such as hills, peaks, mountains, isolated boulders or rock formations, slopes, and valleys as well as hydrological features, including brooks, springs, and small wells.

The most frequent names within the second group of toponyms included traditional designations of churches and chapels, such as the Assumption of the Virgin Mary *(Nanebevzetí Panny Marie)*, Saint Michael the Archangel *(Svatý Michael Archanděl)*, and the Holy Sepulchre *(Boží hrob)*, which together accounted for approximately 700 records.
A separate assessment was conducted for non-building features. Among these, toponyms for agricultural or forest land such as *U božích muk* (At the Wayside Cross) clearly predominated, including spatial variations utilizing prepositions such as "behind" (*za*), "in front of" (*před*), or "towards" (*k*). Another frequent category of toponyms relates to the practice of feeding ponds solely through atmospheric precipitation (rainwater), leading to the name *Nebeský rybník* (Heavenly Pond). Water-related themes also appear in the names of springs, brooks, and land plots, such as *Boží voda* (God's Water) or *U Boží vody*. Other common names for natural formations or plots of land are derived from the word for "angel," including variations such as *U Anděla*, *U Andílka*, *U Andělíčka*, *Andělka*, or *Andělská hora*.

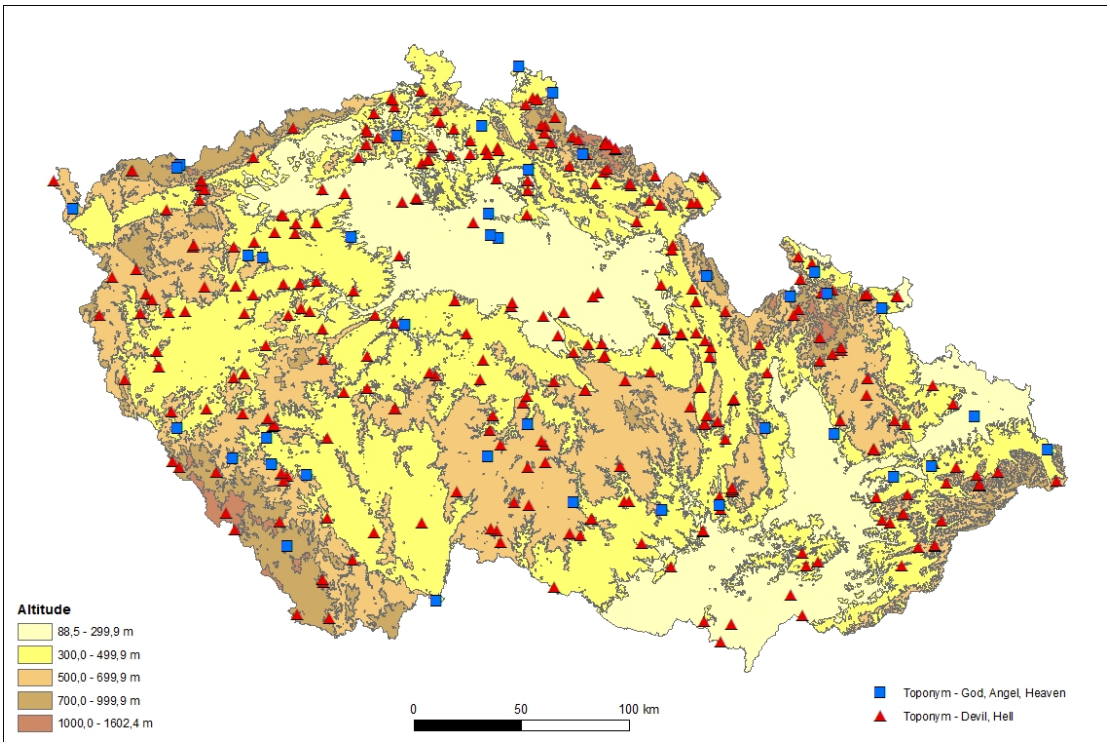

Fig. 1: Toponyms of a natural features derived from the devil and hell, and from God, angels, and heaven

The distribution map of natural toponyms derived from "devil" or "hell" reveals a relatively uniform dispersal across the Czech Republic, with the notable exception of the major lowlands and fertile agricultural regions (Fig. 1). The highest concentration of these features occurs at elevations between 300.0 and 499.9 m a.s.l. - corresponding to rugged hilly terrain and highlands - followed by the 500.0 to 699.9 m elevation band (Tab. 2). A non-negligible presence of both "diabolical" and "angelic" toponyms is also recorded in the highest mountainous regions of the Czech Republic.
In contrast, natural features derived from God, Angel, and Heaven exhibit an uneven distribution, which is partly due to their low overall frequency (40 features). Nevertheless, they are represented across all elevational categories, with their peak occurrence also falling within the 300.0–499.9 m and 500.0–699.9 m ranges (Tab. 2).

Tab. 2: The distribution of natural toponyms by elevation

Altitude above sea level	Devil, Hell	Share %	God, Angel, Heaven	Share %
88.5 - 299.9 m	36	12,29	6	15,00
300.0 - 499.9 m	127	43,34	15	37,50
500.0 - 699.9 m	85	29,01	12	30,00
700.0 - 999.9 m	27	9,22	6	15,00
1,000.0 – 1,602.0 m	18	6,14	1	2,50
Total	293	100,00	40	100,00

Discussion

Preliminary analyses addressing the primary hypotheses confirm a high proportion of natural features among toponyms associated with "hell" and "the devil" in the Czech Republic. These features often possess significant geomorphological value and indicate rugged or dynamic relief (Fig. 2). Furthermore, these sites are frequently attractive for recreation and nature conservation, with several formations integrated into small-scale protected areas (Daníčková & Bajer, 2019). Natural landforms with "diabolical" names are often interpreted through local folklore and legends (Fig. 3AB), which attribute their origin or the naming of the site to the intervention of the devil or infernal forces (Halas & Kallabová, 2026; Kubalíková et al., 2025).

Fig. 2: The *Ďáblova prdel* (Devil's Ass) rock outcrop serves as an educational site for hands-on instruction on the weathering processes of granite rocks in the Central Moldanubian Pluton.

Fig. 3: The migmatite rock formations known as A/*Andělka* (Angel´s rock) and B/ *Čertovka* (Devil´s rock) are located near the town of Humpolec, just a few dozen meters apart. The names of these rock formations are linked to a legend about a local devil and an angel.

Regarding toponyms derived from "God," "Angel," and "Heaven," the results confirm the expected predominance of buildings, structures, and small-scale sacral architecture (e.g., churches, chapels, wayside crosses, and crucifixes). However, a high frequency of "celestial" toponyms was also observed for agricultural plots, forest tracts, and municipal districts; a pattern that, notably, also applies to "diabolical" names. In contrast, the occurrence of natural features associated with God, angels, or heaven is very low in the Czech Republic. This scarcity reflects the minimal role attributed to divine forces in traditional folk explanations for the formation of dynamic or dramatic relief features.

Conclusion

The article aims to explore the spatial distribution and relationships between toponyms in the Czech Republic, namely between place names inspired by the themes of hell and the devil on the one hand and contrasting names derived from God, angels and heaven on the other. Preliminary analyses confirm a high proportion of natural elements among toponyms associated with “hell” and “devil” in the Czech Republic. These elements often have significant geomorphological value and indicate a rugged or dynamic relief. Moreover, these places are often attractive for recreation and nature conservation. In contrast, the occurrence of natural elements associated with God, angels or heaven is very low in the Czech Republic. Toponyms derived from “God”, “Angel” and “Heaven” are predominantly in the form of buildings, structures and small sacral architecture in the Czech Republic. However, a high frequency of “heavenly” toponyms was also observed for agricultural land, forest land and urban areas; this pattern also applies to “devil” names.

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Souhrn
Článek si klade za cíl prozkoumat prostorové rozložení a vztahy mezi toponymy v České republice, a to mezi místními názvy inspirovanými tématy pekla a čerta na jedné straně a kontrastními názvy odvozenými od Boha, andělů a nebe na straně druhé. Klíčovou hypotézou bylo ověření, jestli místní názvy odvozené od pekla nebo ďábla často označují zajímavé geomorfologické útvary a dynamický reliéf a obecně se častěji používají pro přírodní objekty, případně místní názvy zemědělských nebo lesních pozemků, zatímco názvy odvozené od Boha, andělů a nebe se používají především pro menší sakrální stavby nebo větší církevní budovy (kostely, kaple). Rozložení přírodně zajímavých objektů vybraných toponym v rámci České republiky je poměrně rovnoměrné, větší podíl objektů odvozených od čerta nebo pekla je evidován ve vyšších nadmořských výškách nebo v členitém reliéfu pahorkatin a vrchovin. Text byl doplněn několika konkrétními příklady přírodních objektů se zajímavými názvy úzce souvisejícími s cestovním ruchem, rekreací nebo ochranou přírody. Předběžné analýzy zabývající se primárními hypotézami potvrzují vysoký podíl přírodních prvků mezi toponymy spojenými s „peklem“ a „ďáblem“ v České republice. Tyto prvky mají často významnou geomorfologickou hodnotu a naznačují členitý nebo dynamický reliéf. Tato místa jsou navíc často atraktivní pro rekreaci a ochranu přírody, přičemž několik útvarů je součástí maloplošných zvláště chráněných území. Přírodní útvary s „ďábelskými“ názvy jsou často interpretovány prostřednictvím místních lidových pověstí a legend, které připisují jejich původ nebo pojmenování místa zásahu ďábla či pekelných sil. Pokud jde o toponymy odvozené od „Bůh“, „Anděl“ a „Nebe“, výsledky potvrzují očekávanou převahu budov, staveb a drobné sakrální architektury (např. kostely, kaple, kříže u boží muky). Vysoká frekvence „nebeských“ toponym však byla pozorována i u zemědělských pozemků, lesních pozemků a městských částí; tento vzorec platí ale také pro „ďábelská“ názvy. Naproti tomu výskyt přírodních prvků spojených s Bohem, anděly nebo nebem je v České republice velmi nízký. Tato vzácnost odráží minimální roli připisovanou božským silám v tradičních lidových vysvětleních formování dynamických nebo dramatických reliéfních prvků.

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DIVERSITY OF CYNIPID WASPS ON OAKS IN THE URBAN GREENERY OF NITRA

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Abstract
In this study, we focused on analysis of spectrum and trophic relationships of gall-inducing species from the family *Cynipidae* associated with the genus *Quercus* in the urban environment of Nitra city. The research was carried out in 2022-2025. We have also evaluated the visual attractiveness of the galls and which parts each species uses to create galls. We have found 36 species of gall-inducing cynipid wasps, on 6 oak species, which were planted in urban greenery of Nitra city. Our results reveal that the majority of cynipid wasps develop on pedunculate oak (*Quercus robur*) and turkey oak (*Quercus cerris*). The most preferred part for gall formation is bud (24 species) and leaf (13 species). The least preferred part for gall formation was the roots. In 4 species, the part of development of the sexual generation is unknown. The galls of the agamous generation are more visually attractive. The sexual generation produces mostly inconspicuous types of galls from buds or male catkins. All found cynipid wasp species are native, except *Andricus quercusfoliatus*, which has native range in southern parts of North America and Mexico.

Key words: Hymenoptera, Quercus, gall, entomofauna, biodiversity

Introduction

Galls of cynipid wasps have been important resources to human societies for millennia (Csóka, 1997, Csóka et al., 2005). Modern scientific study of the galls and their inhabitants dates back at least as far as Malpighi's 'De Gallis' (1687). Later reviews and biology of cynipids were addressed by Askew (1984), Shorthouse, Rohfritsch (1992), and Stone et al. (2002). In Slovakia, gall wasps were dealt with, for example, in works by Červenák (1958), Hrubík (1976), Hrubík, Požgaj (1988), Kelbel (2002, 2004), Skuhravý et al. (1998).
Galls of cynipid wasps are structures developed exclusively for the benefit of the gall inducer (Romanes, 1889, Cockerell, 1890). Gallwasps use various coatings of sticky resins or hairs and spines of varying lengths as protection (Stone, Cook, 1998). Many cynipid galls change color during development, usually from green to red. There is evidence that female parasitoids recognize color and use it to assess host quality (Askew, 1961, Czecuga, 1977). The definition of genera in the classification of Cynipidae (Hymenoptera), especially in the tribe Cynipini, is problematic (Dailey, Menke, 1980). The alternation of asexual and sexual generations in many genera creates morphological variation among adults, which significantly complicates classification (Melika, Abrahamson, 2002). They are the second most species-rich group of gall-inducing insects after the midges (Diptera: Cecidomyiidae) (Melika, 2006). The Cynipinae are divided into two main trophic groups: gall-inducing and gall-associated inquilins, which together form 6 tribes (Melika, 2006, Abe et al., 2007). The biology of these tribes and their possible phylogenetic relationships are described in Stone et al. (2002) and Csóka et al. (2005). The six tribes of gall-inducing wasps include five gall-inducing tribes and one obligate inquilin, which predominantly attack galls of other cynopods. The majority of gall wasps induce galls on oaks and other Fagaceae (Lithocarpus, Chrysolepis, Castanopsis and Castanea) or roses (Rosa) (Ronquist, Nieves-Aldrey et al., 2015, Melika, 2006, Melika, Abrahamson, 2002). Aproximately 1 370 cynipid gall wasps species are currently recognized, although Nordlander (1984) has estimated that the actual number is between 3000 and 6000 (Csóka et al., 2005). Biodiversity increases the recreational attractivity of landscape settings (Gao et al., 2019) .In this paper, we focus on the fauna of the species spectrum of gall wasps Cynipidae on oak trees growing in the urban environment of the city of Nitra. In addition to the species composition, we also evaluated the visual attractiveness of the galls of individual gall wasp species as a potential interesting visual element in natural settings.

Materials and methods

The research was carried out in Nitra city in 2022–2025. The Nitra city is situated in the southwestern part of Slovakia (N48°18'53" E18°5'28"). It lies 167 m above sea level. Climate is characterized as a semi-arid and humid. The average annual total precipitation is about 600 mm. The average annual

temperature is about 9.5ºC. The cynipid wasps species monitoring in field conditions was realized monthly throughout the year. For monitoring, we selected street areas, housing estates, and park areas in the city where oak trees occur. Individual gall wasp species were determinated mainly according to collected samples of galls. Monitorovali sme agamous aj sexual generation. Zaznamenávali sme u každej generácie, na ktorej časti stromu jednotlivé druhy vytvárajú a ich hostiteľské dreviny. Visual attractiveness was assessed according to the following categories:
1. Multicolored or single-colored lump, reasonably large and distinctive in shape with possible outgrowths or trichomes. Easily visible on the plant. Long-term durability of the lump even after the fruits, inflorescences and assimilation organs have fallen.
2. Multicolored or single-colored lump, reasonably large and distinctive in shape with possible outgrowths or trichomes. Easily visible on the plant. Short-term durability of the lump. After the fruits, inflorescences and assimilation organs have fallen, it loses its visual attractiveness.
3. Multicolored or single-colored lump, smaller in size, but distinctive in shape, with possible outgrowths or trichomes. Less visible on the plant. Long-term durability of the lump even after the fruits, inflorescences and assimilation organs have fallen.
4. Multicolored or single-colored lump, smaller in size, distinctive in shape, with possible growths or trichomes. Less visible on the plant. Short-term durability. After the fruits, inflorescences and assimilation organs fall off, it loses its attractiveness.
5. Inconspicuous in color and shape, difficult to see on the plant, durability long-term or short-term, without significant visual attractiveness.

Results
During research on gall wasps occurring on oaks in urban greenery in the city of Nitra, we identified a total of 8 oak species, from which 6 were infested by cynipid gall wasps. *Quercus rubra* and *Q. palustris* showed no presence of galls. Most gall wasps were associated with native oak species. The only introduced species was *Quercus* × *turneri* 'Pseudoturneri', where only one parent is native (see Table 1). In total, 36 species of gall wasps (Cynipidae) were recorded. The highest number of gall wasp species was found on *Q. robur* (33 species), *Q. cerris* (15 species), and *Q. petraea* (14 species). The most preferred plant parts for gall formation were buds (24 species), leaves (13 species), and catkins (8 species). The least preferred part was the root (1 species). Table 1 also shows data on gall types produced by the agamous and sexual generations. Based on the evaluation of visual attractiveness, the agamous generation produces more attractive gall types compared to the sexual generation. Only *Chilaspis nitida* (category 2), *Andricus conificus* (cat. 1), *Neuroterus quercusbaccarum* (cat. 2), and *Biorhiza pallida* (cat. 2) produce visually attractive galls in the sexual generation. The visual attractiveness levels of individual gall wasp species by generation type are listed in Table 1.Most of the recorded gall wasp species are native. The only non-native species is *Andricus quercusfoliatus*, whose native range is in the southern parts of North America and Mexico. It was found on *Q. virginiana*. For four gall wasp species recorded in Nitra, the gall type of the sexual generation is unknown. For this reason, their visual attractiveness was not evaluated.

Discussion and Conclusion
As the results show cynipid gall wasps have a high diversity on oaks growing in urban settings of the city of Nitra. Similar results were published by Ronquist, (2015) and Csóka et al. (2005). Native oak species contribute significantly to urban biodiversity, therefore making it more attractive for recreation in the urban environment (Gao et al. 2019). Non-native oak species growing in Nitra were less infested by galls. Sporadic occurrence was on *Q.* × *turneri* or absent altogether on *Q. rubra*, and *Q. palustris*. Gall wasps often create visually attractive types of galls that are easily noticeable on trees, and many of them enhance the aesthetic appearance of oaks. From a visual perspective, bud galls are the most attractive, and they are also the most common type. This fact is also reported in the research of Kelbel (2004). The research shows that oaks and gall wasps contribute not only to biodiversity in the urban landscape but also to the visual enhancement of green spaces in the city. They therefore represent a potentially interesting element in the context of recreation.

Tab. 1: List of gall inducing cynipid wasps found in the city of Nitra

Serial number	Species name	Generation agamous/sexual	Host plant in Nitra	Atractivity agamous/sexual
1.	*Cynips quercuscalicis* (Burgsdorff, 1783)	acorn/catkin	Q. robur, Q. cerris	1/4
2.	Cynips quercusfolii Linnaeus, 1758	leaf/bud	Q. robur, Q. petraea	2/5
3.	Andricus caputmedusae (Hartig, 1843)	bud/bud	Q. robur, Q. dalechampii	1/5
4.	Chilaspis nitida (Giraud, 1859)	leaf/catkin	Q. cerris, Q. robur	3/2
5.	Andricus hungaricus (Hartig, 1843)	bud/bud	Q. robur	1/5
6.	Cynips divisa Hartig, 1840	leaf/leaf,	Q. robur	3/4
7.	Cynips disticha Hartig, 1840	leaf/catkin	Q. robur, Q. petraea	4/5
8.	Cynips longiventris Hartig, 1840	leaf/bud	Q. robur, Q. petraea	2/5
9.	Andricus glutinosus (Giraud, 1859)	bud/bud	Q. robur	3/5
10.	Trigonaspis megaptera (Panzer, 1801)	leaf/bud	Q. robur, Q. petraea	4/4
11.	Andricus inflator Hartig, 1840	bud/shoot	Q. robur, Q. petraea	4/3
12.	Andricus foecundatrix Hartig, 1840	bud/catkin	Q. robur	2/5
13.	Andricus solitarius (Boyer de Fonscolombe, 1832)	bud/catkin	Q. robur, Q. cerris	4/5
14.	Andricus testaceipes Hartig, 1840	shoot/leaf	Q. robur, Q. petraea, Q. cerris	4-5/4
15.	Andricus lucidus (Hartig, 1843)	bud/catkin	Q. robur, Q. petraea, Q. cerris	1-2/5
16.	Andricus kollari (Hartig, 1843)	bud/bud	Q. robur, Q. petraea	1/5
17.	Andricus grossulariae Giraud, 1859	Acorn/catkin	Q. robur, Q. cerris	1/4
18.	Andricus conificus (Giraud, 1859)	bud/shoot	Q. cerris, Q. robur	3 or 1/1
19.	Neuroterus anthracinus (Curtis, 1838)	leaf/bud	Q. robur, Q. petraea, Q. cerris, Q. x turneri	4/5
20.	Andricus coriarius (Hartig, 1843)	bud/bud	Q. petraea, Q. dalechampii, Q. robur	1/5
21.	Andricus conglomeratus (Giraud, 1859)	bud/bud	Q. robur, Q. cerris	1/5
22.	Andricus curvator (Hartig, 1840)	bud/leaf	Q. robur L., Q. petraea, Q. x turneri	3/4
23.	Neuroterus numismalis (Fourcroy, 1785)	leaf/leaf	Q. robur, Q. petraea, Q. dalechampii	3/5
24.	Neuroterus quercusbaccarum (L., 1758)	leaf/catkin, leaf	Q. robur	4/2
25.	Neuroterus albipes (Schenck, 1863)	leaf/leaf	Q. robur	4/4
26.	Cerroneuroterus lanuginosus (Giraud, 1859)	leaf/catkin	Q. cerris	3/5
27.	Biorhiza pallida (Olivier, 1791)	root/bud	Q. robur, Q. petraea, Q. cerris	5/2

28.	**Andricus truncicola (Giraud, 1859)**	**bud/bud**	**Q. dalechampii, Q. robur, Q. cerris**	**1/5**
29.	**Aphelonyx cerricola (Giraud, 1859)**	**shoot/unknown**	**Q. cerris, Q. turneri**	**1/-**
30.	**Andricus lignicolus (Hartig, 1840)**	**bud/bud**	**Q. cerris, Q. robur**	**1/5**
31.	**Andricus dentimitratus (Rejtő, 1887)**	**acorn/unknown**	**Q. robur**	**1/-**
32.	**Andricus aries (Giraud, 1859)**	**bud/bud**	**Q. robur**	**1/5**
33.	**Andricus galeatus (Giraud, 1859)**	**bud/unknown**	**Q. robur**	**1/-**
34.	**Andricus polycerus (Giraud, 1859)**	**bud/bud**	**Q. robur**	**1/5**
35.	**Andricus corruptrix (von Schlechtendal, 1870)**	**bud/bud**	**Q. robur, Q. petraea, Q. cerris**	**3/5**
36.	**Andricus quercusfoliatus (Ashmead, 1881)**	**bud/unknown**	**Quercus virginiana**	**4/-**

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Souhrn
V této studii jsme se zaměřili na analýzu spektra a trofických vztahů hrčkotvorných druhů z čeledi Cynipidae spojených s rodem *Quercus* v urbanizovaném prostředí města Nitra. Výzkum probíhal v letech 2022–2025. Hodnotili jsme také vizuální atraktivitu jednotlivých hálok a části stromů, které jednotlivé druhy využívají k tvorbě hrček. Zjistili jsme 36 druhů hrčkotvorných vosiček na 6 druzích dubů vysazených v městské zeleni Nitry. Naše výsledky ukazují, že většina druhů se vyvíjí na dubu letním (*Quercus robur*) a ceru (*Quercus cerris*). Nejpreferovanější částí pro tvorbu hálok jsou pupeny (24 druhů) a listy (13 druhů). Nejmenší zájem byl o kořeny. U čtyř druhů není známo, na které části stromu se vyvíjí sexuální generace. Hálky agamní generace jsou vizuálně atraktivnější. Sexuální generace vytváří převážně nenápadné typy hálok z pupenů nebo samčích jehněd. Všechny zjištěné druhy hrčkotvorných vosiček jsou původní, s výjimkou *Andricus quercusfoliatus*, jehož přirozený areál rozšíření se nachází v jižních částech Severní Ameriky a Mexika.

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EDUCATION IN PARKS – PLANT COLLECTIONS AND EXHIBITIONS

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Abstract
Recreational and educational functions in parks are supported by purposeful plant compositions that enhance the attractiveness of these spaces and promote cognitive development. Such compositions include established collections of useful plants, such as herb gardens and orchards, as well as ornamental plants that form the foundation of thematic gardens, including rosariums, alpine gardens, and arboretums. Plant groupings featuring rare and endangered species are significant for biodiversity conservation, offering opportunities to preserve old and disappearing varieties of cultivated plants, including fruit trees. Additionally, plant arrangements facilitate the exploration of cultural dimensions, such as utilitarian and decorative uses of plants, and contribute to the formation of comprehensive landscape sequences.

Key words: plant collections, nature exhibitions, thematic gardens, arboretum

Introduction

Integrating recreational and educational functions in parks can be achieved by introducing programmatic elements, such as intentional plant compositions, into garden spaces. While specialized buildings, structures, and artistic furnishings may complement these areas, vegetation remains the primary feature. Plant displays, designed with botanical expertise and contextual awareness, are essential. These displays often consist of established collections of useful plants, such as herb gardens, herbaria, and orchards, or ornamental plants, which serve as the foundation for thematic gardens including *rosariums, alpine gardens, arboretums,* perennial gardens and water gardens (Fig. 1). Frequently, these collections are composed of visually striking, fragrant, and colorful plants.

A-B

Fig. 1: Themed gardens: A/ Medicinal plant garden, *Chelsea Physic Garden*, London;
B/ *Kew Kitchen Garden*, RBG Kew, London (photo: B. Fortuna-Antoszkiewicz, 2015)

Plant groupings that include rare and endangered species are vital for biodiversity conservation. These collections enable the preservation of old and disappearing varieties of cultivated plants, including fruit trees. Object-oriented plant arrangements also facilitate the exploration of cultural aspects, such as utilitarian, decorative, or landscape uses of plants, the presentation of historical garden design styles, garden art from non-European cultures, and the display of plants from various climate zones and natural habitats.

Material and methods

This research is based on multi-year field observations (2015-2025) conducted in Poland and throughout Europe. The study analyzed the presence of plant collections, primarily dendrological, as programmatic elements in public parks and gardens, considering their spatial context, intensity of use, and effectiveness. To illustrate contemporary approaches, examples of plant displays implementing recreational and educational functions in parks were drawn from selected European facilities.

Results

Since the earliest gardens, intentional plant compositions have been created to showcase plants with exceptional decorative qualities, such as striking flowers, ornamental foliage, fruit, and distinctive forms (e.g., specimen trees, climbers, shrubs) [Dolatowski 1999; Seneta, Dolatowski 2025]. When grouped throughout the garden, these collections enriched the space and enhanced its prestige. This approach has persisted through successive eras and remains a foundational element of scientific and educational institutions, including arboretums and botanical gardens [e.g., Hryniewiecki, Kobendza 1932; Szmajda et al. 1995; Nowak et al. 1999; Jerzak 2007]. The rosarium exemplifies such collections and demonstrates advanced horticultural expertise (Fig. 2, 3).

A-B

Fig. 2: An example of a *rosarium* as a collection in a larger park:
A/ the historic park in Łańcut, Poland; B/ the contemporary Silesian Park in Chorzów, Poland
(photo: B. Fortuna-Antoszkiewicz, 2013-2014)

Fig. 3: *Rosarium*, Dendropark "Olexandria" NAS of Ukraine, Bila Tserkva, Ukraine.
The rose collection (built in 2008–2013, area 0.22 ha) presents 115 varieties of *Rosa hybrida* hort. from 12 groups; it is the largest collection of David Austin's selection roses in Ukraine - 56 varieties (photo: N. Boiko, 2024)

Historically, gardens have included both utilitarian and ornamental plants, offering decorative value and economic benefits. For instance, ancient Egyptian gardens featured valuable grapevines (*Vitis vinifera* L.), as evidenced by preserved wall paintings. In Mediterranean and Middle Eastern cultures, olive trees (*Olea europaea* L.), fig trees (*Ficus carica* L.), and pomegranate trees (*Punica granatum* L.) were prevalent. This led to the development of orchards, where fruit trees and shrubs are systematically cultivated under optimal conditions [Sękowski 1990; Dolatowski, Prokopiv 2011; Kucharska 2011; Chmielewska 2018; Żygała 2018]. Orchards represent a distinct form of tree cover, characterized by regular, loosely spaced rows. In certain regions, this form has become dominant, shaping the local landscape, as seen in the old olive groves of Italian Liguria (Fig. 4) and the orchard basins of the Grójec and Łowicz regions in the Masovian Voivodeship, Poland (Fig. 5).

Fig. 4: Old olive grove, Liguria, Italy
(photo: B. Fortuna-Antoszkiewicz, 2002)

Fig. 5: Orchards near Łowicz,
Mazovian Voivodeship, Poland
(photo: B. Fortuna-Antoszkiewicz, 2013)

Orchards have been cultivated since ancient times, with trees and their fruit symbolizing prosperity, peace, and beauty. Biblical texts reference the common fig, pomegranate, olive, date palm, grapevine, and apple tree among fruit-bearing plants [Darom 2007]. The advanced horticultural expertise required for fruit tree and shrub cultivation made them the most valuable and prestigious elements of commercial gardens [Jankowski 1923]. A notable example is the famous, extensive and meticulously maintained, orchards of the Counts Branicki in the "Olekxandria" park in Bila Tserkva. In the nineteenth century, both traditional fruit trees, such as apple trees, and more delicate species, including grapevines, apricots, peaches, and their select varieties, were cultivated. Decorative features and spaces for relaxation were also emphasized, reflecting the significance of the fruit tree collection within the park complex [Lippoman 1832; Drège 1904; Gałkin 2013].

In Poland, orchards were predominantly located on landed estates until the late nineteenth century, with only occasional presence near peasant cottages in villages [Chmielewska 2018]. During the interwar period, orchards were widely promoted under the slogan "Orchard by every cottage" [Jankowski 1927; Slaski 1936; Zaliwski 1938], and plantings were established along public roads [e.g. Gałczyński 1928; Fortuna-Antoszkiewicz, Łukaszkiewicz 2012, 2017]. The post-war era saw intensive development of fruit cultivation in Poland, supported by specialized research and scientific initiatives [Pieniążek 1980].

Traditional fruit cultivation persists today through both professional, large-scale fruit production and the maintenance of fruit tree and shrub collections in arboreta and specialized research institutions. The primary objective of assembling such dendrological collections in garden settings is the preservation of old and endangered varieties, which are of significant value for biodiversity. Collections of rare and endangered plants serve as an essential gene pool, supporting the sustainable development of future horticulture. Notable examples of sites with valuable fruit tree and shrub collections include: the Arboretum in Bolestraszyce (one of the richest collections of old varieties, including unique local apple, pear, and edible dogwood varieties), Muskauer Park (250 old and rare fruit tree varieties, mainly apple, plum, and pear trees in the historic Nursery in the Polish section of the park) (Fig. 6), Park-Arboretum in Gołuchów (protection of old varieties and historic fruit tree specimens), Chrystkowo (conservation orchard for old apple, pear, plum, and cherry varieties in the Lower Vistula Valley), National Museum of Agriculture in Szreniawa (orchard of old fruit tree varieties), Botanical Garden of the Polish Academy of Sciences in Powsin (over 500 historic apple and pear varieties, chokeberries, quinces, and Japanese quinces), Silesian Botanical Garden in Radzionków (conservation orchards of old local fruit tree varieties, including apple, gooseberries, currants, blackberries, raspberries, dogwoods, chokeberry, mulberries, etc.) and the park-arboretum "Olexandria" in Bila Tserkva / Dendropark “Olexandria”, NAS of Ukraine, Kyiv Region (mulberries, fruit shrubs and trees - the garden boasts a collection of over 50 old varieties of large-flowered apple trees) (Fig. 7).

A-B

Fig. 6: Collections of old, endangered apple varieties: A/ Bolestraszyce Arboretum, Poland; B/ Muskauer Park, Poland/ Germany (photo by B. Fortuna-Antoszkiewicz, 2016, 2018)

Fig. 7: Plant collections in “Olexandria”,, Bila Tserkva, Ukraine:
1/ a group of trees of the *Morus* ‘Pendula’ species (in the back on the right);
2/ a collection of fruit trees recreated since 2010 on the historic site – *“The Wall" Garden*, apple trees (*Malus* Mill.) (photo: N. Boiko, 2024, 2026)

Fruit tree collections that emphasize old and native varieties fulfill both conservation and educational roles. These collections contribute to the preservation of horticultural cultural heritage by showcasing a diverse array of valuable plants and demonstrating both traditional and contemporary methods of plant cultivation, including ornamental nursery practices and the art of fruit tree management (Fig. 8).

Fig. 8: Demonstration of the art of fruit tree management, RHS Garden Wisley, England (photo: B. Fortuna-Antoszkiewicz, 2015)

In general, plant collections in parks - including utility plants, ornamental species, and natural communities - are organized as selected groups based on botanical classification (genera, species, varieties), habitat (forest, meadow, marsh, aquatic vegetation), or usage (ornamental or utility plants). These collections are situated in designated areas, such as thematic gardens, or arranged along programmed routes, including pomological and dendrological paths.

Conclusions

Contemporary public parks and gardens, including those with historical backgrounds, provide not only recreational opportunities - particularly in urban environments - but also comprehensive environmental and cultural education. Vegetation, as the core component, is methodically selected and arranged to facilitate exploration and understanding of natural diversity, complex ecological relationships, and structural intricacies, ultimately highlighting its influence on human life. Through skillful spatial compositions, these spaces also demonstrate human achievements in the economic and technical utilization of vegetation, both historically and in modern contexts. Plant collections serve as an effective means of nature conservation, especially for rare or endangered species, supporting ecological balance and promoting the multicultural character of landscapes. This educational approach enhances ecological awareness and fosters aesthetic appreciation in both spatial and artistic dimensions.

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Souhrn

Rekreační a vzdělávací funkce parků jsou podpořeny účelovými rostlinnými kompozicemi, které zvyšují atraktivitu těchto prostor a podporují kognitivní vývoj. Mezi tyto kompozice patří zavedené sbírky užitkových rostlin, jako jsou bylinkové zahrady a ovocné sady, stejně jako okrasné rostliny,

které tvoří základ tematických zahrad, včetně růžových zahrad, alpských zahrad a arboret. Skupiny rostlin zahrnující vzácné a ohrožené druhy jsou důležité pro zachování biologické rozmanitosti, protože nabízejí příležitost k zachování starých a mizejících odrůd pěstovaných rostlin, včetně ovocných stromů. Kromě toho uspořádání rostlin usnadňuje zkoumání kulturních rozměrů, jako je užitkové a dekorativní využití rostlin, a přispívá k vytváření komplexních krajinných sekvencí.

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ENVIRONMENTAL EDUCATION AND LEGAL SOCIALIZATION

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Abstract
This paper deals with forming a responsible relationship to the environment and sustainable development, for which environmental education is the key, which not only transfer ecological knowledge, but also cultivates people in the field of nature protection. Applying Kohlberg's theory of moral development, the authors recall the issues of creating attitudes and accepting values, as well as the interconnection of social behaviour and social values.
Cognitive maturity is a necessary, but not sufficient, prerequisite for moral reasoning of higher stages of moral development. Therefore, it is very important, in addition to acquiring knowledge, to develop proper internal motivation, which seems to be the most difficult task in today's hedonistically oriented society. This paper includes model types of legal socialization, including a number of examples that demonstrate the necessity of values, attitudes, internal motivation and critical thinking, which enable people to adequately understand the legal environmental regulations, which often damage nature in the interests of economic and contemporary civilization needs. Without deep understanding and internalized motivation of environmental protection the human cannot act in the interests of nature and pursue reasonable environmental regulations. At the end of this paper, the authors clearly present the questions and problems that research in this area faces.

Key words: internalized motivation of nature conservation, legal environmental regulations, moral development

Introduction

Environmental education is a lifelong process whose aim is to understand the relationships between humans and the environment and to promote a responsible approach to nature. Its goal is to enable individuals to adopt attitudes and behaviours that reduce the negative impacts of human activity on the environment. Through this process, people develop respect for both living and non-living nature, adopt environmentally friendly consumer behaviour, and acquire critical thinking skills. This includes the ability to recognise the impact of human activities on ecosystems and to seek solutions that support the preservation of biodiversity. Environmental education therefore plays an important role in shaping individuals in the field of nature conservation and in developing their values and attitudes.
There are many definitions of environmental education, the scope of which goes beyond the limits of this text. Therefore, we will deliberately mention only the definition provided by UNESCO, which, although not directly related to environmental education, formulates the broader concept of Education for Sustainable Development (ESD). According to UNESCO, education for sustainable development should provide learners of all ages with the knowledge, skills, values, and abilities needed to address interconnected global challenges, such as climate change, loss of biodiversity, and the unsustainable and unequal use of resources. UNESCO has also explicitly declared that environmental education "must be a core component of the curriculum by 2025" (UNESCO declares environmental…, 2023). Education for Sustainable Development also enables learners to make informed decisions that lead to active participation and contribute to positive social change. It is a lifelong learning process and an integral part of quality education. It supports the cognitive, socio-emotional, and behavioural dimensions of learning. The inclusion of environmental education as a cross-curricular theme at all levels of schooling has led to a significant shift in its understanding. It is no longer seen merely as a subfield of biology, but as a genuinely interdisciplinary area that integrates both natural sciences and the humanities, linking environmental topics with philosophical, sociological, economic, political, and legal issues. Environmental education is thus becoming an essential part of the socialisation of each individual.

Materials and methods

The paper takes the form of a review study using analytical and comparative methods. The theoretical foundations provide the basis for the results as well as for both explicit and implicit proposals for further topics that would merit attention.

Theoretical background

In its most general sense, socialisation is understood as the process of integrating an individual into society, as well as the process by which society accepts the individual. The search for and attainment of a balance between individual self-assertion, symbolising creativity, and social control expressed primarily through generally accepted values and norms of behaviour, constitutes the core of socialisation. The outcome of socialisation is the formation of a fully developed personality, that is, a personality that has adopted and internalised specific values and developed a sense of moral responsibility. The philosophical and sociological perspective on this issue relates to the system: human – world – normative order – responsibility. Responsibility is understood as a dialogue with other people and, in this context, also with nature. It may also be viewed as an issue of personal responsibility. The achievement and development of a system of internal restraints is one of the main aims of the socialisation process. The goal is the internalisation of socially approved values and norms, which should become an inseparable part of personal identity.

Environmental education should play a key role in fostering responsibility for the environment in which we live. In addition to personal responsibility, there is also legal responsibility, which is acquired through legal socialisation (Urbanová, 2006).

Environmental education and legal socialisation represent interrelated processes that fundamentally influence individual behaviour in relation to the environment as well as the legal system. Environmental education seeks to develop knowledge, values, and skills that lead to a responsible approach to nature and to an understanding of the consequences of human activity for ecosystems (Palmer, 1998; UNESCO, 2017). It is not limited to the acquisition of factual knowledge but also involves the formation of attitudes and the development of critical thinking skills, which enable individuals to make informed and sustainable decisions (Kollmuss & Agyeman, 2002). Legal socialisation, by contrast, represents the process through which individuals acquire the norms, rules, and values of the legal system, including respect for law and institutions (Berger & Luckmann, 1966). This process takes place within the family, educational institutions, and wider society, leading to the internalisation of legal norms—that is, their acceptance as one's own (Bandura, 1977). The connection between these two areas lies primarily in the fact that environmental education provides the substantive basis for understanding the importance of environmental legislation, while legal socialisation ensures that these norms are not perceived merely as external constraints, but as legitimate instruments for the protection of the public interest (Stern, 2000). The result is a higher level of voluntary compliance with rules, active civic engagement, and responsible behaviour on the part of individuals, all of which contribute to the sustainable development of society (Ajzen, 1991).

However, in light of the ongoing degradation of the environment, it cannot be concluded that environmental education is functioning effectively. Environmental Education, Training and Awareness (EVVO) has a long tradition in the Czech Republic. While there is a wide range of programmes for schools of all types, the theoretical dimension does not fully correspond to them.

The issue is not merely the acquisition of certain habits and skills, but rather a transformation of values and attitudes towards nature and its protection. This is a topic currently addressed by numerous studies and academic publications, for example Činčera, J., Goldman, D. & Válková, T. (2026); Činčera, J. & Kroufek, R. (2022); Kroufek, R., Jáč, M., Janštová, V., Pražáková, M. & Čiháková, K. (2020); Činčera, J., Kroufek, R. & Bogner, F. (2023); Svobodová, S. & Kroufek, R. (2016); Svobodová, S. & Kroufek, R. (2022); Činčera, J., Šimonová, P., Kroufek, R. & Johnson, B. (2020); Činčera, J., Johnson, B. & Kroufek, R. (2020); and Chawla & Flanders (2007).

The legal regulation of nature protection in the Czech Republic is primarily based on Act No. 114/1992 Coll., on the Protection of Nature and Landscape. This is followed by Act No. 16/1997 Coll., an amendment regulating procedures in matters of nature protection. Nature protection is defined as a matter of public interest. Within the framework of legal awareness, the principle "Ignorance of the law is no excuse" applies. Therefore, it is necessary in environmental education not only to become familiar with legal regulations, but equally importantly, to internalise them in terms of values and attitudes. All of this is achieved through legal socialisation.

Legal socialisation should be understood as a functional necessity for the existence of law as a sphere of social life (Večeřa, 2013). Its purpose is primarily to reproduce knowledge of legal norms and ways of acting in legal relationships and situations, as well as the frameworks of legal motivation, values, and attitudes in relation to law. In this process, we acquire legal regulations concerning nature—that

is, notions of what is permitted and prohibited. Our values and attitudes towards nature are also formed. Legal socialisation serves as a means of influencing everyday social life, fostering a well-established value-based legal consciousness, and shaping the capacity to distinguish right from wrong, and permissible from impermissible, from early childhood. „One manifestation of society's expectation to maintain the regulatory function of law is the pressure for the law to adapt to a changing reality." (Lubelcová, 2024, s. 34)

In addition to legal socialisation, a range of other factors within environmental education significantly shape individual's attitudes and behaviour towards the environment. As previously mentioned, the family plays a key role as the primary socialisation environment, where individuals acquire basic values, habits, and behavioural patterns, such as attitudes towards nature, consumption habits, and approaches to responsibility (Berger & Luckmann, 1966; Bandura, 1977). Equally important is the influence of educational institutions, which, through formal teaching and informal activities, develop environmental literacy and support critical thinking (Palmer, 1998; UNESCO, 2017). Media and social networks are also significant factors, shaping public opinion, providing information on environmental issues, and motivating pro-environmental behaviour, while at the same time potentially spreading distorted or incomplete information (Boykoff, 2011).

Cultural and societal norms further determine which behaviours are considered desirable or acceptable, thereby influencing an individual's willingness to engage in environmental protection (Hofstede, 2001; Inglehart, 1995). Economic factors, such as income levels, energy prices, or the availability of ecological alternatives, can practically facilitate or hinder environmentally responsible behaviour (Stern, 2000). The influence of peer groups and the broader community should also not be overlooked, as they can reinforce or weaken certain attitudes through social pressure and shared experiences (Ajzen, 1991; Chawla, 1998, 2007).

Finally, personal characteristics of the individual, such as value orientation, empathy towards nature, sense of responsibility, and long-term thinking, play an important role. Together, these factors create a complex framework in which environmental education operates and determine the extent to which acquired knowledge translates into real-life behaviour (Schwartz, 1992; Kollmuss & Agyeman, 2002).

A significant contribution to the analysis of legal socialisation was provided by the cognitive-developmental approach of the American social psychologist Lawrence Kohlberg, who emphasised the close interconnection between cognitive, moral, and legal development. Kohlberg linked the stages of moral development to the formation of an individual's relationship with legal norms and identified developmental stages of legal socialisation that are closely tied to the maturation of cognitive abilities and the development of social experience (Heidbring, 1997). Kohlberg's stages of moral and legal development have become part of the scientific discourse in numerous fields, including legal sociology, social psychology, and psychology, and are also applicable to environmental education, as it is not only about receiving information but also about internalising it, adopting it, and transforming social values and attitudes.

Kohlberg (1981, 1984, 2008) formulated three main levels of legal socialisation, each of which is further divided into two qualitative sub-stages. The following section presents the application of this theory to environmental education.

Results

The application of Lawrence Kohlberg's theory of moral development to environmental education represents an important approach to understanding how individuals' moral attitudes towards environmental protection are formed. Kohlberg's framework distinguishes three basic levels of moral development—pre-conventional, conventional, and post-conventional—each further divided into two stages (a total of six stages), with each stage reflecting a different motivation for ethical behaviour.

At the pre-conventional level, the first two stages are located. Stage 1 – obedience and punishment orientation – is characterised by behaviour aimed at avoiding sanctions; in an environmental context, for example, an individual may sort waste solely to avoid a fine. Stage 2 – instrumental relativism (reward orientation) – involves acting based on self-interest; pro-environmental behaviour is motivated by expected personal gain, such as financial savings or other rewards.

At the conventional level, the individual is guided by social norms. Stage 3 – "good boy/good girl" orientation – is based on the desire for recognition from others; the individuals behave environmentally because they want to be perceived as responsible and proper members of society. Stage 4 – law and order orientation – reflects respect for rules and authorities; environmental behaviour is motivated by the belief that laws and regulations should be obeyed because they maintain social order. However, at this stage, there is little consideration of the fairness or moral quality of the laws themselves.

At the post-conventional level, values are more deeply internalised. Stage 5 – social contract orientation – is based on the understanding that rules exist to protect the public interest and may be

changed if unjust; in environmental education, this is reflected, for example, in support for environmental policies and active participation in shaping them. Stage 6 – universal ethical principles – represents the highest level, where the individuals act according to their own moral principles, such as justice, responsibility, and respect for life; environmental protection is regarded as a moral duty, regardless of external rules or expectations.

The application of these stages in environmental education emphasises the need to systematically develop individuals' moral reasoning. Pedagogical approaches should therefore support discussion of environmental dilemmas, critical thinking, and value-based decision-making. The goal is not merely to increase knowledge, but primarily to advance towards the post-conventional level of moral reasoning, enabling responsible and sustainable action based on internal conviction.

Applying Kohlberg's theory in environmental education highlights the necessity of developing not only knowledge but also moral reasoning. Pedagogical approaches should foster discussion of ethical dilemmas, critical thinking, and the ability to adopt prosocial and pro-environmental values and attitudes. This shifts the focus from mere rule-following to conscious and value-based internalisation of norms, which is essential for long-term sustainable and responsible individual behaviour towards the environment.

Kohlberg formulated the stages independently of their specific content, based on the apparent universality of what is considered good, right, just, and desirable, as well as the standards applied to human behaviour. Contemporary postmodern contexts, however, relativise these assumptions to some extent. For socially differentiated content of good and evil, right and wrong, just and unjust, and other bipolar concepts, it is difficult to assign specific stages of legal socialisation unequivocally, as different individuals, societies, or legal systems may attribute different weight to these values (goodness, correctness, loyalty, etc.) in specific situations. This is also evident in the acceptance of nature protection.

Discussion and Conclusion

Legal socialisation and environmental education together form a significant tool for shaping responsible citizens who are aware of their rights and duties towards nature.

Our study raises a number of questions and issues related to research that connects environmental education and legal socialisation. These issues can be categorised into the following areas. (Since very little specialised literature addresses the link between environmental education and legal socialisation, we also include references that are inspirational for the respective category.):

1. Assessment of educational impact

Despite the existence of theoretical frameworks and empirical studies, the measurement of the actual impact of environmental education on pro-environmental behaviour and compliance with legal norms remains insufficiently clarified. While environmental education provides a wealth of valuable information, it is difficult to empirically track how this knowledge translates into changes in attitudes and values. It therefore remains unclear how to precisely evaluate the influence of knowledge, attitudes, and values on individuals' long-term behaviour (Chawla, 1998; Činčera, Kroufek & Bogner, 2023).

2. Integration of legal and environmental education

There is a significant gap in the systematic integration of environmental education with legal socialisation. While environmental programmes often raise awareness of ecological issues, they pay less attention to how this awareness can be transformed into concrete compliance with legal norms (Ajzen, 1991; Cotterrell, 1992).

3. Social influences and normative pressures

Peers, family, schools, mass media, social networks, and the community environment play a major role in shaping prosocial and pro-environmental behaviour. Individuals are also influenced by habits, traditions, customs, morality, religion, ideology, and occupation. It remains an underexplored question how these social factors modulate the effectiveness of educational interventions and the extent to which they support the internalisation of environmental and legal norms (Bandura, 1977; Kollmuss & Agyeman, 2002; Činčera, Šimonová, Kroufek & Johnson, 2020).

4. Moral dimension of environmental behaviour

It remains unclear how the moral development of the individual influences environmental decision-making. For instance, the application of Kohlberg's stages of moral development to environmental behaviour and the internalisation of legal norms provides potential hypotheses; however, empirical testing of these hypotheses is very challenging (Kohlberg, 1984; Heidbrink, 1997).

5. Contextual and cultural determinants

Cultural and institutional influences are significant but still insufficiently studied. Different cultural frameworks, value systems, and institutional structures can substantially affect how effectively

environmental and legal education shapes individual behaviour (Berger & Luckmann, 1966; Hofstede, 2001; Inglehart, 1995).
In addition to these research problems, we see other professional challenges in a deeper interconnection of the theoretical framework of environmental education and legal socialization, in the discrepancy between declared attitudes and actual human behaviour, in the operationalization of concepts, since in the research on environmental education and legal socialization we work with very complex concepts. Furthermore, ethical issues must also be considered (e.g. intentional incitement to unecological behaviour within the framework of research), economic aspects (financial cost of longitudinal but also other studies), and the limited connection between research and practice, i.e. research findings are not always effectively reflected in educational programs or public policies.
Resolution all of these issues is crucial for both the theoretical understanding and practical application of environmental education programmes.

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Souhrn
V tomto příspěvku se autorky zabývají budováním odpovědného vztahu k životnímu prostředí a udržitelnému rozvoji, přičemž klíčovou roli přisuzují environmentálnímu vzdělávání a právní socializaci. Toto propojení obou oblastí by mělo vést k formování komplexní odpovědnosti za prostředí, ve kterém žijeme, a spočívá zejména v tom, že environmentální vzdělávání poskytuje obsahový základ pro pochopení významu environmentální legislativy, zatímco právní socializace zajišťuje, že tyto normy nejsou vnímány pouze jako vnější omezení, ale jako legitimní nástroj ochrany veřejného zájmu zajišťující bezpečnost, ochranu zdraví, životního prostředí a hodnot přesahujících individuální zájmy, s nimiž se jednotlivec vnitřně ztotožňuje.
V tomto kontextu je v příspěvku mimo jiné představena aplikace teorie morálního vývoje Lawrence Kohlberga na oblast environmentálního vzdělávání. Autorky ji využívají jako názorný nástroj k pochopení toho, jak se formují morální postoje jednotlivců k ochraně životního prostředí. Studie rovněž nabízí přehled otázek a problémů spojených s empiricky zaměřenými výzkumnými aktivitami propojujícími environmentální vzdělávání a právní socializaci.“

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EXPLORING INCLUSIVE TOURISM: ACCESSIBILITY OF TOURISM PRODUCTS FOR TOURISTS WITH ACCESS NEEDS IN SERENGETI NATIONAL PARK, TANZANIA

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Abstract
The global population of tourists with access needs is expanding, and many possess both the financial capacity and motivation to travel. However, participation remains constrained by inadequate accessibility and limited inclusivity across tourism destinations. This study examines inclusive tourism by assessing the accessibility of tourism products for tourists with access needs in Serengeti National Park. Guided by the Long Tail theory of market expansion, an exploratory research design was employed. From a target population of 292 individuals, 66 participants were purposively selected, with data collection continuing to saturation. Data were gathered through interviews, focus group discussions, and field observations and analyzed thematically. Findings reveal that most tourism products in the park are not designed to accommodate tourists with access needs, limiting meaningful engagement and restricting them as a viable market opportunity. Despite its economic potential, accessible tourism provision remains limited. The study recommends establishing and enforcing accessibility standards and developing supportive tools and digital applications to enhance travel planning and on-site navigation. By highlighting accessibility gaps in protected areas, the study advances knowledge on inclusive tourism product design and its role in promoting equitable and sustainable tourism development.

Key words: universal design, market diversification, visitor experience, disability inclusion, sustainable destination development

Introduction

Accessible tourism represents a dynamically growing and profitable sector with significant potential to enhance destination competitiveness and promote social inclusion (Luiza, 2010; Buiga et al., 2017; Porto et al., 2019), enabling millions of Tourists with Access Needs (TwANs) to participate freely regardless of their functional limitations (Darcy et al., 2008; Darcy, Dickson, 2009; Darcy, 2012). Global statistics confirm the immense purchasing power of this group, which includes approximately one billion people; in Europe and New Zealand alone, this segment represents a key domestic market with multi-billion euro contributions (Domínguez et al., 2013; Zealand, 2014; UNWTO, 2013). Within the specific environment of national parks, accessibility involves not only the physical reachability of sites but also the capacity of tourists to fully engage with complex services tailored to their diverse needs, including safe mobility and specialized programming (Cappelletti et al., 2019; Radygina, 2019). Although evidence from countries like Tanzania confirms that inclusive tourism in protected areas generates economic benefits while fulfilling the principles of sustainable development (Lwoga, Mapunda, 2017), studies from Europe point to persistent barriers that often lead many tourists with access needs to opt for "non-travel" (for example Hungary, Csapó et al., 2019). Despite the growing importance of this segment, there remains a lack of extensive literature addressing tourism products specifically designed for tourists with access needs within national parks.

Materials and methods

The study evaluates accessible tourism products for tourists with access needs in Serengeti National Park (SENAPA), a UNESCO World Heritage Site managed by Tanzania National Parks. Using an exploratory qualitative design (April – July 2024), data were collected from a purposive sample (n=66) via triangulated methods – interviews, observation, and focus group – following approval from Tanzania Wildlife Research Institute and Tanzania Commission for Science and Technology. Findings are contextualized within Tanzania's tourism sector, which attracts ~80 % of international visitors (Bayliss et al., 2014; Hunt, Gorenflo, 2019).

Using non-participant observation across key sites in Serengeti National Park, supplemented by mini-focus group discussions, the study captured service delivery and facility accessibility for tourists with access needs. Qualitative data were thematically analyzed through iterative coding and categorization following established mini-group (Krueger, 1994; Morgan, 1997) and six-phase thematic analysis procedures (Braun, Clarke, 2006).

Results

Following a thematic analysis, the study elucidated key dimensions of accessible products, associated challenges, and tourist spending patterns.

Accessible Tourism Products

The study examines the experiences of Tourists with Access Needs (TwANs) in alignment with accessible tourism frameworks (Buhalis, Darcy, 2011). The findings highlight social support as a central factor in tourism participation, as 58 % of respondents do not travel independently, viewing companionship as a critical enabling mechanism for accessing services. Although SENAPA offers a diverse portfolio of products – from wildlife viewing to varied accommodation – visitors require enhanced support from providers. Specifically, transportation remains a critical gap, emphasizing the need for inclusive mobility solutions and accessible vehicles to improve the overall tourism experience.

Challenges in Product Accessibility

Guides identified the poor condition of roads between Ngorongoro and Serengeti as a major obstacle, causing discomfort and fatigue, particularly for the elderly and those with limited mobility. Field observations in SENAPA also revealed poorly designed pathways restricting wheelchair users and safety risks such as damaged handrails. Furthermore, the absence of sign language interpretation highlights significant gaps in inclusive communication.

Spending on Accessible Products

Tourists with access needs typically stay two to four nights, spending between $800 and $2,000 on service packages. Since they often travel with companions, their overall economic contribution to the destination is higher. They show the greatest interest in iconic experiences, such as the wildebeest migration, where the accessibility of these attractions directly increases satisfaction and word-of-mouth recommendations. SENAPA holds high potential to become a competitive destination if it improves the quality and accessibility of its key products.

Discussion

The study of accessible tourism products SENAPA highlights the provision of universally designed services enabling independent, dignified access for tourists with diverse needs (Darcy, Dickson, 2009). Findings indicate TwANs often rely on close assistance during travel, corroborating previous research showing caregiver accompaniment enhances both tourist satisfaction and service quality (Kang et al., 2020).

The study identified the Serengeti Media Center as an accessible tourism product, aligning with Jamaludin and Kadir (2012), who argue that public buildings should adopt barrier-free designs to promote inclusive access, accommodating individuals with visual or hearing impairments, wheelchair users, the elderly, and parents with strollers, thereby facilitating integration and usability for all visitors. The study identified special rooms with ramps in service areas such as dining and reception as accessible tourism products in Serengeti National Park, reflecting consideration for tourists with access needs. This aligns with Yau et al. (2004), who note that individuals with disabilities have similar travel desires but specific requirements, and Boxall et al. (2018), emphasizing that comfortable, accessible accommodations foster attachment, identity, and likelihood of repeat visitation.

Observations revealed that outdated, inaccessible tour vehicles reduced satisfaction among tourists with access needs (TwANs). Consistent with Devile et al. (2012), much of tourism infrastructure remains inadequately prepared for accessibility, and despite progress, access to tourism products and services for people with disabilities remains limited. Destinations that effectively address these needs gain a competitive advantage (Smith, Richards, 2013).

Conclusion

The study concludes that Serengeti National Park holds strong potential to serve tourists with access needs, offering diverse tourism products across wilderness, accommodations, and tour services. Nonetheless, opportunities exist to develop additional accessible offerings. Addressing current accessibility challenges is essential for enhancing visitor satisfaction and promoting sustainable tourism development in Tanzania’s national parks.

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Souhrn
Cestovní ruch pro osoby se specifickými potřebami se celosvětově rozšiřuje, avšak jejich účast je omezena nedostatečnou přístupností a inkluzivitou. Tato studie zkoumala inkluzivní cestovní ruch v národním parku Serengeti a posuzovala přístupnost produktů cestovního ruchu pro tyto návštěvníky. Průzkumný design, vedený teorií dlouhého chvostu (Long Tail theory), využil záměrný výběr vzorku; data byla sbírána prostřednictvím rozhovorů, ohniskových skupin a terénních pozorování až do bodu nasycení a následně tematicky analyzována. Zjištění naznačují, že většina nabídek parku nedostatečně vyhovuje turistům se specifickými potřebami, což omezuje jejich zapojení i tržní potenciál. Studie doporučuje zavést standardy přístupnosti, podpůrné nástroje a digitální aplikace pro zlepšení plánování a navigace, což přispěje k rovnému a udržitelnému rozvoji cestovního ruchu.

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FLOOD EXPOSURE OF SLOVAK BIOSPHERE RESERVES

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Abstract
Biosphere reserves represent unique UNESCO model areas that integrate biodiversity conservation with sustainable socio-economic development. Given the expected increase in the frequency of flash floods caused by extreme manifestations of climate change, it is necessary to assess their impact on these areas. The aim of the study was to determine the extent of flooding in Slovak biosphere reserves (Slovak Karst, Poľana, Tatras, Eastern Carpathians) based on flood hazard maps of the Slovak Water Management Enterprise for average return periods of 10, 100 and 1 000 years. The methodological approach was based on delineating reserve boundaries, extracting flood lines, and calculating the inundated area. The results showed significant differences between the reserves. The study highlights the need for more detailed research on flood risks in biosphere reserves and their integration into area management.

Key words: Biosphere reserve, flood, extent

Introduction

UNESCO-designated biosphere reserves (BR) hold a unique position as model areas for sustainable development, as they aim to reconcile biodiversity conservation with the socio-economic vitality and cultural identity of local communities (Briegez et al., 2025). Flash floods are highly destructive due to their sudden onset, and scientists expect their frequency to increase as a result of current extreme rainfall events driven by climate change. Such repeated occurrences of flash floods have significant implications for BR, which host diverse plants, animals, and microorganisms and support local livelihoods (Eze, Siegmund, 2023). Floods regularly cause substantial damages worldwide. Their characteristics are changing—for example, due to climate change—which poses challenges for flood-risk management. The spatial extent of floods is an important indicator of potential impacts, as the consequences of large-scale flooding are particularly difficult to mitigate. Across Europe, we observe an average increase in flood extent of 11.3% over the past 70 years, although this trend is highly spatially variable (Fang et al., 2023).

BR perform three fundamental functions. The conservation function ensures the preservation of genetic, species, and landscape diversity, maintaining ecosystems in a favourable state. The development function supports economic and human development that is socio-culturally and environmentally sustainable, as well as the socio-economic and ecologically sustainable development of the region. The logistic function provides support for education, research, and environmental monitoring (Vitálošová et al., 2025). These functions are implemented through an appropriate delineation of the territory into three zones: (1) one or more legally protected core areas designated for long-term conservation; (2) a clearly defined buffer zone or zones surrounding the core area; and (3) an outer transition area where practices of sustainable natural-resource management are promoted and developed (Hriňová, 2014). The transition zone is the part of the BR that is neither a core area nor a buffer zone. It represents a “transition” toward the surrounding landscape and differs from the boundaries of large-scale protected areas. Its defining feature is direct human intervention and activity in the landscape in accordance with the principles of sustainable development (Vitálošová et al., 2025).

In our research, we focused on calculating the areas of BR within the flood-hazard maps published by the Slovak Water Management Enterprise, considering return periods ranging from 10 to 1000 years.

Area of interest

Four BR have been designated in Slovakia: Slovak Karst (1977), Poľana (1990), the Tatra Transboundary BR (Poland/Slovakia, 1992), and the East Carpathians Transboundary BR (Poland/Slovakia/Ukraine, 1992). They are protected under Act No. 543/2002 Coll. on Nature and Landscape Protection as areas of international importance, and at the same time as areas of national importance Poľana as a Protected Landscape Area, and the others as national parks (Špulerová et al., 2023).

Methods

In our methodology, we followed the methodological procedure of Grežo et al. (2020). The aim of the authors in that study was to demonstrate how data from historical maps could be applied in the process of flood-risk assessment in suburban zones located within flood-prone areas, serving as complementary datasets to national flood maps. We modified and adapted their methodology to our study area. The methodology consists of the following steps: a) delineation of BR based on publicly available data from the State Nature Conservancy of the Slovak Republic (PABR, 2025); b) extraction of flood lines using available data from the Slovak Water
Management Enterprise (SWMC, 2025); c) calculation of the area of BR within the flood-hazard extents.

A flood-hazard map is prepared at the most appropriate scale for each geographical area where a potentially significant flood risk exists, or where the occurrence of significant flood risk can be expected. The flood-hazard map depicts the possible inundation of the area by:

a) a flood with a low probability of occurrence, meaning a flood that may occur on average once every 1,000 years or less often, or one with exceptionally dangerous characteristics;

b) a flood with a medium probability of occurrence, which may occur on average once every 100 years;

c) a flood with a high probability of occurrence, which may occur on average once every 10 years (7/2010 Z. z., 2025).

Result

Within the total area of the BR, the flood-hazard maps show that areas inundated at an average return period of once every 10 years amount to 512.67 ha, once every 100 years to 1 536.56 ha, and once every 1 000 years to 1 976.47 ha. Summed across all reserves, this corresponds to 3 451.25 ha in Slovak Karst, 89.04 ha in Poľana, 485.166 ha in the Tatras, and 0.22 ha in the Eastern Carpathians.

Tab. 1: Flooded Area in the Biosphere Reserves of the Slovak Republic

Biosphere reserve	**Q10 (ha)**	**Q100 (ha)**	**Q1000 (ha)**	**Together (ha)**
Slovak Karst	428.76	1341.73	1680.76	3451.25
Poľana	21.17	31.48	36.40	89.05
Tatry	62.69	163.27	259.21	485.17
Eastern Carpathians	0.05	0.08	0.1	0.23
Together (ha)	512.67	1536.56	1976.47	4025.7

Source: SWME, 2025; PABR, 2025

The Slovak Karst BR has the largest inundated area, totalling 3 451.25 ha, of which 428.76 ha correspond to the Q10 return period, 1 341.73 ha to Q100, and 1 680.76 ha to Q1000. In the Poľana BR, the inundated area for an average return period of once every 10 years is 21.17 ha, for Q100 it is 31.48 ha, and for Q1000 it is 36.40 ha (Map 1).

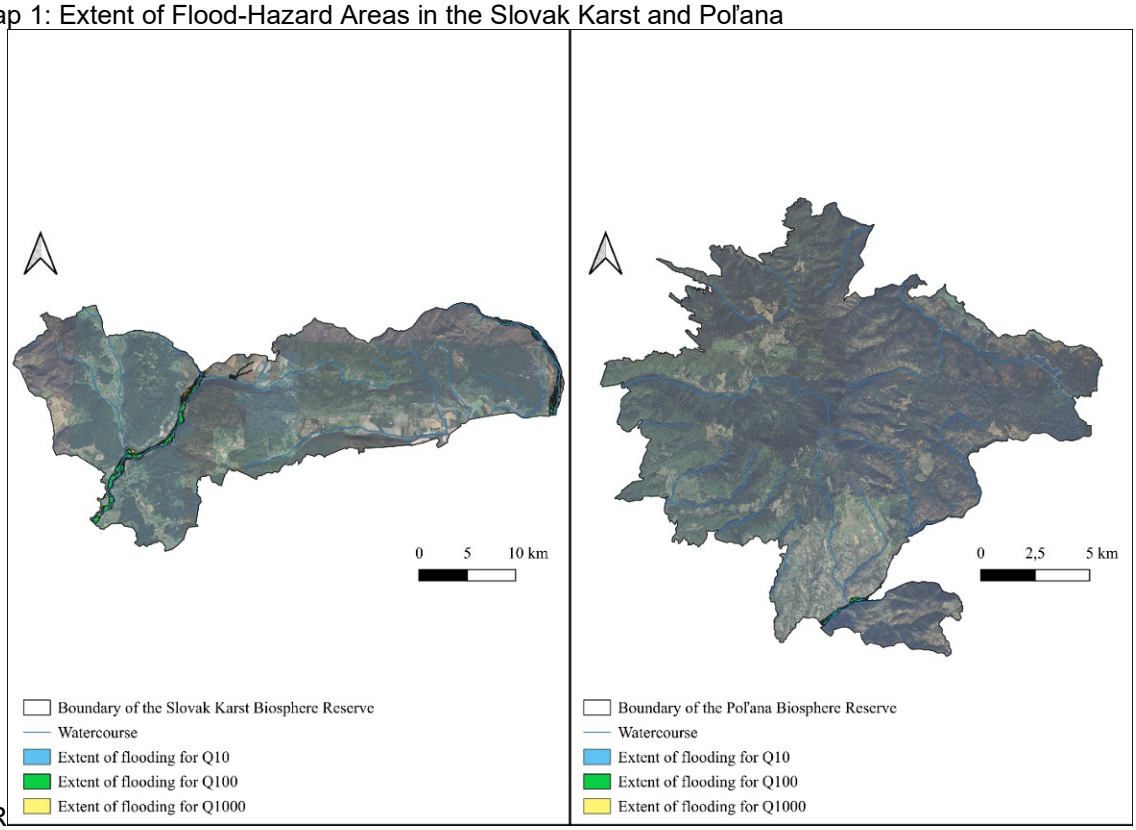
In the Tatras BR, the inundated area for a return period of once every 10 years is 62.69 ha, for Q100 it is 163.27 ha, and for Q1000 it is 259.21 ha. In the Eastern Carpathians BR, the inundated area is 0.05 ha for the 10-year return period, 0.08 ha for Q100, and 0.1 ha for Q1000 (Map 2).

Conclusion

In general, flash floods have destroyed human and animal lives, livelihoods, and infrastructure. In some cases, floods have been followed by displacement of people, alterations to the landscapes of BR, and further disasters. A study by the authors revealed that flash floods in BR have been insufficiently researched. Specifically, no study was found documenting the occurrence of flash floods in Africa (Eze, Siegmund, 2023).

Within the Slovak Republic, several studies focus on flash floods; however, we were unable to identify any research dedicated specifically to the study of flash floods or floods comprehensively addressing BR. The aim of this research was to assess and calculate the inundated area of all BR in Slovakia. Across the four BR, the total area at risk according to flood-hazard maps amounts to 512.67 ha for floods with an average return period of once every 10 years, 1 536.56 ha for the 100-year return period, and 1 976.47 ha for the 1 000-year return period.

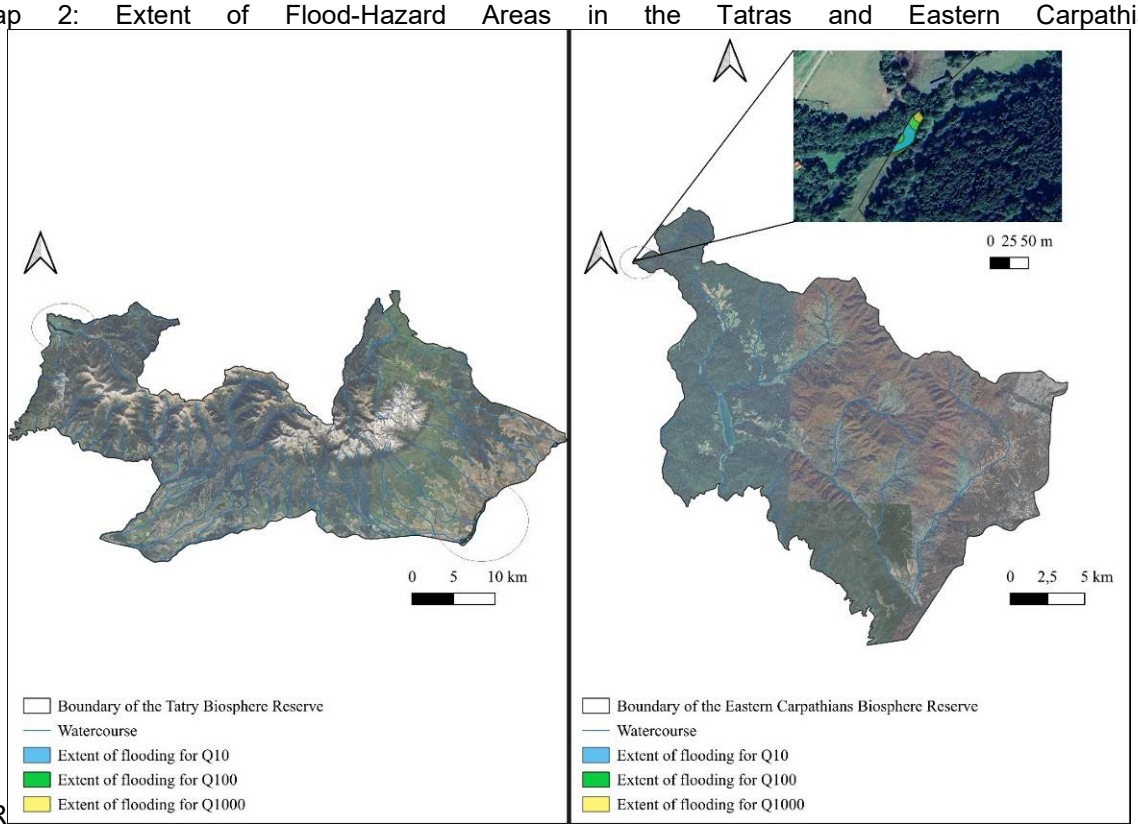
Map 1: Extent of Flood-Hazard Areas in the Slovak Karst and Poľana



BR

Zdroj: SWMC, 2025; PABR, 2025

Map 2: Extent of Flood-Hazard Areas in the Tatras and Eastern Carpathians



BR

Source: SWMC, 2025; PABR, 2025

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Souhrn
Tato studie hodnotí potenciální povodňové riziko ve čtyřech biosférických rezervacích (BR) na Slovensku vyhlášených organizací UNESCO – Slovenský kras, Poľana, Tatranská přeshraniční BR a Východokarpatská přeshraniční BR – pomocí map povodňového ohrožení vypracovaných Slovenským vodohospodářským podnikem. BR slouží jako modelové regiony udržitelného rozvoje, protože spojují ochranu biodiverzity se socioekonomickými potřebami. Stále častěji se vyskytující přívalové povodně způsobené změnou klimatu představují pro tato chráněná území významnou hrozbu.
Výzkum aplikoval upravenou metodiku podle Grežo a kol. (2020), která zahrnovala vytyčení hranic rezervací, extrakci povodňových linií a výpočet zaplavených ploch pro období opakování 10, 100 a 1000 let. Výsledky ukázaly, že rozsah povodňového ohrožení se mezi rezervacemi výrazně liší. Největší zaplavenou plochu má Slovenský kras (3 451.25 ha), následují Tatry (485.17 ha), Poľana (89.05 ha) a Východní Karpaty (0.23 ha). Celkem je ohroženo 512.67 ha při 10 leté povodni, 1 536.56 ha při 100 leté povodni a 1 976.47 ha při 1000 leté povodni.
Studie poukazuje na to, že přívalové povodně v BR jsou na globální úrovni i v rámci Slovenska stále nedostatečně prozkoumány. Zjištění zdůrazňují potřebu integrovat hodnocení povodňových rizik do managementu a dlouhodobého plánování BR.

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FOREST CLASSROOM AS A TOOL OF LANDSCAPE MANAGEMENT: INTEGRATING ENVIRONMENTAL EDUCATION, FORESTRY AND GAME MANAGEMENT

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Abstract
Sustainable landscape management requires not only ecological and economic approaches, but also the long-term development of environmental awareness and responsible attitudes. This work presents the concept of a forest classroom as an innovative tool integrating environmental education, forestry and game management within the framework of landscape management.
The forest is understood not only as an ecosystem, but also as a dynamic educational environment that enables experiential learning and supports the development of environmental literacy. I emphasize here the role of informal education, especially in work with adolescents, as a key factor in the formation of long-term relationships with nature and landscape.
The proposed concept combines traditional approaches to forestry and game management with modern educational methods and interactive elements. It shows how educational infrastructure embedded directly in the landscape can contribute to sustainable landscape management and strengthen regional environmental awareness.

Key words: landscape management; environmental education; forest classroom; non-formal education; forestry; game management

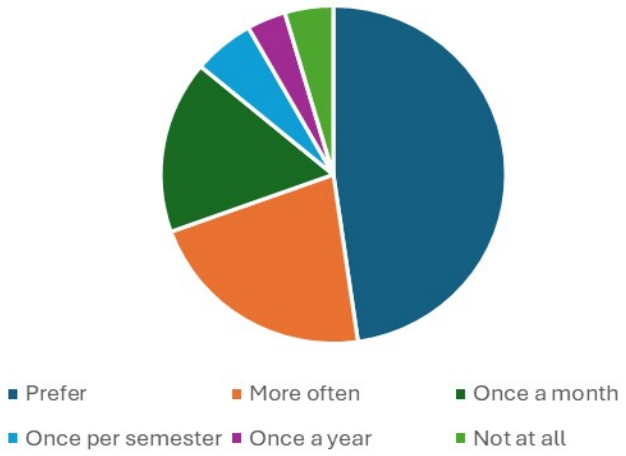
Introduction

The landscape today is facing many challenges, such as climate change, biodiversity loss, and increasing disconnection between society and nature. Although landscape management traditionally focuses on ecological and economic aspects, the social dimension is equally important. Environmental awareness and public engagement play a crucial role in ensuring long-term sustainability.
Environmental education plays a key role in shaping the relationship between society and the landscape (Daniš, 2018). It contributes to the development of environmental literacy, which includes knowledge, skills, values, and attitudes necessary for responsible interaction with the environment (Harazim; Hudaková, 2014). The landscape is not only a physical environment, but also a space influenced by human perception and activity. Therefore, its management must include educational approaches that support awareness and understanding. Educational activities aimed at strengthening the relationship between people and the landscape can serve as a preventive tool against environmental degradation and unsustainable development.
In current education, students often gain knowledge mainly through theoretical instruction. However, understanding nature cannot be based only on information obtained indirectly from books, media, or digital technologies. Direct experience, observation, and personal contact with the natural environment are essential for creating a deeper and lasting understanding.
The natural environment offers a unique opportunity for such learning. It is not only a place where ecological processes take place, but also a space where people can learn through their own experience. Direct contact with the natural environment enables a deeper understanding of ecological processes and encourages the development of a personal connection to the natural world (Andres; Vrtiška, 2018).
Nature can be understood as a living classroom that offers a wide range of learning opportunities. It provides a natural environment where students can directly observe ecological relationships, such as interactions between organisms, natural cycles, and biodiversity. Compared to traditional classroom teaching, this type of learning leads to deeper understanding and longer retention of knowledge (Knotková, 2022).
Nature also enables interdisciplinary education, connecting subjects such as biology, ecology, geography, and social sciences. It creates a space where knowledge is not separated into disciplines but understood in context.
Forestry and game management represent essential components of landscape management, focusing on sustainable use, conservation, and long-term planning. Integrating these fields into educational activities helps to provide a realistic and comprehensive understanding of human interaction with the landscape. Game management plays a significant role in maintaining ecological balance, regulating

wildlife populations, and supporting biodiversity (Českomoravská myslivecká jednota, 2026). When presented in an educational context, it can help overcome misconceptions and promote a deeper understanding of its ecological and cultural importance.
Forest pedagogy, as a method of non-formal education, combines professional knowledge with experiential learning approaches (Pešek et al., 2019). It enables participants to gain insight into landscape ecosystems and management practices directly in the field.
The aim of this paper is to present the concept of a Forest classroom as a tool of landscape management that connects environmental education, forestry, and game management. The concept is based on experiential learning and non-formal education and aims to strengthen the relationship between people and the landscape, while also integrating modern digital technologies and innovative tools for outdoor education.

Materials and Methods
The research presented in this article is based on a questionnaire survey designed to identify the attitudes, preferences, and needs of students and teachers regarding outdoor education and the concept of the Forest classroom.
The survey was conducted among elementary and secondary school students (aged 15 and older) and teachers at selected educational institutions. This age group was chosen based on the respondents´ ability to independently formulate opinions and attitudes toward environmental topics and educational approaches.
The questionnaire included questions focused on respondents´ relationship with nature, their perception of game management, interest in learning in natural environment, preferred teaching elements (interactive and digital), and willingness to participate in activities in a forest classroom.
The collected data were analysed using basic statistical methods, primarily percentage analysis.

Results
- The results of the questionnaire survey show that respondents have a strong interest in outdoor education. A total of 91.4% of students stated that they prefer outdoor education, with 41.7% wanting it more often, 31.7% at least once a month, 11% once per semester, and 7% once a year. Only 8.7% of respondents do not prefer this form of instruction.
- Teachers expressed a high degree of willingness to incorporate outdoor education into their teaching practice. A total of 83.3% of teachers stated that they would use the forest classroom regularly, with 35.3% visiting it once a month, 29.4% more frequently, and 17.6% once every six months. Only 17.6% of teachers stated that they were not interested in visiting.
- Regarding the use of digital and interactive elements, 52.9% of teachers unequivocally support their inclusion in outdoor instruction. Another 23.5% are somewhat inclined to use them. A lack of interest in the use of digital technologies was expressed by 17.6% of respondents, and only 5.9% completely reject them.
- Tracking and wildlife observation are perceived as the most interesting for students (e.g., 56.3% chose “animal identification and tracking” as the most interesting).



- Fig. 1: Students interest in outdoor education

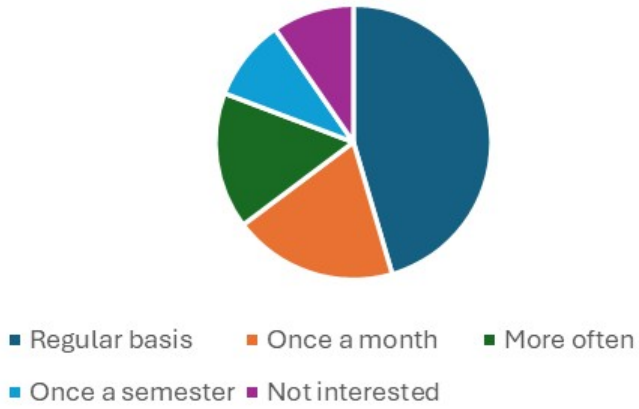


Fig. 2:Teachers interest in outdoor education

Fig. 3:Students interest in hunting related topics

- Students believe that game management is primarily about the care and protection of forests and wildlife. They largely prioritize conservation over hunting (71.7% game management – care for wild animals; 60.7% hunting).
- Students' personal experiences or contact with hunters are associated with greater interest in game management. (63.7% know someone in their circle who is involved in hunting; social contact increases students' interest).

Overall, the results confirm a high level of interest in experiential learning, openness to innovative educational approaches, and a positive attitude toward the integration of forestry and hunting into environmental education.

Discussion

The results of the questionnaire survey confirm that teaching in natural environments holds significant potential within the current educational system. Students´ high interest in learning outside the traditional school setting suggests a need for greater integration of experiential and field-based forms of instruction into educational practice. These results align with general findings in environmental education, which emphasize the importance of direct experience in shaping a relationship with nature.
Respondents´ positive attitude toward the natural environment and their willingness to participate in outdoor learning support the idea that environmental education should be more closely linked to the real environment. Direct contact with nature enables a deeper understanding of ecological processes and fosters the development of environmentally responsible behaviour.
Another important aspect is the perception of game management as part of education. This factor is key to the practical implementation of the concept, as without the active involvement of teachers, it would not be possible to effectively utilize such educational tools. At the same time, it appears that educators are open to innovative approaches, including the integration of digital technologies into teaching in natural environments.

The inclusion of interactive and digital elements was viewed predominantly positively by respondents, confirming the importance of combining traditional and modern educational methods. Linking direct experience with technology can increase the appeal of instruction while expanding the possibilities for interpreting natural phenomena.

Modern technologies play a significant role in today's education and landscape management, enabling the effective integration of theoretical knowledge with practical application in the field. Technologies such as drones, sensors, and artificial intelligence-based tools are now essential instruments not only for research but also for nature conservation and landscape management (Chytré technologie chrání přírodu, 2026).

Drones are used, for example, in landscape monitoring, wild animal population counting, or locating young deer before haymaking, thereby significantly contributing to the protection of young animals. In forestry, they are used to monitor the health of trees, detect damage, and map areas, enabling more effective planning and decision-making. Camera traps, meanwhile, are an important tool for long-term monitoring of wildlife movement and behaviour, and the data obtained can be used not only for professional purposes but also as an educational element in teaching.

Digital tools directly accessible to participants are also a significant element of modern outdoor education. QR codes placed within the forest classroom area can provide quick access to supplementary information, multimedia content, or interactive tasks. Mobile apps, for example, allow users to identify plant and animal species, record observations, or work with maps and navigate the terrain.

Another innovative feature could be the use of a 3D shooting range, which allows for a safe and ethical introduction to hunting-related topics without the need to use real firearms. This feature can contribute to a better understanding of hunting as part of landscape care while eliminating the risks associated with the practical handling of firearms.

The integration of technology and education is also evident in activities such as geocaching (Geocaching, 2026), which combines outdoor exploration with the use of digital tools. This activity allows participants to actively discover the natural environment while developing their sense of direction and environmental knowledge. In the context of a forest classroom, geocaching can be used as an interactive educational element, for example in the form of thematic tasks focused on identifying wildlife, tracks, or hunting equipment.

The integration of modern technologies into teaching in a natural environment does not disrupt contact with nature; on the contrary, it expands the possibilities for exploring it.

A well-chosen combination of experiential learning and digital tools can increase the appeal of instruction and contribute to a deeper understanding of how landscape ecosystems function. This approach also reflects the need to modernize environmental education in the context of current technological trends.

Another important aspect is the perception of game management as part of education. The positive attitude of teachers and the interest of students in topics related to wildlife observation and the functioning of ecosystems suggest that game management can be effectively integrated into environmental education. This can contribute to a better understanding of humanity´s role in the landscape and promote the perception of game management as part of caring for the natural environment, rather than merely as an activity associated with hunting.

The concept of the forest classroom thus reflects current educational needs as well as requirements for sustainable landscape management. It creates space for linking theoretical knowledge with practical experience and enables a comprehensive perception of the landscape as a dynamic system.

However, certain limitations of the research should also be noted. This is an exploratory study with a limited number of respondents and a regional focus, which does not allow for the generalization of results to the entire population. Further research should focus on a broader sample of respondents and on the long-term impacts of forest classroom instruction on participants´ attitudes and behaviours.

Conclusion

The forest classroom represents an innovative approach to landscape management that integrates environmental education, forestry, and game management into a single functional unit. It demonstrates that landscape stewardship involves not only technical interventions but also the cultivation of people's relationship with the natural environment.

The results of the questionnaire survey confirmed students' high interest in outdoor education, teachers' positive attitude toward its use, and openness to incorporating modern educational elements, including digital technologies. These findings suggest that the concept of a forest classroom meets the current needs of educational practice and has the potential to become an effective tool for environmental education.

The combination of experiential learning, informal education, and specialized knowledge in the fields of forestry and game management enables the creation of a comprehensive educational environment that supports the development of environmental literacy and responsible behaviour toward the landscape.

At the same time, integrating educational infrastructure directly into the landscape offers new opportunities to strengthen the public's connection to the natural environment and promote sustainable approaches to its use.

The forest classroom can thus serve as a significant tool for developing environmental awareness and contribute to the long-term sustainable management of the landscape.

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Souhrn

Udržitelné hospodaření s krajinou vyžaduje nejen ekologické a ekonomické přístupy, ale také dlouhodobé rozvíjení environmentálního povědomí a odpovědného přístupu. Tato práce představuje koncept lesní učebny jako inovativního nástroje, který v rámci hospodaření s krajinou propojuje environmentální výchovu, lesnictví a myslivost.

Les je chápán nejen jako ekosystém, ale také jako dynamické vzdělávací prostředí, které umožňuje zážitkové učení a podporuje rozvoj environmentální gramotnosti. Zdůrazňuji zde roli neformálního vzdělávání, zejména v práci s dospívajícími, jako klíčového faktoru při utváření dlouhodobých vztahů k přírodě a krajině.

Navrhovaný koncept kombinuje tradiční přístupy k lesnictví a myslivosti s moderními vzdělávacími metodami a interaktivními prvky. Ukazuje, jak může vzdělávací infrastruktura přímo zakotvená v krajině přispět k udržitelnému hospodaření s krajinou a posílit regionální environmentální povědomí.

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FOREST THERAPY AND FOREST BATHING IN 5 EUROPEAN COUNTRIES – BASIC DESCRIPTION

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Abstract

Project Integrating Nature into Higher Education: Forest Bathing has the mail goal to create digital training modules on forest bathing to make forest bathing more known and accessible. It is important to first increase the skills and knowledge of the education personnel for this purpose. When academics reach a sufficient level of knowledge about forest bathing, they will contribute to the society benefiting from the importance of nature on the mental health and well-being of individuals. Our aim is to make the idea of forest bathing more accessible to academics and students in other fields, including forestry and social sciences, with digital training modules. In this article we are desribing the basic of the state of art of the forest therapy and forest bathing in 5 european countries.

Key words: Articles, literature review, methodology, Europe

Introduction

Originating in Japan as Shinrin-yoku, forest bathing is a practice that is becoming increasingly popular and allows people to experience the forest through their five senses (Li, 2010). Literature shows that forest bathing has many positive physical and psychological effects on human health (Wen et al., 2019). However, in Turkey, studies on the concept of forest bathing are still in their infancy. Considering the potential and abundance of forests in Turkey, it is possible to say that there is a suitable environment for marketing forest bathing as a tourism product. Research on the subject generally seems to focus on environmental sustainability and individual well-being (Çalhan, 2025).

Materials and methods

This study is a descriptive bibliometric study based on data from the Web of Science (WoS) collection. It is a popular database for bibliometric analysis due to its wide range of topics, high-quality content, citation-tracking capabilities, and advanced features that enable efficient and reliable searching, filtering, and the generation of impact indicators.

The data strategy used included the search vector: "therapy" (topic) or "landscape" (topic) or "forest" (topic) or "human health" (topic). The search for articles was conducted using the keywords "forest bathing," or "forest therapy" or "green therapy" or "peri-urban forest" or "positive and negative affect schedule" or "profile of mood states" or "restorative outcome scale" or "shinrin-yoku" or "therapeutic landscape" "urban forest" or "subjective vitality scale." The global literature review on the above-mentioned issues was limited to articles and review articles (document types: article or review article), with a time limit of the last 10 years (publication years: 2015-2025) and presenting results of research conducted in Poland, Turkey, Czechia, Italy and Lithuania (countries/regions: Poland, Turkey, Czechia, Italy, Lithuania).

Results

Poland

In Poland, since the onset of the COVID-19 pandemic, the number of publications on the impact of forests on human health has increased significantly. Approximately 75% of the publications in the collection were produced after 2020. Most of the works on this topic were produced in forestry and environmental sciences. This dominance underscores the importance of both disciplines in advancing knowledge of cultural services, particularly relaxation and therapeutic services provided by forest

ecosystems. The next positions are occupied by studies in the field of technological sciences, as well as psychiatry and psychology. The leading universities conducting research on forest bathing and forest therapy are the University of Warmia and Mazury and the Warsaw University of Life Sciences. Both institutions serve as key centers for academic collaboration in research on the therapeutic benefits of forest landscapes. The vast majority of published works present results based on the impact of the forest landscape or selected features on the relaxation of only one research group: young Polish adults. In the remaining cases, the study sample consisted of working adults and psychiatric hospital patients. All analyzed studies used psychological tests to identify the relaxation benefits of forest contact; in several studies, selected physiological parameters, such as heart rate and blood pressure, were also monitored. In general, the restorative effects of the forest were assessed using psychological tests such as the Positive and Negative Affect Schedule (PANAS), the Restorative Outcome Scale (ROS), the Subjective Vitality Scale (SVS), and the Profile of Mood States (POMS). In addition to the POMS and ROS tests, SVS, a specialized questionnaire—the Pure Procrastination Scale (PPS)—was used, as were the Fluid Procrastination Scale (FPS) and the State-Trait Anxiety Inventory (STAI-S). All of the analyzed studies measure the impact of landscape on human psychological and physiological characteristics using a Pre-Post Test design, which involves conducting a measurement (test) on the same group of individuals before (pre) the intervention (e.g., exposure to a forest landscape), and then repeating the measurement after (post) the conclusion of that intervention to assess its effectiveness by measuring changes in mood, well-being, blood pressure, and heart rate. The vast majority of studies focused on the physiognomic variability of the forest landscape. Among the analyzed features of the forest landscape were, for example, forest type (deciduous forest, coniferous pine forest, mixed forest); the presence of open non-forest enclaves such as wetlands or treeless dunes; forest plantations; and clear-cut areas. Several studies analyzed the temporal variability of the forest landscape, including comparisons of the forest landscape with vegetation in a dormant state and in spring, and examined the impact of a snow-covered forest landscape on visitors' relaxation. The subject of analysis in the published, reviewed studies was elements that diminish landscape value, such as illegal trash dumps in the forest. In summary, all of the analyzed studies demonstrate that the forest landscape possesses regenerative properties. Despite the already considerable number of studies in this area, the relationship between the forest landscape and the observer remains poorly understood. Further research is necessary to determine how the auditory and olfactory qualities of the forest landscape influence human relaxation, as well as studies testing the impact of exposure time on the level of relaxation benefits.

Italy

A growing number of initiatives and activities referred to as "Forest Bathing" or "Forest Therapy" (FB/FT) is currently being implemented in Italy, as a result of the increasing interest in alternative and integrated solutions for treatment and healthcare promotion. Due to the benefits, often supported even by clinical studies, confirming the therapeutic effectiveness of these activities, FB/FT initiatives offer a business opportunity both for the forestry sector – through an increase of public recreation and sustainable development of rural areas - and for the socio-economic system - thanks to the positive impact on the National Health Service. However, despite its significance, determining whether an FB/FT site is suitable in Italy, still lacks a precise legal foundation and conventional operating processes. Because of this, FB/FT programs have been implemented in a not yet adequately regulated variety of settings, including urban and extra-urban forest areas, using a "self-referential" strategy, to carry out activities deemed appropriate. The first step in promoting a significant tool that can address many social needs, should therefore start from a consistent scientific and technical approach for the identification of FB/FT-suitable places and associated activities.

In the present paper, the literature review carried out within the INHEF Project, to assess the state of FB/FT in Italy, has resulted in the identification of 43 most relevant scientific articles describing the situation in this Country. From this analysis, it may be concluded that FB/FT had gained a significant scientific and institutional recognition. Indeed, some of the most important Italian research institutes (CNR, CAI, CREA) are currently working together, to develop medical protocols that demonstrate positive health effects - such as reduced cortisol levels and lower blood pressure. Green prescriptions are being introduced within the National Health Service to treat medical conditions - such as anxiety and depression. Strict standards have been established for the certification of forests used for FB/FT, taking into account factors such as air quality and biodiversity. The sector is regulated through training programmes for Forest Bathing guides and Forest Therapy practitioners, with national registers managed by certification bodies. Furthermore, there is a growing popularity of urban Forest Therapy, as well as an increase in wellness tourism, with regions (e.g., Tuscany; Trentino; etc.) which are capitalizing on its great economic potential.

Czechia

Presented studies confirm that forests are essential tools for supporting mental and physical health in an increasingly urbanized world. Short-term exposure (as brief as 15–20 minutes) has been shown to lower stress biomarkers like saliva cortisol, alleviate symptoms of anxiety and depression, and significantly increase feelings of vitality.

A key finding is the distinction between actual and perceived biodiversity. While measured tree species richness often has a limited impact on immediate regeneration, the perceived richness of the environment—a subjective assessment of diversity and "wildness"—is a powerful predictor of psychological well-being. From a management perspective, mature forest stands are the most suitable for mental restoration. Conversely, clear-cut areas evoke negative emotions, increase tension and depression, and demonstrably disrupt the restorative process.

Modern technology offers alternatives for individuals who cannot easily access nature. Virtual Reality (VR) and forest "digital twins" provide levels of relaxation comparable to real environments, although their efficacy can be limited by cybersickness. In clinical practice, such as oncology waiting rooms, audio-visual forest stimulation significantly improves patients' emotional valence and reduces arousal.

Forests also serve as tools for social restoration. For adolescents exhibiting risky behavior, forest therapy combined with observational learning from animal social structures (e.g., wolves or bees) helps reduce aggression and improves cooperative skills. Economically, studies prove it is possible to harmonize recreational functions with timber production if these ser

vices are an owner's priority and utilize diverse funding sources

Lithuania

A bibliometric analysis was conducted using the Web of Science (WoS) database, focusing on research and review articles published between 2015 and 2025. The selected publications, prepared in collaboration with international co-authors, were further analyzed based on their relevance to the research objectives. In total, 15 publications were included in the analysis.

The analysis revealed that two studies directly addressed forest therapy and forest bathing, emphasizing the recreational and emotional relationship between humans and natural environments. Five additional studies examined aspects related to the topic, including ecological processes in urban green spaces, air quality improvement, plant species identification, and ecosystem services. These studies provide an important contextual foundation for understanding environmental quality, the structure and functioning of green infrastructure, and its relevance to nature-based health practices.

International research highlights the significant role of urban green spaces in promoting human wellbeing. Studies on public participation in urban forest planning demonstrate that community involvement enhances human–nature interaction and supports the use of green spaces for recreation and environmental awareness. Similarly, research on tourist perceptions shows that urban green infrastructure is widely used for relaxation, physical activity, and social interaction, even when users are not familiar with the concept itself

Ecological studies conducted in Lithuania further emphasize the importance of urban ecosystems. Research on leaf litter decomposition and soil properties indicates that tree species, seasonality, and green space type influence ecosystem functioning. In addition, studies on air pollution mitigation highlight the role of urban trees in improving air quality and contributing to better living conditions.

In Lithuania, research on forest therapy has developed across three main domains: biomedical, psychological, and landscape architecture. Biomedical studies focus on the effects of phytoncides on the immune system and blood pressure, while psychological research emphasizes stress reduction and improvements in emotional wellbeing. Studies in landscape architecture highlight the importance of planning and designing therapeutic environments.

An analysis of Lithuanian scientific literature, based on national academic databases (Lituanistika and eLABa), underscores the growing relevance of nature-based health approaches. Research demonstrates that forest therapy can support immune system functioning and reduce stress levels, thereby contributing to the development of “green prescription” strategies as preventive healthcare measures. Other studies emphasize the therapeutic potential of forest environments, particularly pine forests, and their application in rehabilitation and health promotion.

Furthermore, landscape-based research indicates that well-designed natural environments can enhance emotional and spiritual wellbeing. Studies on forest bathing confirm that structured activities in natural settings contribute to stress reduction and improved psychological wellbeing

Overall, although forest therapy remains a relatively new and interdisciplinary field in Lithuania, both international and national studies consistently highlight the significant role of natural environments in enhancing human health, wellbeing, and quality of life.

Turkey

Studies on forest bathing in Türkiye have identified specific destinations and routes. Accordingly, Fethiye Günlüklü Bay, Karabük Yenice Forests, and Artvin Kafkasör City Forest have been evaluated for forest bathing purposes (Ardahanlıoğlu, 2023; Karaşah, 2022). Karaşah (2022) emphasizes in their study that many recreational activities can be considered within the scope of forest bathing. In addition, they stated that there was a positive effect on their mood after spending time in the forest. This indicates that forest bathing can be developed as a nature-based tourism product in Türkiye. The study conducted on Kafkasör City Forest emphasizes that this practice can create a strong brand value in destination marketing in the Black Sea Region. In another study conducted in Turkey, Ekinci (2025) examined the effects of forest bathing experience on camping individuals and found that time spent in a forest environment led individuals to inner transformation and awareness. This study demonstrates that forest bathing deepens the recreational experience. Furthermore, the İzmir Balçova and Narlıdere Therapy Forests, implemented in Turkey under the leadership of the Ministry of Agriculture and Forestry, provide concrete examples of how this concept has been integrated into public policies and tourism management strategies (Karaşah, 2022).

In the literature studies conducted in the field of health in Turkiye, it has been stated that forest bathing and forest therapy have positive effects on the cardiovascular system, nervous system, immune system, and mental health, but it has been emphasized that empirical studies on this subject in the field of health in Türkiye are quite limited. It is stated that research in this field will make important contributions, given Türkiye's rich forest resources (Kutlu, 2025).

In accordance with the principles of environmental and cultural sustainability, forest bathing is considered as an environmentally friendly, low-impact model against the destruction that mass tourism can create. Accordingly, forest bathing can play an effective role in protecting our forests, which are our natural heritage, for future generations (Akyol & Tolunay, 2006).

Another dimension that has recently attracted attention in studies conducted in Turkey is the therapeutic effects of forest bathing on stress management and burnout syndrome. Studies in the fields of organizational behavior and human resources suggest integrating forest therapy into corporate health and wellness programs to increase the psychological resilience of corporate employees. Findings show that these practices reduce negative moods and positively contribute to work-life balance are being adapted to the context of working life and health tourism in Turkey (Pekince & Balmumcu, 2023).

Forest bathing in Türkiye is not yet as institutionalized a practice as in Japan or Europe. However, urban forests, national parks, nature parks, and ecotourism areas are considered suitable areas for forest bathing practices. It is stated that forest areas, especially in the Black Sea, Mediterranean, and Marmara Regions, have significant potential for forest bathing and nature-based wellness tourism (Ergüven, 2019). In Türkiye, forest bathing practices are generally carried out through walks in urban forests, nature meditation, forest yoga, camping and nature therapy, ecotourism activities, and nature-based wellness programs. In conclusion, in the Turkish literature, forest bathing practices are considered a simple form of recreation.

Conclusion

Current State and Perspectives of Forest Therapy in an International Comparison

The presented studies from Poland, Italy, Czechia, Lithuania, and Türkiye confirm that forest ecosystems play an indispensable role in supporting public health. Although individual countries are at different stages of implementation, common trends and specific benefits can be clearly identified.

1. Evidence-Based Health Benefits

All analyzed countries agree on the **positive impact of forests on mental and physical health**. Research consistently demonstrates:

- **Physiological effects:** Reduction in blood pressure, heart rate, and cortisol levels, and strengthening of the immune system (notably through phytoncides, as highlighted by Lithuania).
- **Psychological effects:** Reduction of stress, anxiety, depression, and burnout syndrome; improvement in vitality and subjective well-being.
- **Specific findings:** Czechia emphasizes the role of "perceived biodiversity," while Turkish studies point to the potential for inner transformation and mindfulness among participants.

2. Institutionalization and Legislative Framework

Significant differences exist in the level of formal integration across the regions:

- **Italy** is the most advanced in integrating these practices into public policy, introducing **"green prescriptions"** and establishing strict certification protocols for therapeutic forest sites.

- **Lithuania and Poland** are experiencing intensive academic growth. Lithuania is already working on green prescription strategies as preventive healthcare measures.
- **Türkiye** currently views forest bathing primarily as a form of recreation and a niche tourism product, although it has begun implementing therapeutic forests under the Ministry of Agriculture and Forestry.

3. Methodology and Target Groups

Research relies on a multidisciplinary approach combining biomedicine, psychology, forestry, and landscape architecture.

- **Poland** has seen a surge in publications since 2020, though research remains primarily focused on young adults.
- **Czechia** expands the field with innovative uses of technology (**Virtual Reality**) and social restoration (working with at-risk youth).
- The **Pre-Post Test design** has become the methodological standard, providing exact measurements of physiological and psychological changes before and after forest exposure.

4. Socioeconomic and Environmental Significance

Forest therapy is recognized not only for its health benefits but also as:

- **An economic opportunity:** Driving wellness tourism and the sustainable development of rural areas (Italy, Türkiye).
- **A management tool:** Harmonizing timber production with the recreational functions of forests (Czechia).
- **A conservation driver:** Acting as an environmentally friendly model that fosters awareness of natural heritage protection for future generations.

While **Poland and Lithuania** are building a robust theoretical and bibliometric foundation, **Italy** is successfully translating theory into public health practice. **Czechia** contributes innovative perspectives on social dimensions and technology, while **Türkiye** identifies vast potential within the tourism sector. The common denominator for future development is the need for further research—specifically regarding sensory influences and exposure time—and the establishment of unified standards for site certification to ensure the quality and safety of therapeutic services.

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Souhrn
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FORMS OF APPLICATION OF GRASS–HERBACEOUS PLANT COMMUNITIES IN URBAN ENVIRONMENTS

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Abstract
Grass–herbaceous mixtures represent an important component of contemporary urban environments, contributing to ecological stability, aesthetic quality, and the overall resilience of cities. As urban areas increasingly face the impacts of climate change, the urban heat island effect, biodiversity loss, and growing maintenance demands for public spaces, the use of meadow-like vegetation as a designed landscape element is gaining particular importance. Grass–herbaceous plant communities provide a sustainable alternative to traditionally intensively mown lawns and offer a wide range of ecological, social, and economic benefits. This paper focuses on the forms of application of grass–herbaceous mix tures in urban environments, drawing on experiences and current trends observed in Slovak and Czech cities. It examines different types of plantings, including meadow mixtures for extensive areas, park lawns, specialized mixtures for dry or highly exposed sites, and plantings that combine aesthetic value with ecological function. The study analyzes the role of these vegetation elements in urbanized environments, particularly their contribution to supporting biodiversity, improving urban microclimates, enhancing rainwater retention, and reducing maintenance requirements. The findings highlight the potential of grass–herbaceous communities as multifunctional elements that can improve both the ecological performance and visual quality of urban landscapes.

Key words: urban greenery; grass–herbaceous plant communities; biodiversity; urban microclimate; sustainable urban landscape

Introduction

Urban green infrastructure constitutes a significant component of the urban environment, with the capacity to support biodiversity, deliver ecosystem services, and enhance the quality of life of urban residents. In the context of accelerating global urbanization, cities are assuming an increasingly important role in nature conservation and the maintenance of ecological balance. Consequently, urbanized environments are no longer perceived solely as drivers of environmental degradation but are increasingly understood as spaces with the potential to actively contribute to biodiversity conservation and the provision of ecosystem functions.

Despite this potential, the ability of cities to fulfil these functions is substantially constrained by the loss of green spaces due to redevelopment and urban densification (Trémeau et al., 2024; Haaland and van den Bosch, 2015; Vinczeová, Tóth, 2025; Hus, Pástorová, 2025; Tóth, Slobodníková, 2025), as well as by conventional approaches to urban green space management that often fail to incorporate ecological principles and the need to promote biodiversity (Aronson et al., 2017; Manninen, 2010; Norton et al., 2019). A typical manifestation of such management is the maintenance of green areas in the form of intensively mown lawns primarily intended for recreational use. These intensively managed lawns are characterized by frequent mowing, low vegetation height, and a homogenized structure, and they dominate both public and private green spaces in temperate-zone cities (Norton et al., 2019).

The extent of intensively managed lawns is considerable. In Swedish cities, they cover approximately 22.5% of the urban area, representing nearly a twofold increase compared to the situation 50 years ago (Hedblom et al., 2017), while similar proportions have been recorded in the United Kingdom (25%; Evans et al., 2009) and the United States (23%; Robbins and Birkenholtz, 2003). This trend highlights the dominance of intensively managed lawns in urban environments, which may be at odds with the objectives of biodiversity conservation and sustainable green space management. At the same time, remnant semi-natural grasslands within urban areas are increasingly fragmented and isolated, negatively affecting their ecological stability and functionality (Gilbert, 1989; Manninen, 2010).

Given these challenges, there is a growing emphasis on the need to transform urban green space management towards more ecologically functional approaches. One promising strategy is the establishment of meadow vegetation, which can be defined as extensively managed grasslands with low mowing frequency and typically containing a significant proportion of flowering forbs. Such stands can mitigate the negative impacts of intensive green space management, and their characteristics can

be achieved primarily through a reduction in mowing frequency, allowing existing plant communities to increase in height and in the proportion of flowering species (Leblanc-Gagné, Brice, Pellerin, 2025; Norton et al., 2019). In urban environments, various types of meadow (grass–herbaceous) communities can be integrated into landscape architectural design, combining ecological, aesthetic, and recreational functions while enhancing the attractiveness of urban spaces (Hus, Saková, 2025; Rózová, Pástorová, Kuczman, 2023; Bellérová and Hus, 2025).
A wide spectrum of grass– herbaceous communities is applied in urban settings, differing in species composition depending on site conditions, spatial function, and the desired aesthetic effect. In intensively used areas, species-poor, stable mixtures with a higher proportion of grasses are often employed to ensure resilience to disturbance and rapid regeneration. In contrast, more extensively managed areas—such as parks, residential green spaces, and urban fringe zones—frequently utilize species-rich flowering meadows with a high proportion of forbs, which support biodiversity and seasonal vegetation dynamics. A specific category includes mixtures designed for extreme site conditions, such as dry and shallow soils on green roofs or slopes, where xerothermic species adapted to water scarcity predominate. Contemporary landscape architectural practice also increasingly incorporates mixtures with a higher proportion of annual species to achieve a rapid aesthetic effect or to facilitate successional processes. The variability of these communities allows for flexible responses to diverse urban conditions while effectively integrating ecological, functional, and visual requirements (Hus, Saková, 2025).

Materials and method
The aim of this paper is to identify and analyze landscape architectural projects in urbanized environments in which grass–herbaceous communities constitute a significant compositional and functional element. Emphasis was placed on projects employing various types of grass–herbaceous vegetation in terms of species composition, structural arrangement, and management regimes. The selection included realized projects from the Slovak Republic and the Czech Republic to illustrate the diversity of approaches to the application of meadow vegetation in different types of urbanized environments. The analyzed examples included implemented projects from public spaces, parks, residential areas, and other urban sites in which grass–herbaceous communities were used as ecological, aesthetic, or spatial-forming elements. Attention was also paid to the mode of application of grass–herbaceous communities, distinguishing between the transformation of existing green spaces and their planned integration into new designs. The analysis focused on vegetation type, species composition, the proportion of grasses and forbs, spatial arrangement, site function, and management regime, particularly mowing frequency and maintenance intensity. The selected projects were examined and compared according to these characteristics to identify differences in the design and maintenance of grass–herbaceous communities in urban environments. The aim was not to provide a complete overview of all realizations, but to demonstrate the range of their application and their potential to support the ecological, aesthetic, and recreational functions of urban green spaces. For the purposes of this paper, the analyzed examples were also classified according to the principal types of grass–herbaceous vegetation used in urban environments. The classification considered vegetation composition, establishment method, visual effect, ecological potential, maintenance intensity, and the mode of application in existing green spaces or new designs. This typological framework served as a supporting basis for the comparison of the selected examples.

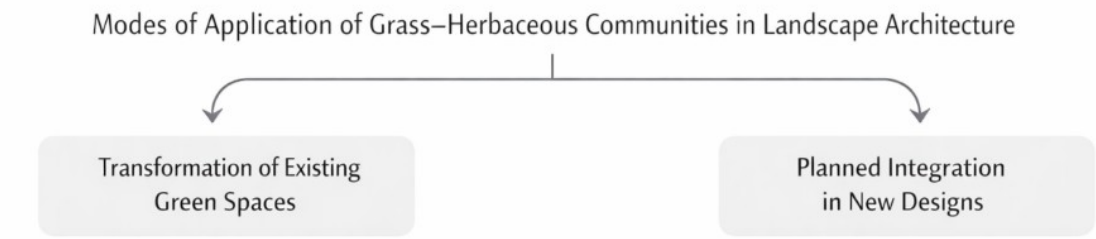

Fig. 1: Modes of Application of Grass–Herbaceous Communities in Landscape Architecture (author: Pástorová, 2026).

Tab. 1: Typology of grass–herbaceous vegetation used in urban environments and selected characteristics relevant to their application in landscape architecture.

Type of vegetation	Main composition	Visual effect	Ecological potential	Maintenance intensity
Annual flowering mixtures	Annual species, often with ornamental flowering effect	high	medium	high
Perennial meadow mixtures	Perennial meadow species, often including grasses and forbs	high	high	low–medium
Perennial mixtures with an annual species	Perennial mixtures with a proportion of annual species	high	high	medium–high
Grass-free / flowering lawns	Low-growing mowing-tolerant flowering species	medium	medium	medium
Managed spontaneous vegetation	Existing or spontaneously developing vegetation regulated by mowing	low–medium	high	low
Designed plant communities / combined systems	Combination of sowing, perennial planting, and designed vegetation structure	high	high	medium–high

Results

The analyzed examples demonstrated that the application of grass–herbaceous communities in urban environments takes different forms depending not only on-site conditions, spatial context, functional requirements, and management regime, but also on the mode of their application within landscape architectural practice. In this respect, the selected projects could be divided into two principal categories: the transformation of existing green spaces and the planned integration of grass–herbaceous communities into new designs. Within these categories, the examples illustrated different approaches to the use of meadow vegetation, ranging from the conversion of intensively managed green areas to newly designed grass–herbaceous compositions incorporated into broader urban and landscape architectural concepts. Together, these projects demonstrate the broad range of possibilities for the application of grass–herbaceous communities in contemporary urban green space design.

- **Transformation of Existing Green Spaces**

This category included projects in which grass–herbaceous communities were introduced into already existing green structures or urban spaces to diversify vegetation composition, enhance ecological value, and modify the visual character of the site, with meadow vegetation applied as part of the regeneration, reinterpretation, or ecological transformation of previously established green areas; selected implementations comprised those designed or initiated by a site green space manager or a landscape architect, as well as cases where such communities occur naturally on the site and are maintained through appropriately set management practices.

Perennial meadow mixtures

Brno- záhrada Vila Löw-Beer

Grass–herbaceous community – category: herbaceous lawn with a spring flowering effect of dandelions. The grasses are enriched with dicotyledonous herbs. The area is used throughout the year for recreation, with a higher mowing frequency.

Annual flowering mixtures

Lanškroun – a frequent example is the integration of summer-flowering seed mixtures (utilizing annual herbaceous species) within urban areas. A representative case is the application of annual meadow plantings along road infrastructure corridors, where spatial constraints limit the use of other types of vegetation; at the same time, this type of vegetative element exhibits a high level of visual attractiveness and user preference within the space.

- **Planned Integration in New Designs**

The second category included projects in which grass–herbaceous communities were incorporated as a deliberate part of newly designed or comprehensively conceived landscape architectural solutions. In these examples, meadow vegetation was not added secondarily to an already existing green structure but formed an integral component of the original spatial and compositional concept.

Fig. 2: Use of perennial grass–herbaceous communities in landscape architectural projects- grass-free/flowering lawns: Brno- záhrada Vila Löw-Beer, grass–herbaceous community (left) and Lanškroun – a frequent example is the integration of summer-flowering seed mixtures (right) (author: Hus, 2022).

Perennial meadow mixtures

Park Zdeňka Kopala in Litomyšl represents an example of the use of grass–herbaceous communities in a historic park environment, where they fulfil both ecological and compositional functions. Flowering meadows were designed with an emphasis on species diversity, seasonal vegetation dynamics, and harmonious integration into the existing vegetation structure while respecting spatial relationships and the character of the site. Regionally appropriate seed mixtures reflecting specific site conditions were used to establish stable and long-term sustainable plant communities. A characteristic feature of the project is the creation of a contrast between intensively maintained areas and more naturalistic parts of the park, thereby strengthening the visual legibility and spatial differentiation of the site. The project also highlights the potential for integrating ecologically oriented elements into a historically valuable park environment through extensive management and sensitive landscape architectural design.

Archaeopark Pavlov (Czech Republic), implemented in 2016, represents an example of the application of grass–forb communities under dry and heterogeneous site conditions. The total area of the site comprises approximately 6,042 m² of meadow vegetation and 1,127 m² of extensive green roof vegetation. Three basic types of seed mixtures were applied: (1) a mixture for dry habitats used on the roof with a shallow substrate, (2) a modified meadow mixture in the immediate vicinity of the building, combining grasses and forbs, and (3) a commercial grass mixture applied in the peripheral parts of the site (Knotek and Knotková, 2019).
As part of the subsequent management, overseeding was also carried out, including mixtures designed for dry conditions with a higher proportion of annual species. The project represents an example of an adaptive landscape architectural solution integrating grass–forb communities into an urban environment while taking into account the specific site conditions of the dry Pannonian region. It is characterized by the use of differentiated seed mixtures and by an emphasis on supporting biodiversity, aesthetic value, and ecological stability.

ZELOKVET Picnic Meadow represents an example of the use of grass–herbaceous communities within renaturalization-oriented approaches in urban environments, particularly in peripheral and transitional zones of cities. The design is based on the use of species-rich, predominantly autochthonous mixtures whose composition reflects site conditions and is informed by the phytocoenological analysis of the area. A characteristic feature of the project is the ecologically sensitive method of stand establishment, based on sowing on prepared surfaces or overseeding into existing lawns without the use of chemical agents. The grass–herbaceous stands are also combined with other vegetation elements, thereby creating a legible spatial structure based on the contrast between formal and more naturalistic parts of the site. The project highlights the potential of extensive meadow management in urban environments while maintaining both ecological functionality and visual acceptability for the public.

Fig. 3: Use of perennial grass–herbaceous communities in landscape architectural projects: Archeopark Pavlov (left) and Zdeněk Kopal Park (right) (author: Hus, 2024).

University meadow project – The BIO:VCEL:IN project, implemented on the campus of the Slovak University of Agriculture in Nitra, represents a comprehensive example of the application of grass–herbaceous communities in an urban environment on an area of approximately 1.5 ha. A total of 18 different meadow mixtures were used to verify their ecological, aesthetic, and operational potential. The design differentiates areas according to their function and intensity of use, combining permanent species-rich meadow communities, supplementary annual mixtures for rapid visual effect, and herbaceous lawns in communication corridors exposed to higher levels of use. The project is also characterized by its research and educational dimension, serving as an experimental and demonstration area for monitoring the influence of management and species composition on the development of meadow communities.

Fig. 4: Use of perennial grass–herbaceous communities with an admixture of annual species- ZELOKVET Picnic Meadow (left); University meadow project – The BIO:VCEL:IN (right) (author: Hus, 2025).

Discussion

The analyzed examples showed that grass–herbaceous communities cannot be understood as a uniform vegetation type, but rather as a diverse group of vegetation and design approaches whose suitability depends on site conditions, spatial context, intended function, and management regime (Norton et al., 2019; Bretzel et al., 2024). The selected projects illustrated different forms of application, ranging from species-rich meadow mixtures and grass–forb communities to renaturalization-oriented solutions and more complex designed compositions. This confirms that the use of meadow vegetation in urban environments requires site-specific and function-specific approaches rather than the application of a single universal model. An important aspect identified in the analyzed examples is the distinction between the transformation of existing green spaces and the

planned integration of grass–herbaceous communities into new designs. In the first case, meadow vegetation is introduced into already established green structures, often through the conversion of intensively managed lawns or through renaturalization-oriented interventions (Chollet et al., 2018; Bretzel et al., 2024). In the second case, grass–herbaceous communities form part of the original landscape architectural concept from the outset. This distinction influences not only the method of establishment, but also the compositional role of vegetation, the expected visual effect, and the subsequent management regime. The comparison further suggests that the successful establishment and long-term functioning of grass–herbaceous communities depend not only on vegetation type and species composition, but also on appropriate management, particularly mowing frequency and timing (Chollet et al., 2018). The analyzed examples indicate that extensive management may reduce maintenance requirements in comparison with conventional lawns; however, its success depends on its adaptation to the ecological conditions and intended function of the site (Bretzel et al., 2024; Norton et al., 2019). At the same time, the projects demonstrate that grass–herbaceous communities fulfil not only ecological functions, but also important compositional and aesthetic roles by introducing seasonal dynamics, colour variation, and spatial differentiation into urban green spaces (Marshall et al., 2023). From the perspective of landscape architectural practice, the analyzed examples highlight the potential of grass–herbaceous communities as a flexible design element that can contribute to biodiversity support, ecological stability, and the diversification of urban green-space structure (Norton et al., 2019; Marshall et al., 2023). Their successful application, however, requires a balanced consideration of ecological function, visual expression, and long-term management; public acceptance of near-natural management should also be considered (Lampinen et al., 2021).

Conclusion

Based on the analyzed examples, it can be concluded that the application of grass–herbaceous communities in urban green spaces takes different forms depending on site conditions, spatial context, functional requirements, management regime, and the mode of their application. The selected projects showed that these communities can be introduced either through the transformation of existing green spaces or through their planned integration into new designs, while differing in vegetation type, species composition, and maintenance requirements. At the same time, the comparison confirmed that meadow vegetation can fulfil ecological, aesthetic, and recreational functions and may represent an alternative to intensively managed lawns in suitable urban contexts. However, their successful establishment and long-term functioning depend on appropriate design, species selection, and subsequent management, particularly mowing regimes.

The analyzed examples thus point to the potential of grass–herbaceous communities as an important component of contemporary landscape architectural practice and sustainable urban green space management.

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Sohrn
Směsi trav a bylin představují důležitou součást současného městského prostředí a přispívají k ekologické stabilitě, estetické kvalitě a celkové odolnosti měst. Vzhledem k tomu, že městské oblasti čelí stále častěji dopadům klimatických změn, efektu městského tepelného ostrova, úbytku biologické rozmanitosti a rostoucím nárokům na údržbu veřejných prostranství, nabývá použití luční vegetace jako prvku krajinářského designu na významu. Společenstva trav a bylin představují udržitelnou alternativu k tradičně intenzivně sekaným trávníkům a nabízejí širokou škálu ekologických, sociálních a ekonomických přínosů. Tento článek se zaměřuje na formy využití travnatě-bylinných směsí v městském prostředí a čerpá ze zkušeností a aktuálních trendů pozorovaných ve slovenských a českých městech. Zkoumá různé typy výsadby, včetně lučních směsí pro rozsáhlé plochy, parkových trávníků, specializovaných směsí pro suchá nebo vysoce exponovaná stanoviště a výsadby, která kombinuje estetickou hodnotu s ekologickou funkcí. Studie analyzuje roli těchto vegetačních prvků v urbanizovaném prostředí, zejména jejich přínos k podpoře biodiverzity, zlepšení městského mikroklimatu, zvýšení retence dešťové vody a snížení nároků na údržbu. Zjištění zdůrazňují potenciál travnatě-bylinných společenstev jako multifunkčních prvků, které mohou zlepšit jak ekologickou výkonnost, tak vizuální kvalitu městské krajiny.

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FROM RESIDUAL SPACE TO RECREATIONAL ENVIRONMENT: THE ROLE OF CO-DESIGN IN THE ACTIVATION OF HOUSING ESTATES

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Abstract
Housing estate in-between spaces represent a significant but often underutilized part of the residential environment with potential for the development of everyday recreation. Their low functional usability is a result of spatial uncertainty, lack of program content, and weak relationship of residents to these areas. This paper focuses on the possibilities of linking co-design as a participatory tool of urban planning with the process of activating housing estate interstitial spaces in order to increase the recreational potential of the area. The theoretical basis is the understanding of housing estate in-between spaces as a specific urban "intermediate scale" between architecture and the city, suitable for the application of co-creation. The paper points to the importance of involving residents in identifying recreational needs and designing small-scale spatial interventions that support recreational and physical activities in the everyday environment of housing estates. The result of the co-design approach is an increase in the functional and social value of the space, a strengthening of residents' relationship to the area, and support for the long-term sustainable development of recreational functions. The paper contributes to the discussion on adaptive and participatory approaches in the planning of residential structures.

Key words: in-between spaces, potential, participatory design, urban activation, morphology

Introduction

Large scale housing estates, constructed predominantly in the second half of the 20th century, represent a substantial component of the contemporary urban landscape across Central and Eastern Europe. While they provide essential residential capacity, their spatial configuration often includes numerous residual or interstitial spaces - commonly referred to as “in between spaces” or urban gaps - which remain underutilized, functionally undefined, and socially fragmented. Recent research identifies these areas as latent spatial resources with considerable potential for recreational use, ecological enhancement, and community development (Čibik and Štěpánková, 2020; Bihuňová and Štěpánková, 2024; Melichová, 2025; Žolobaničová et al., 2023). The transformation of residual spaces into meaningful recreational environments is closely linked to broader discourses on sustainable urban development, green infrastructure, and ecosystem services. Studies focusing on collective housing stress the importance of integrating green and blue infrastructure to improve microclimatic conditions, biodiversity, and overall quality of life (Bechera, 2022; Vinczeová and Tóth, 2025; Vinczeová et al., 2025). Likewise, concepts of “forgotten” or “lost” spaces underline the need to reintegrate neglected urban fragments into resilient urban systems (Žolobaničová et al., 2025). In this context, co-design emerges as both a methodological and conceptual framework. As a participatory approach, it enables residents, professionals, and local authorities to jointly develop spatial solutions, bridging expert knowledge and everyday spatial practices. Previous studies confirm that participatory design can facilitate the successful regeneration of housing estates by strengthening social cohesion, enhancing place identity, and ensuring long term sustainability of interventions (Csizmady et al., 2016; Arslan, 2023). Co-design also aligns with bottom up initiatives and civic activism, which have proved effective in transforming underused spaces into vibrant public environments (Miklášová et al., 2024). Renaturalisation and nature based solutions implemented through participatory processes can mitigate urban heat island effects, improve water retention, and support ecological resilience in densely built environments (Bellérová and Hus, 2025; Włodarczyk Marciniak et al., 2024). Landscape architects play an essential role in this process, acting not only as designers but also as facilitators and mediators of interdisciplinary collaboration. Despite growing interest, there remains a need for a more systematic understanding of how co-design can be applied to activate residual spaces within housing estates, particularly in post socialist urban contexts. Therefore, the aim of this study is to explore the transformation of residual spaces into recreational environments through co-design processes, identifying key principles, methodological approaches, and factors influencing successful implementation.

Materials and methods

This study employs a qualitative research approach combining a literature review, case study analysis, and exploratory spatial assessment. The literature review focused on co-design and participatory urban planning, open spaces in housing estates and their recreational potential, green infrastructure, and climate change adaptation strategies. Key sources include studies on participatory design in large housing estates (Csizmady et al., 2016; Arslan, 2023), on recreational and spatial characteristics of housing environments (Bihuňová et al., 2021; Bihuňová and Štěpánková, 2025), and on ecosystem services and green infrastructure (Kuczman and Paganová, 2024; Vinczeová and Tóth, 2025). Additional attention was given to renaturalisation approaches (Bellérová and Hus, 2025) and bottom up initiatives (Melichová 2025; Miklášová et al., 2024).

Spatial and conceptual analysis concentrated on residual spaces as "white spaces" in mental maps (Čibik et al., 2023) and urban gaps as potential intervention sites. The analysis also observed the role of green infrastructure in improving spatial functionality (Kristiánová and Štěpánková, 2015) and the interaction between top down and bottom up approaches (Štěpánková and Kristiánová, 2015).

The Vlčince housing estate in Žilina was selected as a model area. Built between 1971 and 1982, it is one of the city's largest residential districts, comprising approx. 7,500 flats and 17,455 inhabitants. Its modernist spatial structure features functional segregation, open block development, and a high share of open spaces (Vinczeová et al., 2025). These include intensively used recreational spaces as well as neglected, low attractiveness areas (Žolobaničová et al., 2023; Bihuňová and Štěpánková, 2025). Despite basic civic amenities and nearby large green areas, deficiencies persist in smaller recreational and community spaces. Environmental conditions show a need to improve shading, microclimate, and stormwater management due to extensive paved surfaces and insufficient tree cover (Bellérová and Hus, 2025). Socially, Vlčince is a heterogeneous environment requiring inclusive and participatory planning approaches. Interstitial spaces perceived as anonymous or "white spaces" present areas of low perceptual significance but high transformative potential (Čibik et al., 2023).

Results

Open spaces within the Vlčince housing estate show substantial potential for applying co-design principles. Their transformation into high quality recreational and community spaces requires expert design as well as meaningful resident involvement, ensuring the identification of local needs and long term sustainability of interventions.

A multi layered analytical framework was developed combining: spatial analysis, functional classification, perceptual assessment. This framework enables a systematic understanding of interstitial spaces, identification of their potential and creation the typology of Interstitial Spaces:

A. Recreational interstitial spaces – near housing blocks, containing basic amenities, suitable for community recreation.
B. Transit spaces – tied to pedestrian routes, low stay value, potential for "slow space" interventions.
C. Residual areas – undefined, neglected, seen as "blank spots", suitable for experimental or nature based interventions.
D. Low use green spaces – unprogrammed lawns, suitable for rain gardens, community gardens.
E. Semi public spaces – entrances, courtyards, often informally appropriated; sensitive for participatory processes.

Each category was assessed according to: spatial quality, functional use, social potential, environmental quality, transformative potential. The field analysis was conducted using a combination of map analysis, field mapping, and subjective perception of space. The result is a synthetic map of interstitial spaces that classifies the territory according to typology while visualizing its transformative potential. The analytical framework serves as the initial phase of co-design and enables: identifying priority locations for intervention, assigning appropriate participatory tools based on the type of space, formulating transformation scenarios (recreational, ecological, community-based), supporting decision-making based on a combination of data and local experience. A large share of Vlčince's interstitial spaces are functionally weak yet spatially flexible, supporting earlier findings on their latent recreational and ecological potential (Vinczeová et al., 2025; Žolobaničová et al., 2023). Effective co-design requires: early, iterative resident engagement, interactive methods: workshops, community walks, temporary interventions and mediation by landscape architects bridging expert and local

perspectives. Interventions designed through co-design include: recreational micro-spaces, green and blue infrastructure for climate adaptation, community-oriented spaces, tactical urbanism tools for real-time testing (Arslan, 2023). Participatory, nature-based solutions: improve microclimate, increase biodiversity, enhance water retention, strengthen local identity and social cohesion. Challenges include institutional constraints, uneven participation, maintenance issues, and stakeholder conflicts.

Conclusion

Residual spaces in housing estates represent valuable spatial resources capable of addressing contemporary urban, social, and environmental challenges. The Vlčince case demonstrates that co-design can transform these spaces into functional recreational environments supporting social interaction and nature based interventions. Co-design functions as a process oriented framework enabling collaboration between residents, experts, and institutions. Landscape architects play a key role as mediators translating local needs into spatial solutions and balancing top down and bottom up approaches. Long term success depends on incorporating co-design into broader planning and management structures. As a continuous practice rather than a one off intervention, co-design can contribute to the development of resilient, inclusive, and context sensitive public spaces in post socialist housing estates.

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Souhrn
Článek se zabývá reziduálními prostory sídlišť jako nedostatečně využívanými, avšak potenciálně hodnotnými součástmi městského prostředí. Na příkladu sídliště Vlčince v Žilině ukazuje možnosti jejich transformace na rekreační a komunitní prostory prostřednictvím co-designu, propojujícího odborné poznání s lokální zkušeností obyvatel. Tento přístup podporuje sociální soudržnost, posiluje identitu místa a umožňuje efektivní integraci zelené a modré infrastruktury v postsocialistickém městském kontextu.

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GENDER DIFFERENCES IN SEASONAL DECLINE OF PHYSICAL ACTIVITY IN NATURAL ENVIRONMENTS AND THEIR ASSOCIATIONS WITH HEALTH LIMITATIONS

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Abstract

Physical activity in natural environments plays an important role in adolescent health, yet seasonality and health barriers may affect participation. Differences in gender may indicate needs for targeted interventions; therefore, the study examined differences in gender in seasonal changes in physical activity and their relationship to health limitations during summer and winter. The sample included 1,034 adolescents (boys, N = 545; girls, N = 489). Differences in responses underwent evaluation with the chi-square test and Cramér's V. Seasonal changes in activity (summer - winter) underwent analysis with the Mann-Whitney U test. Seasonal differences in health limitations underwent assessment with McNemar's test for paired binary data. Statistically significant differences in gender appeared in both the frequency of physical activity and health barriers (p < .001; small to medium effects). Girls showed significantly greater seasonal declines in physical activity (p < .001; r = .10). Among girls, health limitations increased significantly during winter (p = .007), whereas no significant seasonal changes appeared among boys. These findings highlight greater seasonal vulnerability among girls in relation to physical activity in natural environments. We recommend targeted school- and community-based programs that support winter physical activity and reduce health barriers, in particular, girls.

Key words: Adolescents, health promotion, outdoor recreation, participation barriers.

Introduction

Physical activity in natural environments is an important determinant of adolescent health because outdoor movement supports cardiorespiratory fitness, psychological well-being and social connectedness (Bull et al., 2020; Fyfe-Johnson et al., 2021). Yet insufficient physical activity remains widespread among young people worldwide, with girls consistently reporting lower activity levels than boys, making gender-sensitive prevention continuing public health priority (Guthold et al., 2020). Participation in outdoor activity is shaped by season. Cold temperatures, shorter daylight, and reduced accessibility discourage recreation in parks, forests, and other natural settings, leading to lower winter activity and greater sedentary time (Turrisi et al., 2021).

Natural environments may be, in particular, vulnerable to these seasonal effects because use often depends on weather tolerance, perceived safety, and available companionship outdoors (Mygind et al., 2019). Health limitations such as illness, pain, fatigue, or perceived low fitness may further reduce adolescents' willingness to be active outdoors, and these barriers may be reported differently by girls and boys (Ferreira Silva et al., 2022). Despite growing interest in physical activity in nature, evidence integrating gender, seasonality, and health-related barriers in adolescence remains limited; therefore, this study examined differences in gender in seasonal changes in physical activity and their relationship to health limitations during summer and winter.

Materials and Methods

This cross-sectional study included 1,034 adolescents, of whom 545 were boys (52.7%) and 489 were girls (47.3%). The age (M ± SD) of sample was 16.95 ± 1.18 years. Participants attended either grammar schools (N = 709, 68.6%) or vocational secondary schools (N = 325, 31.4%) (Table 1).

Data collection used questionnaire examining outdoor physical activity and perceived health-related limitations in natural environments across seasons. The instrument covered the frequency of outdoor physical activity during summer and winter, the perceived effect of season on outdoor physical activity, and health-related factors limiting activity in summer and winter. For analysis of seasonal changes in physical activity, responses for summer and winter activity frequency underwent recoding in ordinal numerical scales from 1 to 5, with higher values indicating more frequent activity.

Statistical analysis aimed to identify differences in gender and evaluate seasonal changes in outdoor physical activity and health-related limitations. Associations between gender and responses to Questions 1, 2, 3, 4, and 5 underwent testing with Pearson's chi-square tests of independence. Effect size estimation relied on Cramér's *V*, interpreted according to conventional thresholds. Seasonal changes in physical activity took the form of difference scores (Δ = summer - winter). Because the data had ordinal and nonparametric characters, comparisons of difference scores between boys and girls used the Mann-Whitney U test. Effect size had the form of coefficient r, calculated from the standardized test statistics. For seasonal differences in health-related limitations within the same respondents, responses underwent recoding in binary variables (0 = no limitation; 1 = limitation). Comparisons of summer and winter responses then used McNemar's tests for paired binary data. Statistical significance followed the threshold of $\alpha = .05$.

Tab. 1: Characteristics of sample according to gender and school (*N* = 1,034)

Variable	Male	Female	Sample
% of sample	52.7%	47.3%	100%
Age (years; *M* ± *SD*)	16.95 ± 1.30	16.94 ± 1.04	16.95 ± 1.18
Grammar school (*N; %*)	305 (56.0%)	404 (82.6%)	709 (68.6%)
Vocational secondary school (*N; %*)	240 (44.0%)	85 (17.4%)	325 (31.4%)

Results

Differences in gender appeared across all analyzed domains of outdoor physical activity and perceived health-related limitations. In summer, boys reported more often outdoor physical activity than girls. Daily outdoor activity reached 56.5% among boys and 40.7% among girls, whereas girls more often selected several times/ week (45.4% vs. 36.0%), > 1/ week (3.9% vs. 1.8%), and almost never (2.5% vs. 0.0%). In winter, the same pattern continued. Boys reported more often daily outdoor activity (27.2% vs. 13.5%), while girls more often reported 1/ week, > 1/ week, or almost never (Table 2).

Perceived seasonal influence on outdoor activity differed by gender. Girls more often stated that summer enabled more outdoor physical activity (37.8% vs. 23.7%), whereas boys more often indicated that season did not influence their activity (15.2% vs. 7.2%). In the domain of health-related limitations, both genders most reported no limitation in either season; however, girls more often identified high temperatures as summer barriers (24.1% vs. 8.6%) and colds or winter illnesses as winter barriers (32.5% vs. 21.3%). Boys indicated that physical activity improved their health in summer (20.2% vs. 12.1%) and winter (13.6% vs. 4.3%).

Inferential analyses confirmed significant differences in gender for all five questionnaire items, with small-to-medium effect sizes (Cramér's $V = .183$ - $.239$). Seasonal changes in outdoor physical activity differed significantly between genders. Girls showed greater declines from summer to winter than boys ($M\ \Delta = 1.125 \pm 1.146$ vs. $.908 \pm 1.137$; *Med* = 1 in both groups), although the effect size remained small (r = .10). Seasonal changes in health-related limitations did not reach significance among boys, but girls showed significant increases in winter limitations compared with summer.

Tab. 2: Comparisons of boys and girls across questions

Analysis	Statistics	*p*	Effect size	Interpretation
Q1: Summer outdoor physical activity	$\chi^2_{(4)} = 37.451$	1.45×10^{-7}	$V = .190$	Sig. gender difference
Q2: Winter outdoor physical activity	$\chi^2_{(4)} = 46.121$	2.32×10^{-9}	$V = .211$	Sig. gender difference
Q3: Perceived seasonal influence	$\chi^2_{(4)} = 34.606$	5.60×10^{-7}	$V = .183$	Sig. gender difference
Q4: Summer health-related limitations	$\chi^2_{(4)} = 58.882$	4.98×10^{-12}	$V = .239$	Sig. gender difference
Q5: Winter health-related limitations	$\chi^2_{(4)} = 42.788$	1.15×10^{-8}	$V = .203$	Sig. gender difference
Seasonal change in activity (boys vs. girls)	U = 118,314	1.14×10^{-3}	$r = .10$	Girls showed decline
Seasonal change in health limitations: boys	McNemar's	.109	-	Not sig.
Seasonal change in health limitations: girls	McNemar's	.007	-	Sig. winter increase

Discussion

The study highlights gender gaps in outdoor physical activity and shows that this disparity intensifies during winter. Boys reported higher outdoor activity in summer, with 56.5% engaging daily compared with 40.7% of girls. During winter, participation dropped in both groups, yet the reduction appeared steeper among girls, as only 13.5% reported daily activity compared with 27.2% of boys. This pattern fits the statistical findings, because all five questionnaire domains reached significance according to gender, with Cramér's *V* values ranging from .183 to .239. Although the effect size remained small, the consistency of patterns across indicators and across the sample of 1,034 adolescents gives the finding practical relevance. These results support the view that season does not influence overall

activity levels; however, amplifies already existing differences in gender. Adolescents tend to reduce their physical activity during colder months, with summer and spring supporting higher levels of movement (Bélanger et al., 2009; Hjorth et al., 2013). Objective monitoring research further indicates that winter commonly brings lower moderate-to-vigorous physical activity and greater sedentary time. The present data extend that line of evidence by showing that the seasonal decline does not affect girls and boys equally. Instead, girls appear more vulnerable to environmental and personal barriers that limit outdoor activity when weather conditions deteriorate.

An important contribution of this study lies in the identification of perceived health-related limitations. Girls more often reported high summer temperatures as limiting factors (24.1% vs. 8.6%) and more often identified colds or winter illnesses as barriers during winter (32.5% vs. 21.3%). Just girls showed significant seasonal increases in health-related limitations (McNemar's p = .007), whereas boys showed no comparable shift (p = .109). This finding adds nuance to the interpretation of gender gaps. It suggests that girls not only participate less often; however, also experience seasonal discomforts and health concerns more strongly. Adolescent girls had lower odds of meeting physical activity recommendations and higher odds of perceiving barriers to participation, which supports the present pattern (Rosselli et al., 2020). Reviews focused on adolescent girls emphasize social support, body image, confidence, time pressure, and feelings of safety as recurring determinants of activity behavior (Hopkins et al., 2022; Martins et al., 2015).

In terms of practical perspective, the findings point toward the need for targeted, season-sensitive interventions. Even though the differences in gender in seasonal decline produced small effects (r = .10), that effect still carries importance at the population level, in particular, school settings. Meta-analytic evidence indicates that physical activity interventions for adolescent girls achieve better outcomes when they include school-based delivery, peer support, and multicomponent designs tailored, in particular, to girls' preferences and needs (Pearson et al., 2015; Owen et al., 2017). In the context of findings, schools and communities should consider structured winter programs that promote enjoyable outdoor movement, flexible intensity and accessible facilities linked to cold-weather discomfort. Recent evidence underlines the influence of parental support, family resources, and neighborhood context on outdoor physical activity, which suggests that effective intervention should not remain limited to school environments alone (Deng et al., 2024).

Conclusion

This study showed that adolescents' physical activity in natural environments declines from summer to winter, with girls experiencing significantly greater decreases than boys. Girls reported more health-related barriers, in particular, winter illness and seasonal discomfort, and just girls showed significant seasonal increases in perceived limitations. These findings suggest that gender and season jointly shape participations in outdoor activity during adolescence. Institutions (i.e., schools) should, therefore, implement gender-sensitive, winter-focused programs that reduce health barriers and make outdoor activity more accessible and appealing. Such interventions may help sustain year-round physical activity and support adolescent health and well-being.

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Souhrn
Studie se zaměřuje na rozdíly mezi chlapci a dívkami v sezónních změnách pohybové aktivity v přírodním prostředí a na jejich souvislost se zdravotními omezeními. Výzkumný soubor tvořilo 1 034 adolescentů. Výsledky ukázaly, že pohybová aktivita v přírodě od léta do zimy klesá u obou pohlaví, avšak výrazněji u dívek. Dívky zároveň častěji uváděly zdravotní bariéry, zejména vysoké letní teploty, nachlazení a zimní nepohodu, přičemž pouze u nich došlo k významnému zimnímu nárůstu omezení. Zjištění potvrzují potřebu genderově citlivých a sezónně zaměřených školních i komunitních programů, které podpoří celoroční venkovní pohyb a zdraví dospívajících.

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GEOSYSTEM SERVICES AND DISSERVICES: AN APPLICATION OF THE CONCEPT ON ABANDONED QUARRIES

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Abstract
The geosystem services concept is, despite certain controversies, widely accepted and reflected in scientific literature with a notable overreach to nature conservation, management, and policies already for several decades.
In contrast, the geosystem disservices approach has not yet received enough attention and is relatively new to the field. Geosystem disservices may be considered as results and outcomes of functions, structures, and aspects related to abiotic entities, processes and interactions that may impact human well-being and are assessed as damaging under a relevant value system at a particular moment. Nevertheless, it is necessary to mention that the attitudes to geodiversity depend on the societal context, time and space; the same entity can be valued as a geosystem service or disservice, depending on the lifestyle, culture, age, experience, or historical period. In this contribution, possible classification frameworks of geosystem disservices are presented and discussed. The qualitative evaluation of both geosystem services and disservices is applied on several examples of abandoned quarries in Czechia, which are usually perceived as important sites with high geoheritage (and eventually ecological, cultural and aesthetic) values. Based on this assessment, management proposals and conservation measures for these specific sites are outlined.

Key words: geoheritage, geohazards, degradation risk, nature conservation, Czechia

Introduction
The ecosystem services (ES) are defined as the benefits that people obtain from ecosystems (Costanza et al., 2017). Originally, the ecosystem services were perceived as benefits provided mainly by living nature, and geodiversity was omitted, however, in the last years, so-called concept of geosystem services (GS) is being developed and used as a basis and justification for conservation efforts and relevant planning and managing of abiotic nature, i.e. geodiversity (Gray et al., 2018, Haines-Young, 2023, Kubalíková, 2024, García et al., 2025, Gray and Fox, 2026).
In recent years, the ES concept has been complemented by the concept of so-called ecosystem disservices (EDS) (Lyytimäki and Sipilä, 2009, von Döhren and Haase, 2015, Vaz et al., 2017, Veibiakkim et al., 2025). Originally, these disservices were simply perceived as negative, harmful or unpleasant impacts of ecosystems on human well-being (Lyytimäki and Sipilä, 2009), however, recently, definitions have shifted towards more complex views, e.g., von Döhren and Haase (2015), or Hardaker et al. (2020) who perceives EDS as outcomes of ecological processes and interactions that impact human well-being and are assessed as damaging under a relevant value system.
Regarding geodiversity and EDS concept, the situation is similar to ES – geodiversity is mentioned only marginally (Rackelmann et al., 2023, Lundin-Frisk et al., 2025), although abiotic components are as relevant as biotic components within ecosystems, and negative or unpleasant impacts of abiotic nature are generally well-known. Kubalíková (2026) provides the following definition of geosystem disservices: “results and outcomes of functions, structures, and aspects related to abiotic entities, processes and interactions that may impact human well-being and are assessed as damaging under a relevant value system at a particular moment”. However, it is necessary to mention that it is sometimes difficult to set a clear boundary between what is a service and a disservice, because one geosystem function may be a service in one context and a disservice in another (Saunders, 2020).
The aim of this paper is to present briefly a framework for the qualitative evaluation of GS and GDS that may be applied to geosites, represented here by an abandoned quarry protected as Nature Monument, thus bearing a significant geoheritage value.

Material and methods
At first, it is necessary to identify the ecosystems within the study sites. Usually, in abandoned pits, these are represented by quarry walls, debris accumulations and eventually wetlands on the quarry bottoms – all of them with a significant abiotic component. For effective nature conservation

(geoconservation), planning and management, a complex approach and adequate framework need to be developed reflecting both GS and GDS.
There are numerous classification systems of GS (Garcia et al., 2025). For this study, the following classification of GS based on Gray (2018) is used: a) *provisioning* services (e.g., extraction of material and its use), b) *regulating* services (e.g., influence on micro-climate), c) *supporting* services (e.g., habitat function), d) *cultural and knowledge* services (e.g., aesthetics, tourism, education). Regarding the classification framework for GDS, it is supposed that some EDS frameworks may be converted to GDS classifications (Kubalíková, 2026). There are several classification systems described and discussed in literature (Veibiakkim et al., 2025), e.g., impact-oriented classification (economic, health, environmental impacts on human society), classification based on spatial scale (negative impact at local, regional or global scale), classification based on distinguishing the natural or human-induced types of EDS or classification based on the MEA framework. For this study, the following impact-oriented classification of GDS based on Vaz et al. (2017) is used: a) GDS related to *geological/geomorphological processes with negative influence on properties and infrastructure*, b) GDS related to *fears, health risks and harms* (e.g., safety, health complications), c) GDS related to *aesthetic issues* (negative perception or connotations of geodiversity), d) GDS related to *inhibition of human activities* (e.g., geosystems represent an obstacle in urban or infrastructure development).

Study site: Panská skála u Habrovan
The abandoned quarry is situated approx. 2 km west of Habrovany village (South-Moravian Region, Czechia). It covers an area of 300×100 m, with quarry walls reaching up to 40 m, where the deposition of conglomerates (namely Luleč conglomerate of Myslejovice Formation consisting mainly of granitic metamorphites, i.e., granulites, gneisses, quartzites) on the eroded surface of Carboniferous greywackes can be observed (Czech Geological Survey, 2026). In the 19th century, greywacke and conglomerate started to be extracted, in the 1970s, the quarrying was finished, and the site was left abandoned. At the bottom of the quarry, there is a wetland, important from the ecological point of view as a refuge of amphibians (e.g., *Lissotriton vulgaris, Triturus cristatus*) and hydrophilic flora. Under the walls, the debris cones are present conditioning the development of debris forests. Several protected and endangered plant species can be found here, e.g., *Cephalanthera damasonium, Campanula moravika* (Jurek, 2020). The site is protected as a Nature Monument (Figure 1).

Fig. 1: Panská skála Quarry near Habrovany (South Moravia, Czechia). A: an overall view of the quarry wall with blocky accumulation, B: a detail of the Luleč conglomerate, C: a wetland at the bottom of the quarry (photo: author).

Results and discussion
The selected study site has been qualitatively evaluated in terms of GS and GDS (Table 1). Generally, the geosystem functions of abandoned quarries may be perceived ambiguously, both positively and negatively, which is supported by this case study. Very often, these geosystems are important from the scientific, and educational point of view, they increase the overall landscape diversity, positively influence biodiversity, they bear an information necessary for understanding the cultural, industrial and technical level of the society including the use of natural resources in relation to geomining heritage, or they enable developing sustainable forms of tourism, which can positively affect local economic development. However, all the above-mentioned benefits can be seen as negative if the perspective is

opposite. Disused or abandoned quarries are very often perceived as “scars on the landscape”, or as sites that are dangerous and unpleasant. The negative connotations may be related to active geomorphological processes (rock fall) that may damage infrastructure or endanger human lives, or they may represent an obstacle to the construction development, or a complication for economically suitable land-use (agriculture, forestry). On contrary, the disservices and geohazards may be considered knowledge services that enable a deeper understanding of natural processes.

Tab. 1: Geosystem services and disservices of Panská skála Quarry

Geosystem services	Regulating	Influence on mesoclimate and water regime (dry quarry walls, wet quarry bottom)
	Provisioning	Source of material (conglomerate and greywackes)
	Supporting	Specific vegetation of bare rock walls, debris forests, wetland ecosystem – presence of protected species, e.g., amphibians or hydrophilic flora
	Cultural and knowledge	Scientific (geoheritage) values, importance for geological mapping, aesthetic values, use of local material at cultural monuments, educational value for visitors
Geosystem disservices	Impact of geohazards	Potential slope processes and instability of debris accumulation, possible contamination of water sources
	Fears, health risks and harms	Rock fall, slope processes, instability of debris and block accumulation may influence the visitor safety
	Aesthetical	For some visitors, the wetland may be disgusting and evoke negative connotations (muddy terrain, mosquitoes, unpleasant biota). Sometimes, there are black dumps that may also be perceived negatively.
	Inhibition of human activities	Practically not possible to use the site for other purposes (its settings, wetlands and unstable walls, are not suitable for economic development), legal protection (the site as a part of natural heritage) also significantly decreases the economic potential (e.g., use of the site for legal dump, potential construction activities, or forestry).

Conclusion

The geosystem services and disservices concept may become a new integrative approach that enables a complex evaluation of natural heritage sites where the geodiversity plays a substantial role. Thanks to the fact that it covers all the spectrum of attributes of the particular geosystems, it provides a holistic view of the site that may contribute to a more effective nature conservation and sustainable use of natural resources. It may also help to understand that nothing is only “positive or negative” and all the values are situated on a spectrum which depends on and may change according to different societal or historical context (e.g., slope processes may be perceived as dangerous, but at the same time, they have an important educational value). This inclusive approach may be more relevant, effective, and fair than applying traditional “black and white” points of view on natural resources.

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Souhrn
Příspěvek představuje koncept tzv. Geosystem services a Geosystem disservices (geosystémové služby a ne-služby, případně geosystémové nevýhody). Na základě již používaných klasifikací geosystémových služeb a s využitím adaptace klasifikací tzv. ekosystémových ne-služeb (nevýhod) je představena metodika, kterou lze využít pro kvalitativní hodnocení lokalit, kde geodiverzita (neživá složka) hraje významnou roli. Pomocí tohoto přístupu je zhodnocena modelová lokalita (opuštěný lom, dnes chráněný) a geosystémové služby a ne-služby (nevýhody) jsou stručně diskutovány.

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GIS-BASED SPATIAL EVALUATION OF RECREATIONAL POTENTIAL IN THE LANDSCAPE UNDER ENVIRONMENTAL AND SOCIO-ECONOMIC CONSTRAINTS

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Abstract
The sustainable development of recreational activities in natural landscapes requires an integrated understanding of both environmental potential and limiting factors. This study presents a GIS-based spatial evaluation of recreational potential, incorporating environmental and socio-economic constraints that affect its practical applicability. Four categories were assessed: winter recreation (snow-based sports), summer outdoor recreation outside built-up areas, cottage and second-home recreation, and educational and exploratory tourism. The evaluation was based on GIS-supported spatial analysis and multi-criteria modelling using selected landscape attributes, including topography, land cover and accessibility. The resulting spatially differentiated values were subsequently analysed in relation to limiting factors, particularly those related to landscape structure, nature and resource protection, and environmental stressors. By integrating calculated potentials with identified constraints, the study defines the realistic recreational potential of the landscape and provides a spatial framework for evidence-based and sustainable recreation planning.

Key words: recreation suitability; spatial modelling; outdoor recreation; nature conservation; land-use planning

Introduction

The evaluation of landscape potential represents a fundamental component of sustainable spatial planning and environmental management. Recreational use of the landscape is strongly dependent on both natural conditions and human-induced constraints, which together determine the actual usability of the territory. The concept of natural capital provides a suitable framework for such evaluations, as it integrates ecosystem functions and services into decision-making processes (Daily et al., 1997). In the Slovak context, this concept has been systematically developed in the Atlas of Natural Capital of Slovakia (Izakovičová et al., 2025), which provides a comprehensive methodological framework for the assessment of landscape potentials and ecosystem services. Advances in geographic information systems (GIS) and spatial data availability have significantly improved the capacity to assess landscape potential in a spatially explicit manner. Despite these advances, many assessments still rely predominantly on theoretical or physical suitability, often neglecting the influence of socio-economic constraints. This leads to systematic overestimation of actual landscape usability. Therefore, there is a need for approaches that integrate both natural determinants and limiting factors into a unified evaluation framework.

The aim of this study is to evaluate selected types of recreational potential using GIS-based multi-criteria analysis and to quantify the impact of environmental and socio-economic constraints on their realistic applicability

Material and methods

The methodological approach applied in this study is based on procedures we developed within the Atlas of Natural Capital of Slovakia (Izakovičová et al., 2025), with partial adaptations to the specific requirements of recreational potential assessment.

Conceptual framework

The evaluation is based on the concept of landscape potential as a function of environmental suitability and limiting factors. The term potential explicitly expresses that the evaluation focuses on potential, not actual conditions of landscape use. Such an approach reflects the concept of natural potential as defined by Drdoš (2006), where the initial calculation is performed without considering limiting factors arising from human activities.

Four categories of recreational potential were assessed:

- R1 – winter recreation (snow-based sports)
- R2 – summer recreation (outdoor activities outside built-up areas)
- R3 – cottage and second-home recreation
- R4 – educational and exploratory tourism

Each category reflects different requirements and sensitivities to environmental conditions.

Input data and determinants
The assessment integrates multiple groups of spatial determinants:
- Abiotic factors – relief, altitude, slope, climate conditions
- Landscape structure – land cover, ecological stability, fragmentation
- Biotic factors – vegetation structure and ecological value
- Accessibility indicators – transport infrastructure and spatial availability

All input data were processed in GIS environment and transformed into raster layers with a spatial resolution of 10 × 10 m.

Multi-criteria evaluation
The evaluation was carried out using a weighted multi-criteria decision approach, following the principles of landscape-ecological planning and functional evaluation of geoecosystems (Ružička & Miklós, 1982; Miklós & Špinerová, 2019; Izakovičová et al., 2025). Each determinant was assigned:
- a functional value (f_{xi}) expressing suitability,
- a weight coefficient (v_{xi}) representing its importance.

The resulting potential was calculated as:
$\varphi_i = \Sigma (f_{xi} \cdot v_{xi})$
The values were classified into six categories ranging from “excluded” to “excellent potential”.

Levels of potential
Three hierarchical levels of potential were defined:
1. Theoretical potential – assumes no constraints
2. Technical potential – excludes unsuitable areas
3. Realistic potential – incorporates partial limitations

Socio-economic constraints were expressed through reduction coefficients: no limitation (1.0), partial limitation (0.5) and exclusion (0.0). Constraints were derived from protected areas and legislative restrictions, protection zones of natural resources (water, soil), built-up areas and infrastructure, environmental stressors (pollution, degradation) and natural hazards (landslides, avalanches).

Results
The evaluation of recreational potential revealed substantial differences between theoretical, technical and realistic potential levels across all categories (R1–R4). These differences reflect the cumulative impact of environmental and socio-economic constraints on the actual usability of the landscape.
A detailed quantitative overview of the results is presented in Table 1.

Tab. 1: Comparison of theoretical, technical and realistic recreational potential

Category	Potential level	Sum of values	Mean value (1–6)	% of theoretical	Loss (%)
R1 (winter recreation)	Theoretical	1719248369	3.51	100	–
	Technical	1620690060	3.52	94.27	5.73
	Realistic	919858277	2.00	53.50	46.50
R2 (summer recreation)	Theoretical	1638697935	3.35	100	–
	Technical	1557096730	3.41	95.02	4.98
	Realistic	1071217759	2.35	65.37	34.63
R3 (cottage and second-home recreation)	Theoretical	1741252926	3.55	100	–
	Technical	1604694160	3.61	92.16	7.84
	Realistic	977617992	2.20	56.14	43.86
R4 (educational and exploratory tourism)	Theoretical	1516782039	3.10	100	–
	Technical	1296766477	2.96	85.49	14.51
	Realistic	1101700010	2.51	72.63	27.36

The transition from theoretical to technical potential results in relatively moderate reductions across all categories. The proportion of technical potential ranges from 85.49 % to 95.02 % of the theoretical potential. The lowest reduction was observed in R2 (summer recreation), where technical potential reaches 95.02 % of the theoretical value, corresponding to a loss of 4.98 %. In contrast, the highest

reduction occurs in R4 (educational and exploratory tourism), where technical potential represents 85.49 % of the theoretical value, corresponding to a loss of 14.51%. Categories R1 and R3 show intermediate values, with technical potential reaching 94.27 % and 92.16 % of the theoretical potential, respectively. A substantially greater reduction is observed when moving from technical to realistic potential, which reflects the influence of partially limited areas. In this case, realistic potential reaches between 53.50 % and 72.63 % of the theoretical potential. The lowest proportion is observed in R1 (winter recreation), where realistic potential represents 53.50 % of the theoretical value, corresponding to a total loss of 46.50 %. Similarly, R3 (cottage and second-home recreation) shows a considerable reduction, with realistic potential reaching 56.14 % of the theoretical value (loss of 43.86 %). Moderate reductions are observed in R2 (summer recreation), where realistic potential reaches 65.37 % of the theoretical value, corresponding to a loss of 34.63 %. The least affected category is R4 (educational and exploratory tourism), where realistic potential remains at 72.63 % of the theoretical value, corresponding to a loss of 27.36 %. In addition to these differences, changes in mean values indicate shifts in the overall quality of remaining areas after the exclusion of unsuitable locations. In categories R1, R2 and R3, the mean value slightly increases when moving from theoretical to technical potential, suggesting that the removal of unsuitable areas leads to a relative improvement in average suitability. In contrast, category R4 shows a decrease in mean value (from 3.10 to 2.96), indicating that excluded areas may also include locations with relatively higher suitability.
Overall, the results indicate that while the exclusion of unsuitable areas has a moderate impact on the total potential, the inclusion of partially limited areas significantly reduces the realistically usable landscape potential across all categories.

Discussion

The results clearly demonstrate that assessments based solely on environmental suitability lead to systematic overestimation of landscape usability for recreational purposes. While the theoretical potential reflects the maximum possible suitability of the landscape, it does not account for spatial, environmental, and socio-economic constraints that significantly limit real-world applicability. The comparison between theoretical, technical and realistic potential highlights the importance of a multi-level evaluation approach. The relatively small reduction between theoretical and technical potential (approximately 5–15 %) indicates that completely unsuitable areas represent only a part of the landscape. However, the substantially larger decrease between technical and realistic potential (15–43 %) confirms that partially limited areas play a crucial role in determining actual usability. This finding suggests that the exclusion of unsuitable areas alone is not sufficient for realistic spatial assessment. The variability observed among individual categories (R1–R4) reflects their differing sensitivity to environmental conditions and constraints. Winter recreation (R1) and cottage and second-home recreation (R3) show the highest reduction of potential, indicating strong dependence on specific environmental conditions such as climate, terrain and landscape protection regimes. In contrast, educational and exploratory tourism (R4) retains the highest proportion of its theoretical potential, suggesting greater spatial flexibility and lower dependence on strict environmental requirements. From a spatial planning perspective, these results have important implications. The use of theoretical or even technical potential alone may lead to inappropriate allocation of recreational functions in the landscape. The incorporation of realistic potential allows for more accurate identification of areas suitable for development, while also supporting the protection of environmentally sensitive or constrained locations. The presented methodology, based on GIS-supported multi-criteria evaluation, provides a robust framework for integrating heterogeneous spatial data and translating them into decision-relevant outputs. Its application can support not only strategic spatial planning, but also environmental impact assessment, land-use planning, and the design of sustainable tourism development strategies. Furthermore, the approach enables the identification of areas where targeted interventions could increase usable potential, for example through infrastructure improvements or mitigation of limiting factors. At the same time, it highlights areas where development should be restricted due to environmental sensitivity or regulatory constraints.

Conclusion

The results demonstrate that the realistic recreational potential of the landscape is significantly lower than its theoretical potential due to the combined influence of environmental and socio-economic constraints. While technical potential remains relatively close to theoretical values, the inclusion of partially limited areas leads to a substantial reduction of usable potential across all evaluated categories. The degree of reduction varies among individual types of recreational activities. The most pronounced decrease was observed in winter recreation (R1) and cottage and second-home recreation (R3), whereas educational and exploratory tourism (R4) retained the highest proportion of

its theoretical potential. Summer recreation (R2) shows intermediate values, indicating a moderate sensitivity to limiting factors. These findings confirm that the evaluation of landscape suitability based solely on natural conditions leads to an overestimation of its actual usability. The integration of constraints provides a more realistic assessment and allows for a more accurate identification of areas suitable for recreational use. The presented GIS-based multi-criteria approach offers a practical tool for spatial planning and decision-making, enabling the evaluation of landscape potential in a way that reflects both environmental conditions and real-world limitations.

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Souhrn

Článek se zabývá GIS hodnocením rekreačního potenciálu krajiny se zohledněním environmentálních a socioekonomických omezení. Hodnoceny byly čtyři typy rekreace: zimní sporty, letní turistika, chalupářství a poznávací turismus.
Výsledky ukazují, že realistický potenciál dosahuje pouze 53–73 % teoretického potenciálu, což poukazuje na významný vliv omezení. Největší pokles byl zaznamenán u zimní rekreace a chalupářství, nejmenší u poznávacího turismu.
Metodika poskytuje vhodný nástroj pro podporu územního plánování a udržitelného rozvoje rekreace.

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HISTORICAL HERITAGE AND MODERN TOURISM IN DOBROGEA, ROMANIA: THE IMPACT OF PHYSICAL AND DIGITAL ACCESSIBILITY

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Abstract
The historical heritage of Dobrogea, one of the richest cultural regions in Romania, represents a highly valuable resource for the development of modern tourism. This study examines the relationship between the physical and digital accessibility of the historical heritage in this southeastern Romanian region and its impact on tourism activities. Physical accessibility is assessed through the quality of transport infrastructure, the facilities available to visitors, and the integration of sites into tourist circuits. Digital accessibility focuses on the online presence of heritage monuments, the use of digital technologies to showcase these sites on web platforms, mobile applications, and virtual tours. The research methodology combines documentary analysis with an empirical qualitative analysis of tourist interviews. The results indicate that an effective correlation between physical and digital accessibility contributes to increasing tourist interest, diversifying visitor experiences, and promoting the sustainable use of historical heritage. The study emphasizes the need for integrated policies that leverage digital technologies alongside infrastructure improvements to support the competitiveness of modern tourism in the Dobrogea region of Romania.

Key words: monuments, competitiveness, infrastructure, tehnology, sustainable promotion

Introduction

Historical heritage is an essential resource for the development of cultural tourism, serving as a vehicle for local identity and historical continuity. In the literature, the relationship between heritage and tourism is analyzed as a dynamic process, in which the promotion of cultural resources contributes both to economic development and to the strengthening of regional identity (Richards, 2018; MacDonald, 2003; Torre, 2017).

Furthermore, the use of web and mobile applications contributes to increasing the accessibility of cultural heritage, providing tourists with tools for planning, guiding, and interpreting tourist attractions (Hausmann, 2015; Dumitrașcu, 2023; Katsoni, 2020). In this paradigm, digital tourism is no longer merely an extension of the physical experience but becomes an integral component of it.

The concept of accessibility thus takes on a dual dimension: on the one hand, physical accessibility, related to infrastructure, transportation, and facilities; and on the other hand, digital accessibility, associated with the availability of information and the use of emerging technologies. Recent studies highlight that informational and digital accessibility significantly influence travel decisions and the tourism experience (Choi, 2012; Tuomi, 2023; Teodorescu, 2023; Szemkovics, 2018). At the same time, recent literature emphasizes the role of emerging technologies - such as artificial intelligence, virtual reality, or augmented reality - in transforming the tourism experience and increasing the accessibility of heritage (Sánchez-Martín, 2025; Katsoni, 2016). These technologies enable the creation of immersive and personalized experiences, facilitating the exploration of heritage even under conditions of limited physical access. At the same time, they contribute to the development of the concept of “smart tourism,” in which data and technology are used to optimize destination management and adapt tourism offerings to visitors’ needs (Liu, 2024; Dincă, 2015; Zeleňáková, 2017).

This paper aims to analyze the impact of physical and digital accessibility on the promotion of Dobrogea’s historical heritage in the context of modern tourism. By linking theoretical perspectives with regional characteristics, the study seeks to highlight how infrastructure and technology can contribute to the sustainable development of cultural tourism, as well as the challenges involved in integrating them. In a global context characterized by accelerated digitalization and competition among destinations, understanding these dynamics becomes essential for formulating effective strategies for promoting and preserving heritage.

Materials and Methods

To analyze the impact of physical and digital accessibility on the promotion of Dobrogea's historical heritage, this study employs a simplified econometric model based on quantifying explanatory variables and estimating their relationship with the level of tourist attractiveness.

The general model can be expressed as a linear function:

$$T=\beta_0+\beta_1 A_f+\beta_2 A_d+e$$

where:

T = level of tourist attractiveness (dependent variable),

Af = physical accessibility index,

Ad = digital accessibility index,

β0 = constant term,

β1, β2 = regression coefficients

e = error term

Physical Accessibility Index (Af)

Physical accessibility is constructed as a composite index:

$$A_f = \frac{1}{n}\sum_{i=1}^{n} x_i$$

where the standardized indicators include:

X1 = quality of transportation infrastructure (score 1–5),

X2 = road/rail connectivity,

X3 = availability of tourist facilities (parking lots, information centers),

X4 = accessibility for people with reduced mobility

Each indicator is standardized on a Likert scale (1 = very poor, 5 = very good), and the final index is the arithmetic mean.

Digital Accessibility Index (Ad)

Digital accessibility is also aggregated:

$$A_d = \frac{1}{m}\sum_{j=1}^{m} y_j$$

where the indicators include:

y1 = existence of an official website,

y2 = quality of online information,

y3 = use of mobile apps,

y4 = availability of virtual tours/augmented reality,

y5 = interactivity of digital platforms.

Scores are evaluated on a standardized scale (1 - 5), similar to the physical index.

Tourist attraction (T): was assessed through semi-structured interviews with tourists (N respondents), coded using scores on a 0–1 scale for each aspect of the tourist experience.

Results

The application of the proposed quantitative model enabled a comparative assessment of physical (Af) and digital (Ad) accessibility for a representative set of historical sites in Dobrogea, as well as an analysis of their impact on tourist attractiveness (T).

Assessment of Accessibility Scores

Following the aggregation of indicators, variable values of physical and digital accessibility were obtained for the analyzed sites. The results indicate that:

- Sites located near urban centers (e.g., Constanța, Tulcea) recorded high physical accessibility values (Af > 0.70), due to more developed transportation infrastructure and superior connectivity.
- More isolated sites or those located in rural areas recorded moderate or low physical accessibility values (Af < 0.50), primarily due to road quality and a lack of supporting infrastructure.
- Digital accessibility (Ad) shows significant variations: some destinations benefit from an active online presence and interactive digital content (Ad > 0.75), while others have low online visibility (Ad < 0.40).

The Correlation Between Accessibility and Tourist Attractiveness

The linear regression analysis revealed a positive relationship between the independent variables and tourist attractiveness:

$$T=\alpha A_f+\beta A_d+e$$

The results suggest that both factors contribute significantly to increasing tourism attractiveness, though to varying degrees:

The coefficient associated with digital accessibility (β) is slightly higher than that of physical accessibility (α), indicating that digitalization has a greater influence on the tourist's information-gathering and decision-making stages.

The value of the coefficient of determination indicates that a significant proportion of the variation in tourism attractiveness is explained by the two variables analyzed.

Discussion

The differences in the levels of physical accessibility (Af) and digital accessibility (Ad) can be explained by a range of structural, geographic, economic, and institutional factors. In the case of the historical sites analyzed in Dobrogea, these differences are not random but reflect real imbalances in territorial development and in the level of integration into tourism and information networks. Thus, the primary determinant of physical accessibility can be considered to be the geographical location relative to urban centers and major transportation infrastructure (with heritage monuments - religious sites and fortresses - being situated in these contexts). Another determining factor is promotion at the local government level. The existence of a genuine promotion strategy can influence the physical and, above all, digital accessibility of heritage monuments in the local area. A third factor is considered to be notoriety. Some monuments are well-known due to how they are promoted through education (history lessons or other means). Other factors may also be added to these.

Conclusion

The analysis revealed that physical accessibility remains a fundamental factor, determining the actual possibility of visiting attractions. Transportation infrastructure, connectivity between sites, and the availability of visitor facilities directly influence tourist flow and the quality of the experience. At the same time, digital accessibility has proven to play an increasingly important role, particularly in the information, planning, and interpretation stages of the tourist experience, contributing to increased visibility of the heritage and stimulating the interest of potential visitors. From the tourists' perspective, the use of digital tools (websites, mobile apps, virtual tours) positively influences the decision to visit and contributes to better information, while physical access conditions and local infrastructure remain decisive for overall satisfaction. In conclusion, the sustainable development of tourism in Dobrogea requires an integrated approach that combines investments in physical infrastructure with the implementation of modern digital solutions.

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Souhrn
Kulturní krajina je dokladem lidské existence, činností, které zde člověk vykonával, a přesvědčeními, která zde komunita vyjadřovala. Tyto důkazy se zhmotňují v památkách, jejichž duchovní hodnota s postupem času roste. Všechny tyto hodnoty, které tvoří posvátnou kulturní krajinu, si zaslouží, aby byly zohledněny v kulturních turistických okruzích.

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HISTORICAL WATER MANAGEMENT STRUCTURES AND THEIR CURRENT POTENTIAL (THE EXAMPLE OF THE BESKIDS AND OTHER AREAS)

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Abstract

A number of water structures have been preserved in Czechia, whose existence was linked to the transport of timber. In the Beskids, where structures used for floating timber can still be found today, the need for timber was primarily related to the processing of iron ore. New water structures—channels and reservoirs (splash dams)—have appeared in the landscape.Later, lower wood consumption caused the decline of the purpose-built water network. Some structures disappeared, while others retained their water management function, albeit in a modified form. Aesthetic value has given many structures a "second life" and turned them into tourist destinations. Information boards and nature trails now present them as part of the cultural heritage. The decline in water in the landscape has raised the question of restoring some of the structures. The potential of water structures is also being explored in the Šumava Mountains / Bavarian Forest, the Gratzen Mountains, etc.

Key words: water channels; reservoirs; timber floating; cultural heritage; tourism

Introduction

Water management structures and systems—an integral part of the development of civilization—now constitute a significant component of cultural and industrial heritage, which has been the subject of research, interpretation, and preservation since the 1970s (Charta 2013). Part of the effort to preserve the vanishing world of (not only) the industrial centuries involves a very intense interest among experts not only in identifying and documenting individual structures, but also in sparking a discussion about their preservation and presentation to the general public. This general effort has recently also extended to water management structures (Vyskočil and Dzuráková, 2022; Ryšková and Dzuráková et al., 2022). One segment of historical water management structures consists of facilities and systems that served, often for centuries, as an absolutely essential means of transport for ensuring a sufficient supply of firewood and lumber. Humans gradually integrated water management elements into the landscape that overcame distances and terrain challenges and connected populated and peripheral areas. However, most of these ingenious engineering projects have disappeared for various reasons. In fact, only those that found new uses had a chance of being preserved in the landscape. Yet their original purpose gradually faded from collective memory. It is important to recall it in order to cultivate cultural awareness and strengthen respect for the work of our ancestors. The following text is the result of a project focused on the historical, technical, and cultural-heritage context of water management systems consisting of splash dams and the associated distribution network (water channels). The study summarizes some of the findings to date by a research team of water management experts and historians regarding systems operating in various regions of the Czech lands. It attempts to compare their current state and highlights their tourism potential.

Materials and methods

The methods used to identify and interpret structures are based on the working methods of an interdisciplinary project team. The foundation upon which both groups operate is field research combined with thorough research of historical sources. Data collected in the field (on-foot surveys, geodetic surveying of structures, and the use of drones) is entered into electronic databases and further processed using specialized SW tools, e.g. GIS. The information obtained is cross-referenced with archival sources in the following steps: 1) detailed research, analysis, and interpretation of available archival fonds (manor farm estates, water cooperatives, state administration offices, and local governments); 2) analysis of contemporary cartographic materials; 3) digitization of selected archival (map, project, and other) materials and their interpretation using SW tools (GIS). Consultations with local experts from various memory and specialized institutions, as well as research into specialized literature—not limited to regional studies—played a significant role in the final interpretation and description of history.

Regions of interest

Beskids. A comprehensive water management system developed gradually from the 17th century onward in connection with iron ore processing. It reached its peak in the 19th century, during the heyday of the local ironworks. Timber was floated down the *Ostravice*, *Morávka*, and *Olše* river basins. From the last quarter of the 19th century, the industry began to decline due to the transition from charcoal to coal coke, and during World War II, timber floating ceased entirely. The most conspicuous remnants of this activity are the reservoirs, built on mountain streams with steep gradients. Their state of preservation varies. The situation is more favorable in the *Ostravice* River basin, particularly thanks to seven reservoirs that have undergone reconstruction over the past approximately 30 years. These are the *Friedrich* (*Bedřich*), *Lučovecký* (*Kocián*), *Čurabka*, *Max*, *Černá Ostravice*, *Studenčanka* (*Kyčerov* or *Klínská*), and *Panský* reservoirs (Polášek 2006). The restoration of these reservoirs is linked to their new purpose, in which they serve as retention basins for sediment. All are easily accessible, and their aesthetic value makes them attractive tourist destinations. This also led the Odra River Basin Authority to install informational signs that provide tourists with basic information about the history and current use of these water structures. Only fragments of the water channels remain, leveled in the agricultural landscape and covered by later construction within urban agglomerations. A notable exception is the relic canal on the right bank of the *Morávka* River in the area between *Dobrá* and *Staré Město u Frýdku*.

Giant Mountains. The situation here is completely different from that in the Beskids. In the past, this region had the densest network of splash dams of any Czech mountain range, but none have survived in working condition. The largest number of reservoirs was built in the *Úpa* and *Malá Úpa* river basins, from where timber was floated for the needs of the *Kutná Hora* mines for only a few decades at the turn of the 16th and 17th centuries. The depletion of the forests was followed by the demise of the water management systems. Other reservoirs associated with timber floating for local ironworks have survived in the terrain only as ruins, as iron ore mining and processing in the Giant Mountains ended during the first half of the 19th century, and the unused structures found no further use. One source of hope for the future, which could revive long-gone times, is the reservoir on *Luční potok*, where, due to its easy accessibility and the good condition of the right bank of the dam, reconstruction for tourist purposes is being considered. The site is part of the *Vlčí jáma* nature trail (Pilous 2015, 2017).

Gratzen Mountains. It was here, starting in the last quarter of the 18th century, that the story of a water transport system began—one that is truly unique within the Czech lands. A network of natural watercourses (the *Černá* River and its tributaries) and reservoirs made it possible to float logs and rafts from the high mountain regions to the interior. The system operated until the end of World War II; since then, it has fallen into disrepair. The most prominent remnants are (similar to those in the Beskids) reservoirs, known here as ponds. In addition, mostly inconspicuous remnants of structural modifications to the stream channels have survived. An exception is the remains of a timber-lined channel (slides) on the *Pohořský potok* below a place called *Baronův Most* (Vyskočil, 2024).

Šumava Mountains. One of the most famous historical waterworks in the country is the Schwarzenberg Floating Canal, built at the turn of the 18th and 19th centuries and initially used to float timber from forest areas to the Danube basin, and later in the opposite direction to the Czech interior. It remained in use in certain sections until 1961. It is an extensive complex that no longer serves its original or any other water management function, but has become a major tourist attraction in both the Czech and Austrian border regions. Selected sections of the canal have undergone reconstruction since the end of the last century. Several hiking and cycling trails run along the channel, featuring a number of informational stops. Its tourist potential is further enhanced by the presence of related structures, such as the tunnel or the so-called *Jelení smyk* in *Jelení Vrchy*, where the Schwarzenberg Floating Canal Exhibition is also located. The situation is similar in the case of the second channel, the Vchynice-Tetov Floating Canal, where timber was last floated in 1958 (Hladík 2021). Both canals have been part of the Šumava Floating Canals national cultural monument since 2014. Only a limited number of related reservoirs (ponds) have survived. For example, the Jelení and Žďárecké ponds have been restored and are open to tourists. Others that are clearly visible in the terrain, such as the *Rosenauer* Reservoir at the very beginning of the Schwarzenberg Floating Canal, or the *Luzenské*, *Roklanské*, *Ptačí*, and many other ponds, have not, however, been restored.

The Bavarian Forest. Timber was also floated on the German side of the Šumava Mountains, in the *Ilz* and *Regen* river basins. As in the Czech lands, timber floating ceased here around the mid-20th century. As part of the extensive waterway systems in both river basins, a network of reservoirs was built in the 18th and 19th centuries; most of these have survived to the present day, and many were restored in the postwar period and are now maintained as cultural monuments.

Discussion

Awareness of these historical water management systems varies across the Czech lands. This is largely related to the extent to which they have been preserved and presented in public spaces. A lack of knowledge is particularly evident in areas where only barely identifiable remnants of channels and reservoirs remain in the terrain (Giant Mountains). In contrast, in the Beskids, on both the Czech and Bavarian sides of the Šumava Mountains, and in the Gratzen Mountains, there are structures that are often of exceptional value. However, even these do not demonstrate a continuous history or functional use. Timber floating ceased during World War II, with the exception of the Giant Mountains and the Šumava Mountains. This was due to technological advances and changes in the transportation network. However, the subsequent deterioration of individual structures and the decision not to repurpose them were clearly influenced by the political and social context. These systems were located in the so-called Sudetenland, an area severely affected by the population exchange after 1945, the devastation of local spiritual and material values, and the creation of a border zone with a specific character. The existence of the current structures is thus linked to the reconstructions carried out over the past three decades. This applies to the Šumava canals, which were partially restored with the aim of creating tourist attractions, rather than as structures serving a water management function. By contrast, the splash dams in the Beskids have retained this function; they were reconstructed as erosion-control features in the landscape, which, incidentally, is a prerequisite for their continued existence in the future. In contrast, the Šumava reservoirs, with few exceptions, have not been restored, and it remains to be seen to what extent the National Park Administration's policy will be inclined to implement the general concept of returning water features to the landscape—a concept that would not only enhance biodiversity but, in our case, also raise awareness of our technical heritage. An exemplary approach to the heritage of our ancestors, unburdened by the historical discontinuity, can be observed on the Bavarian Forest, where a number of revitalized water reservoirs are part of tourist and nature trails, accompanied by visually uniform and attractive tourist information boards. This information system is created and maintained by the Bavarian Forest National Park and the Bavarian State Forests in cooperation with local municipalities. While a shift in the approach to preserving cultural heritage can be observed in the aforementioned mountain regions—whether in the form of historic preservation of buildings or the visual representation of historical themes in public spaces—the Gratzen Mountains remain neglected to this day. Yet the uniqueness of the local waterway system and the preserved reservoirs directly invites efforts to highlight the significance of these activities, which have the potential to become a rediscovered identity for this region.

Conclusion

It is clear today that the original purpose of these waterway systems has disappeared, and their function can now only be demonstrated to the public through exhibits, such as those found on the Šumava canals. However, the preservation, restoration, and protection of historic water management structures embody the hope of reconciling the sustainable use of the landscape with the legacy of our ancestors' technical ingenuity. Popularizing this topic through nature trails, interpretation panels, or educational materials in tourist information centers contributes to a deeper understanding of the landscape. This is also because floating systems are often located in former Sudetenland affected by „historical blindness". The question always remains as to which water features should be preserved or reconstructed, and why. As a rule, they were part of more complex systems that cannot be fully restored. The location of individual structures also plays an important role, as they are quite often situated in protected areas with specific landscape regimes. Any implementation must proceed in cooperation with various stakeholders who often have conflicting interests—water managers, conservationists, administrative authorities, heritage preservationists, and tourism entrepreneurs.

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Souhrn
V horských oblastech Česka se dochovala řada vodních objektů, jejichž existence souvisela s průmyslovým rozvojem, resp. transportem dřeva. Jednou z oblastí, kde je možno dodnes objekty sloužící ke splavování dřeva nalézt, jsou Beskydy. V povodí Ostravice, Morávky a Olše potřeba dřeva primárně souvisela se zpracováním železné rudy. V jejím důsledku se přirozená vodní síť zásadně proměnila. Koryta byla upravována a do krajiny vstoupily nové vodní prvky – kanály a tzv. klauzy. S odklonem od využívání dřevní hmoty souvisí úpadek účelově vytvořené vodní sítě. Nastal její „druhý život“. Některé objekty odvál čas, jiné si uchovaly svoji vodohospodářskou, byť pozměněnou funkci. Jejich estetická hodnota v členité krajině učinila z mnohých turistické lákadlo. Přibyly informační tabule a naučné stezky odkazující na dávno ztracené souvislosti. Staly se součástí kulturního dědictví. Úbytek vody v krajině nastolil otázku, zdali některé z prvků neobnovit. Otázku umělých vodních prvků a jejich potenciálu řeší také na Šumavě / v Bavorském lese, v Novohradských horách i jinde.

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IDENTIFICATION OF THREATS IN URBAN GREEN SPACES IN WARSAW BY THE USE OF A VOLUNTEERED GEOGRAPHIC INFORMATION (VGI) TOOL

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Abstract

Urban green spaces are attractive public areas, and a sense of safety is crucial for their use. In addition to their benefits, they may also pose certain risks that limit accessibility and willingness to use them. The study aimed to identify and analyse the hazards reported by residents of Warsaw (Poland) in parks and green squares and their immediate surroundings, using the National Map of Security Threats (NMST) in 2025. The types of hazards and the scale of their occurrence in access to and use of green spaces were taken into account. The results show that 59 reports were identified in the NMST concerning 23 parks and 10 green squares. Residents considered the most troublesome threats to be alcohol consumption by other users in parks and green squares, and incorrect parking on routes leading to them. They also pointed to the groups of young people at risk of demoralisation gathering in green spaces and their surroundings, which may pose a threat to other users. Despite the overall limited number, the reports indicate real hazards that affect users' sense of security and their willingness to visit green spaces, resulting in practical conclusions for local authorities and managers to shape parks and green squares by eliminating crime-prone areas.

Key words: parks and green squares, users, threats, public security, greenery

Introduction

Urban green spaces play a crucial role in enhancing well-being for city residents (Dietz et al., 2025). Providing contact with nature in highly urbanised areas improves mental health and reduces stress (Wood et al., 2017). Urban parks and green squares are also recreational spaces that contribute to improving physical health (Jimenez et al., 2021; WHO, 2024). People's exposure to greenery positively influences the amount of physical activity they regularly engage in (Persson et al., 2018), while high-quality green spaces better support users' time spent outdoors. However, urban parks and green squares can also be sites of various threats to their users, arising from factors such as maintenance, cleanliness, or other users' inappropriate behaviour (Kimic, Polko, 2022b; Polko, Kimic, 2022). Personal security is one of the key aspects affected by perceptions of urban green spaces, which play an important role for city residents (Polko, Kimic, 2021). In the face of perceived danger, people tend to avoid public spaces, including green spaces, which are affected by this behaviour.

Nowadays, publicly available tools for Volunteered Geographic Information (VGI) have become a method of data collection in which geospatial content is generated by non-professionals using online mapping systems. Those systems offer an opportunity to collect spatially referenced information on hazards to urban public spaces, including green spaces (Brown et al., 2018; Hooper, Edwards, 2024). Identifying undesirable behaviours among users may help eliminate hazards and thus improve accessibility and safety of parks and green squares. The National Map of Security Threats (NMST), implemented in Poland in 2016, is a GIS-based, publicly available digital tool for crime and hazard mapping that engages citizens in shaping local security by reporting hazards from a list of categories in their neighbourhoods (KMZB, 2025; Polko, 2022). This provides insights into common threats to human life, health, property, and public order, as perceived by its users, and accounts for their spatial distribution (Polko, Kimic, 2024).

The study aimed to determine whether the city residents of Warsaw (Poland) report hazards in green spaces and their immediate surroundings (access zones) that could affect the safety of reaching and using them.

Material and methods

Parks and green squares formally designated as urban green spaces in Warsaw served as the study area. Both the space within their borders and the immediate surroundings of the entrance zones were analysed.

To achieve the above-mentioned aim, the National Map of Security Threats (NMST) was used. The study accounted for 27 available types of hazards recorded in green spaces (parks and green

squares) and their immediate surroundings in 2025. At the first stage, they were divided into three main groups:
1. Hazards occurring in the immediate vicinity of green areas, primarily related to road traffic (roads and their use), including 9 types: incorrect parking, inappropriate road infrastructure, poor traffic management, speeding, illegal car racing, unguarded railway crossings, unguarded level crossings, driving off-road in forest areas, and road accidents involving forest animals.
2. Hazards occurring in the immediate vicinity and in green areas, primarily related to social behaviours, including 7 types: acts of vandalism, alcohol consumption in prohibited places, homeless persons requiring assistance, groups of minors at risk of demoralisation, places of dangerous entertainment activities, use of intoxicants, begging.
3. Hazards occurring in green spaces, primarily related to water bodies, including 4 types: wild bathing areas, dangerous places in water areas, dangerous places on water, drowning; related to vegetation including 4 types: destruction of greenery, illegal tree felling, burning of meadows, illegal rubbish dumps; related to the presence of animals (wild and domestic) including 3 types: stray dogs roaming around, animal abuse, poaching.
At the second stage, the hazards were identified through the individual map study and then linked to the green spaces. The quantitative analysis indicated which hazards were reported most frequently in and around each park and green square, enabling the selection of those requiring intervention to improve safety.

Results
Based on data collected from NMST in 2025 for Warsaw, a total of 59 hazards have been reported in and around green spaces. The hazards were identified in 23 parks (Table 1) and 10 green squares (Table 2). Most of them belong to two categories occurring in the immediate vicinity of green spaces and are related to:
- road traffic (roads and their use) and include 5 of the available 9 types: incorrect parking, inappropriate road infrastructure, poor traffic management, speeding, and illegal car racing.
- social behaviours and include 4 of the available 7 types: acts of vandalism, alcohol consumption in prohibited places (also identified in green areas), homeless persons requiring assistance, and groups of minors at risk of demoralisation.

The hazards occurring in green spaces were identified only in those related to vegetation, and include only 1 of the available 4 types: destruction of greenery.

The most frequently reported hazards across all identified green spaces were: alcohol consumption (21 reports) and improper parking (18 reports). The others did not exceed 6 reports in each type and are thus classified as incidental.
Five types of transport-related hazards (roads and their use) were identified in around 22 green spaces: 15 parks and 7 green squares. The most common problem was illegal parking near 10 parks and 4 green squares. Inappropriate road infrastructure was identified near 3 parks and 3 green squares, and poor traffic management near 2 parks. Speeding occurred directly adjacent to 2 parks and 1 green square. Illegal racing was identified near only 1 park. At the same time, two types of hazards were reported only near 3 of the 23 parks and 2 of the 10 green squares, whilst in other locations, one case of each type was reported.
Four types of hazards associated with social behaviours were identified in the vicinity of 14 green spaces: around 9 parks and 5 green squares. The most frequently reported issue was alcohol consumption, which affected 21 green spaces and occurred both within their boundaries and in their surrounding areas. These incidents were recorded in 7 parks, with repeated incidents occurring in 4 of them. Only one such incident was recorded in the surrounding area. Few incidents related to alcohol consumption were identified in the 5 green squares.
Gatherings of minors at risk of becoming delinquent were rarely reported. Such incidents were identified as recurring only in one park (three times) and as a one-off incident in the vicinity of another park. No such reports were recorded in or around green squares. Acts of vandalism were not reported in parks; such incidents occurred only once at the green square. As for reports concerning homeless people requiring assistance, such cases were also rarely reported. They occurred in the vicinity of one park and one green square.
Risks associated with vegetation were reported in only one park, and these concerned damage to greenery.

Tab. 1: Hazards identified in and around parks in Warsaw, by the number of reports (Source: KMZB, 2025).

Park name	Types of hazards									
	Related to transport (roads and their use)					Related to social behaviour in green space (in) / around green space (out)				Related to vegetation
	incorrect parking	inappropriate road infrastructure	poor traffic management	speeding	illegal car racing	acts of vandalism	alcohol consumption in prohibited places	homeless persons requiring assistance	groups of minors at risk of demoralisation	destruction of greenery
Moczydło Park	1			1					1 / out	
Skaryszewski Park				1						
Fosa Park	1									
Żołnierzy Żywiciela Park	2		1							
Stawy Kellera Park	1									
Olszyna Park							1 / in			1
Z. Herbert Park							2 / in			
Sady Żoliborskie Park	1									
St. Żeromski Park		1								
Świętokrzyski Park									3 / in	
Forty Korotyńskiego Park							2 / in			
Linde Forest							1 / out			
Stawy Brustmana Park	1						1 / in			
Krasińskich Garden			1		1					
J. Kusociński Park		1								
Szczęśliwicki Park	1									
Skaryszewski Park	4						6 / in			
Polish-German Gardens							1 / in			
Pole Mokotowskie Park							2 / in			
I. Jarocka Park	1									
F. Acher Park		1								
Park Pięciu Sióstr								1 / out		
Lasek na Kole	1									
Total:	**14**	**3**	**2**	**2**	**1**	**-**	**15**	**1**	**4**	**1**

Table 2. Hazards identified in and around green squares in Warsaw, by the number of reports (Source: KMZB, 2025).

Green square name	Types of hazards									
	Related to transport (roads and their use)					Related to social behaviour in green space (in) / around green space (out)				Related to vegetation
	incorrect parking	inappropriate road infrastructure	poor traffic management	speeding	illegal car racing	acts of vandalism	alcohol consumption in prohibited places	homeless persons requiring assistance	groups of minors at risk of demoralisation	destruction of greenery
A. Scholtz Square		1				1				
St. Skibniewski Cubryna Square		1								
A.W. Żurowski Square							1 / in			
Senior Square	1						1 / in			
M. and A. Radziwiłł Square	1									
Sybiraków Square	1									
Nelson Mandela Square							1 / in			
Pies Fafik Square							1 / in			
Więźniów Politycznych Stalinizmu Square		1								
Grzybowski Square	1			1			1 / in	1 / out		
Total:	**4**	**3**	**-**	**1**	**-**	**1**	**5**	**1**	**-**	**-**

Discussion

The surroundings of urban green spaces in big cities are characterised by extensive road infrastructure and heavy traffic. The results showed that the majority of reports to the NMST in areas around parks and green squares concerned illegal parking, which limits pedestrian movement and access to green spaces. Traffic hazards are compounded by inappropriate road infrastructure and driver behaviours (e.g., speeding) (Luo et al., 2022). The accumulation of these hazards reduces the sense of safety on the route to green spaces, significantly limiting their accessibility for pedestrians.

The behaviour of other users is a significant factor influencing the sense of safety in parks and green squares (Polko, Kimic, 2022), as evidenced by the high number of reports concerning alcohol

consumption in and around green spaces. Parks are regarded as attractive places for engaging in prohibited activities, especially for young people at risk of demoralisation (Townshend, Roberts, 2013). Urban green spaces provide casual, open-air, often 'hidden' and secure locations to consume alcohol, away from formal, structured, and more expensive venues (Khazaei et al., 2026). Alcohol consumption is perceived as a problem also associated with other negative outcomes, such as litter, noise nuisance, and violence (Polko, Kimic, 2022; de Loyola González-Salgado et al., 2023).
Reported only once, damage to greenery may indicate either an absence of such negative behaviour in other green spaces, or that such behaviour is tolerated, or that users do not regard it as a threat to their safety. This issue is often overlooked in research (Loughran, 2020), although the destruction of greenery by people in parks is a complex and multifaceted problem ranging from direct, intentional vandalism to careless, everyday behaviour (Ostoić et al., 2024). At the same time, key findings indicate that actions such as damaging trees reduce the sense of safety in green spaces (Kimic, Polko 2022a; Polko, Kimic, 2022).

Conclusion

Based on data collected by NMST in Warsaw in 2025, the most common hazards identified in and around green spaces included alcohol consumption in prohibited areas and incorrect parking on roads leading to parks and green squares. The next two were the poor condition of road infrastructure on the route to green spaces and the gathering of minors at risk of demoralization. These hazards should be considered significant for green space users, and therefore, their elimination should be a priority.
The functioning of the NMST tool, including the ongoing analysis of reports documenting hazards, is important for identifying the real safety situation in green spaces and in their immediate surroundings. This source is crucial for improving the accessibility and safety of urban parks and green squares today, even if the tool has some limitations: collected data is available only within the last 30 days, and the tool's design allows reporting only threats from a closed list of categories.

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Souhrn
Městské zelené plochy jsou atraktivními veřejnými prostory a pro jejich využívání je zásadní pocit bezpečí. Kromě svých přínosů mohou však představovat i určitá rizika, která omezují jejich dostupnost a ochotu je využívat. Cílem studie bylo identifikovat a analyzovat nebezpečí, která nahlásili obyvatelé Varšavy (Polsko) v parcích a na zelených náměstích a v jejich bezprostředním okolí, a to s využitím Národní mapy bezpečnostních hrozeb (NMST) z roku 2025. Byly zohledněny typy rizik a rozsah jejich výskytu v souvislosti s přístupem do zelených ploch a jejich využíváním. Výsledky ukazují, že v NMST bylo identifikováno 59 hlášení týkajících se 23 parků a 10 zelených náměstí. Obyvatelé považovali za nejobtížnější hrozby konzumaci alkoholu ostatními uživateli v parcích a na zelených náměstích a nesprávné parkování na cestách vedoucích k nim. Upozornili také na skupiny mladých lidí ohrožených demoralizací, které se shromažďují v zelených prostorech a jejich okolí, což může představovat hrozbu pro ostatní uživatele. Navzdory celkově omezenému počtu poukazují hlášení na reálná rizika, která ovlivňují pocit bezpečí uživatelů a jejich ochotu navštěvovat zelené prostory, což vede k praktickým závěrům pro místní samosprávy a správce, aby formovali parky a zelená náměstí tak, že odstraní oblasti náchylné ke kriminalitě.

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IMPORTANCE OF PHYSICAL ACTIVITY IN NATURAL ENVIRONMENTS FOR MENTAL AND PHYSICAL RECOVERY OF STUDENTS IN PERFORMING ARTS

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Abstract
Physical activity in natural environments offers an important means of mental and physical recovery and may help reduce psychological strain, relieve muscle tension, and improve recovery; therefore, the study examines how often students in performing arts use outdoor physical activity as forms of recovery and identifies differences in gender in perceived mental and physical effects. The sample included 144 students from faculty of performing arts (60 men and 84 women). Data came from questionnaire. Differences in gender underwent assessments with Pearson's chi-square test and Cramer's *V*, while ordinal items underwent analysis with the Mann-Whitney U test ($\alpha = .05$). Walking or hiking emerged as the most common activity in both groups (men 80.0%, women 84.5%). Statistically significant differences appeared in frequency of using outdoor physical activity and in perceived reduction of muscle tension ($p < .01$), which the Mann-Whitney U test confirmed ($p < .05$). No significant gender differences appeared in perceived reduction of psychological stress ($p > .05$). The findings highlight the importance of physical activity in natural environments for recovery of performing arts students. Support for regular participation may improve recovery and help prevent health problems.

Key words: Gender differences, health prevention, muscle tension, performing arts students, psychological strain.

Introduction

Students in performing arts are exposed to unique combinations of psychological and physical demands, including intensive practice schedules, performance pressure, repetitive movement, and elevated injury risk, all of which can compromise recovery and long-term wellbeing (Marko et al., 2025). Research shows that music students report stress, anxiety, constant tiredness, and other health problems during demanding periods (Araújo et al., 2017; Perkins et al., 2017). Music students experience musculoskeletal pain and playing-related disorders, with physical and psychosocial factors contributing to symptom development and persistence (Cruder et al., 2021; Bruyneel et al., 2024). In this population, recovery (i.e., strategy) is important for protecting health and preserving performance quality (Azor et al., 2024).

Physical activity in natural environments may represent an important form of recovery because it combines the general benefits of movement with the restorative effects of contact with nature. Recent research indicates that green exercise and other nature-based interventions are associated with improvements in mood, anxiety, positive affect, perceived stress, and broader indicators of mental health and quality of life (Coventry et al., 2021). These findings suggest that outdoor physical activity may offer practical, health-promoting recovery strategy for performing arts students facing both psychological strain and musculoskeletal overload in modern higher education; therefore, this study examines how often students in performing arts use outdoor physical activity as forms of recovery and identifies differences in gender in perceived mental and physical effects.

Materials and Methods

The study included 144 students from the Academy of Arts (i.e., Faculty of Performing Arts) enrolled in bachelor's and master's programs. The population of faculty (full) comprised 157 students, so the research sample represented 91.7% of all students. The sample contained 60 men and 84 women, corresponding to 41.7% and 58.3% of respondents. In relation to faculty population, the study captured 89.6% of all men (60 of 67) and 93.3% of all women (84 of 90). Across study years, coverage ranged from 89.3% to 92.9%, which indicates strong representation across all cohorts. The largest subgroup included first-year bachelor's students ($N = 38$; 26.4% of sample), followed by

second-year bachelor's students (*N* = 33; 22.9%), second-year master's students (*N* = 26; 18.1%), third-year bachelor's students (*N* = 25; 17.4%), and first-year master's students (*N* = 22; 15.3%) (Table 1).
With faculty populations of 157 students, the minimum required sample for 95% confidence level and 5% margin of error was 112. The sample included 144 students, covering 91.7% of population, with an estimated margin of error of ±2.36%; therefore, the sample may be considered representative of the Faculty of Performing Arts (i.e., Academy of Arts) student population.

Tab. 1: Characteristics of sample by study level and gender

Study year/ level	Men (*N*)	Women (*N*)	Sample (*N*)	Students at faculty	%
Bachelor's study - 1st year	16	22	38	41	92.7
Bachelor's study - 2nd year	11	22	33	36	91.7
Bachelor's study - 3rd year	12	13	25	28	89.3
Master's study - 1st year	10	12	22	24	91.7
Master's study - 2nd year	11	15	26	28	82.9

Data collection used questionnaire focused on regenerative role of physical activity in natural environments after music practice. The instrument examined frequency of outdoor activity as recovery strategy, the type of outdoor activity used during the year, perceived character of regeneration after music load, perceived reduction of psychological stress after music performance, and perceived reduction of muscle tension and pain after intensive music periods.
Data analysis used descriptive and inferential statistics, as well as sample adequacy statistics. Descriptive analysis included absolute frequency (*N*) and relative frequency (*%*). Percentages for questionnaire responses were calculated separately within the male and female groups to support direct comparisons. Sample adequacy was assessed by calculating the minimum required sample size for finite population, the coverage rate, and the estimated margin of error. Pearson's chi-square tests assessed differences in gender in categorical items, and Cramer's *V* quantified effect sizes (.10 small, .30 medium, .50 large). In terms of ordinal variables, the analysis used the Mann-Whitney U test after recoding responses in ordinal numeric scales. Statistical significance was set at $\alpha = .05$.

Results
Differences in gender emerged in the frequency (*N*) with which students used physical activity in natural environments for recovery after music practice. Men participated in such activity 1 - 2x/ week (55.0%), whereas women selected this frequency less often (28.6%) and rather indicated ≥3 times/ week (27.4%) or <1x/ month (25.0%). Differences in gender reached statistical significance ($p < .05$) and reflected medium effect sizes (Table 2).
With respect to type of activity, walking, hiking, and general outdoor walks predominated in both groups, accounting for 80.0% of men and 84.5% of women. Other forms of outdoor activity, including winter sports, cycling, and running, appeared only at irregular intervals. Distributions of outdoor physical activities did not differ significantly by gender ($p > .05$).
Regarding the perceived nature of recovery following music-related strain, men allocated their responses between combined physical and psychological recovery and psychological recovery (50.0% each). Women indicated that outdoor physical activity contributed in equal measures to physical and psychological recovery (70.2%). Differences in gender achieved statistical significance ($p = .0025$) and reflected medium effect sizes.
In the evaluation of roles of outdoor physical activity in reducing psychological stress after music performance, both groups expressed positive perceptions. Men selected the response "to great extents" (45.0%), whereas women chose "to great extents" (42.9%) and "to very great extents" (32.1%). Neither the chi-square tests nor the Mann-Whitney U test identified statistically significant differences in gender in this domain ($p > .05$).
Distinct patterns emerged in assessments of reduced muscle tension and pain following an intensive music period. Women indicated strong physical recovery effects, in particular, through the response "to great extents" (50.0%), whereas men selected "to moderate extents" (45.0%). Difference in gender reached statistical significance in both the chi-square tests and the Mann-Whitney U test ($p < .05$), suggesting stronger perceptions among women regarding the physical restorative benefits of outdoor physical activity.

Discussion
The study extends growing evidence that recovery in performing arts students should be understood as both psychological and physical process. In this sample, students reported regular engagement in outdoor physical activity in natural environments, with walking and hiking as the dominant choices

among both men (80.0%) and women (84.5%). This pattern has practical importance because these activities remain accessible, low-cost, and easy to fit into demanding academic and artistic routines. The preference for restorative forms of movement rather than competitive exercise may hold special value for students facing continuous rehearsal, performance, and study demands (Guerriero et al., 2025).

Tab. 2: Comparisons of results by gender

Analysis	χ^2 / U	p	**Interpretation**
Q1: Frequency of outdoor activity use	$\chi^2 = 21.6$	.000079	Sign. gender difference
Q2: Type of outdoor activity	$\chi^2 = 6.78$	.237802	No sign.
Q3: Character of recovery after music strain	$\chi^2 = 14.32$	.002505	Sign. gender difference
Q4: Reduction of psychological stress	$\chi^2 = 6.47$ / $U = 2088$	.091041/ .0618	No sign.
Q5: Reduction of muscle tension and pain	$\chi^2 = 24.58$ / $U = 1936.5$	.000061/ .0135	Sign. gender difference

Positive ratings for stress reduction align with recent literature showing that music students experience anxiety, fatigue, and high-performance pressure (Vengurlekar et al., 2023). Recent research indicates that physical activity in natural settings can support emotional regulation, lower perceived stress, and improve wellbeing, which strengthens its relevance as recovery strategy for this population (Coventry et al., 2021). Although the present analysis does not indicate statistically significant differences in gender in perceived psychological stress reduction, the responses across both groups suggest that outdoor activity may offer similar mental restorative benefits for male and female students (Nel & Tshikovhele, 2018; Zhang et al., 2023).

The study highlights differences in gender in recovery experience. Women indicated that outdoor activity supported physical and psychological recovery in equal measures and reported stronger reductions in muscle tension and pain after intensive music periods. This trend deserves attention because current evidence identifies performing arts students as group at elevated risk of musculoskeletal pain and playing-related disorders (Marko et al., 2025) with both physical load and psychosocial stress contributing to symptoms (Cruder et al., 2021; Bruyneel et al., 2024). One possible explanation involves greater sensitivity to changes or more effective use of outdoor movement for releasing accumulated tension. Even so, the cross-sectional and self-reported nature of the data limits causal interpretation (Derelioğlu et al., 2025)

In practical terms, the study supports the inclusion of simple nature-based movement, in particular, walking, in health-promotion and recovery programs for performing arts students. This idea fits with intervention-based research showing that targeted physical programs can improve musculoskeletal outcomes in this population (Azor et al., 2025). Higher education institutions may therefore benefit from promoting regular outdoor activity via recovery education, timetable design that protects time for regeneration, and wellbeing initiatives focused on sustainable self-care (Tekin & Yarar, 2021).

Conclusion

Physical activity in natural environments appears to offer recovery strategy for performing arts students, supporting mental and physical wellbeing. Walking and hiking emerged as the most common activity, underscoring the accessibility and practicality of nature-based movement within demanding study routines. Both men and women reported beneficial effects on psychological stress, while women perceived stronger relief from muscle tension and pain. These findings emphasize the preventive and restorative value of regular outdoor activity. Higher education institutions should, therefore, promote simple, sustainable forms of movement in nature to enhance recovery, protect health, and sustain long-term performance capacity in students.

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Souhrn
Studie se zaměřila na význam pohybové aktivity v přírodním prostředí pro psychickou a fyzickou regeneraci studentů múzických umění. Výzkumný soubor tvořilo 144 studentů, kteří vyplnili dotazník zaměřený na frekvenci venkovní aktivity, její formy a vnímané regenerační účinky. Nejčastější aktivitou byla chůze a turistika. Analýza ukázala statisticky významné rozdíly mezi pohlavími ve frekvenci využívání pohybové aktivity v přírodě a ve vnímaném snížení svalového napětí a bolesti, výrazněji u žen. Naopak v oblasti redukce psychického stresu se rozdíly nepotvrdily. Výsledky podporují zařazení jednoduchých forem pohybu v přírodě do podpory zdraví, regenerace a dlouhodobé výkonnosti studentů vysokých uměleckých škol.

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INCREASING THE SUSTAINABILITY OF AGRO-TOURISM ACTIVITIES WITHIN THE AGROECOLOGY CONCEPT THROUGH GIS TECHNOLOGIES

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Abstract
The sustainability of agro-tourism activities may strongly benefit from an analysis conducted within the Agroecology concept at landscape level. This approach could expand sustainable farming beyond individual fields, to entire ecosystems, optimizing biodiversity and ecological connectivity. Such an integrated analysis could be favourably performed through the implementation of GIS technologies, that would allow the view of the territory no longer as a simple static map, but as a dynamic ecosystem, where sustainable agricultural production and public recreation influence each other. Indeed, the use of GIS in this field would connect geospatial data (*i.e.*: slopes; land use; biodiversity; *etc.*) cross-referenced with socio-economic variables (*e.g.*: tourist flows; presence of agritourism facilities; *etc.*). This article presents the initial results obtained through the implementation of GIS tools, to perform a Land Suitability Analysis on a study area in Southern Italy (Basilicata Region), in which agroecology and tourism can suitably coexist. In this context, a mapping of ecosystem services was obtained, together with the planning of some excursion networks and "*Food tours*". These results, enabled an analysis of landscape fragmentation, together with an assessment of climate change resilience, which ultimately led to the creation of tools useful to help operators into diversifying their tourism offer.

Key words: Rural landscape; agro-tourism; biodiversity preservation; ecological connectivity; *Food tours*.

Introduction

In recent years, the increasing pressure of climate change, biodiversity loss, and the growing demand for sustainable rural development, have highlighted the need for innovative approaches to land management. In this context, agro-tourism has emerged as a strategic tool to support the multi-functionality of agricultural systems, combining food production, environmental conservation, and recreational activities (Picuno P., 2022). However, the sustainability of agro-tourism initiatives cannot be effectively addressed at the single-farm scale alone, as it inherently depends on broader landscape dynamics and ecological interactions (Bianchi et al., 2006).
Agroecology offers a valuable conceptual framework to address these challenges, promoting a systemic vision that integrates agricultural practices within ecological processes and territorial planning (Puglisi et al., 2024). By extending the analysis from individual farms to the landscape level, agroecology enables the enhancement of ecosystem services, the preservation of biodiversity, and the strengthening of ecological connectivity, all of which are essential for long-term sustainability (Cillis et al., 2021; Diantini, 2022).
In parallel, the advancement of Geographic Information Systems (GIS) has provided powerful tools for the spatial analysis and management of complex agro-environmental systems (Rettore et al., 2023; Statuto et al., 2016). GIS technologies allow the integration and visualization of heterogeneous datasets, combining biophysical variables—such as topography, land use, and ecological indicators—with socio-economic factors, including tourism flows and the distribution of rural infrastructures. This integrated approach transforms the territory into a dynamic system, where agricultural production and tourism activities may interact and co-evolve (Moore et al., 2018; Yu, 2025).
This study explores the integration of agroecology and sustainable tourism in a study area – the whole Basilicata Region (Southern Italy) - through the application of GIS-based spatial analysis. The aim is to identify territorial patterns and support the planning of agro-tourism activities, consistent with landscape conservation, ecological connectivity, and local cultural heritage.

Material and methods

The analysis was carried out in the Basilicata Region (Southern Italy), where territorial diversity, agricultural traditions of rural communities and natural resources, offer suitable conditions for the integration of agroecology and tourism. By applying spatial analysis in a GIS environment, the present study sought to identify homogeneous geographical areas and support the planning of agro-tourism

activities, consistent with landscape protection and local development. Agro-tourism - often referred to as “farm holidays” - has by now become a cultural phenomenon that is spreading to many countries in the world, particularly in Europe, thanks to the great attraction the countryside holds for an increasingly urbanized society. By applying land suitability analysis and ecosystem services mapping in this study area, the present analysis seeks to provide decision-support tools for improving territorial planning and enhancing the diversification strategies for agro-tourism operators.
For this purpose, the territory of the Basilicata region has been analyzed as divided into the following four geographical areas, characterized by similar physical and cultural features:

- The ***Valdagri-Lagonegrese area***, a intensively forested area, which preserves an archaeological heritage, telling of successive settlements in the area dating back to the Iron Age and the archaic era;
- The geographic region of ***Metapontino***, which preserves in its name its founding by the Greeks, and which is currently known as the “*California* of Southern Italy”, for its flourishing agriculture (extensive vegetable cultivation);
- The area of the ***mountains and hills of Matera***, in which agriculture remains the principal productive sector, with a prevalence of arable crops (mainly barley), olive cultivation, and sheep, goat, pig and cattle breeding. The rural identity of this area is even embodied in its particular farm building style;
- The geographic area of ***Potentino-Vulture***, consisting of the „Vulture“ area, which presents an exceptional natural heritage, protected by parks and nature reserves, containing rare and interesting flora and distinctive plant species, along with fauna noted for its wide variety of birds.

Results

A GIS tool (QGIS) aimed to analyzing and emphasizing the restoration of biodiversity has been here used to implement the Agroecology concept. In this way, the main ecological corridors which intersect with public recreation areas have been mapped and designed. Fragmentation of habitat has been so analyzed, to determine where hedgerows, buffer strips, or agroforestry plots should be placed, to connect isolated patches of wilderness. The management of buffer zones is therefore possible, enabling to establish "soft" boundaries between sensitive protected areas and recreational paths, ensuring that human activity (hiking, biking) does not disturb pollination reservoirs or nesting sites. This, creates a "*working landscape*" that protects native species, while providing a scenic backdrop for public enjoyment. Finally, by integrating statistical data (ISTAT, 2024), thematic maps have been also generated, to illustrate the relationship between the distinctive characteristics of the four identified areas (Fig. 1) and the spatial distribution of agritourism accommodations.

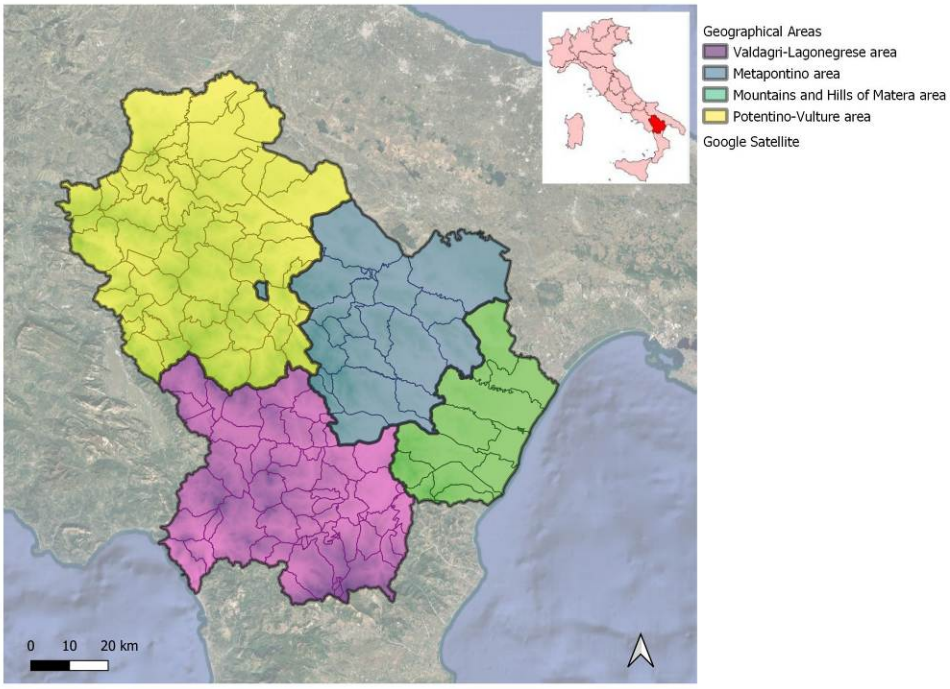

Fig. 1: Identification of the main geographical areas of the Basilicata Region considered in the GIS-based analysis

As it shown in Figure 2, the greatest concentration of agro-tourism facilities is located in the Mountain and hills of Matera, along the Ionian coast and in Pollino area (Valdagri-Lagonegrese area). The area surrounding the UNESCO Site of Matera mostly shows a strong potential for the integration of agritourism, trekking, and cultural heritage, even due to the presence of the „Murgia Materana“ natural Park, the „Sassi“ districts, and a well-recognized rural identity. These features make this area particularly suitable for the development of landscape-based and food-related tourism activities.

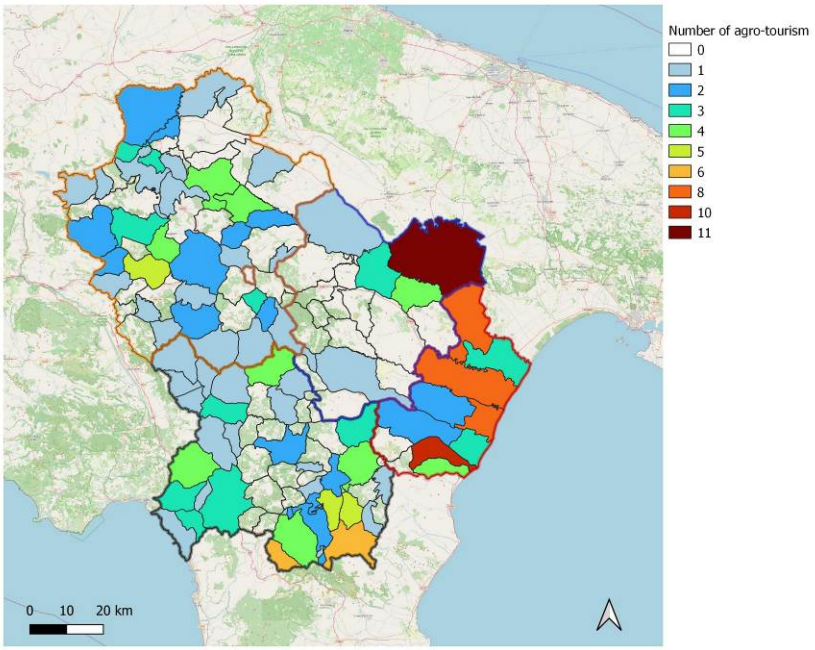

Fig. 2: Distribution of agro-tourism facilities by Municipality in Basilicata Region, based on ISTAT 2024 data

Discussion

Landscape protection is influenced by human perceptions of beauty. GIS technologies facilitate objective modeling of subjective aesthetic values, aiding in viewshed analysis and *Landscape Character Assessment* (LCA), to preserve the countryside's "visual integrity." This protection supports ecotourism and enhances visitors' psychological well-being. Agroecology promotes public engagement with food sources, while GIS aids in creating „*Agri-Recreational*“ networks through Optimized Path Routing, ensuring trails which enhance visitor experience, by showcasing diverse crop cycles and avoiding sensitive areas. It also facilitates „*Service Infrastructure Placement*“ for educational signs and visitor centers, based on environmental factors, and converts farms into "*open-air classrooms*" to enhance awareness of sustainable food systems. The potential of combining agroecology and GIS-based spatial analysis to support the sustainable development of agro-tourism in Basilicata has also revealed as the spatial distribution of agritourism facilities is closely related to the environmental, cultural, and agricultural identity of the different geographical areas. In particular, the Matera area, the Metapontino plain, and the mountainous areas of Pollino and Val d'Agri appear as particularly relevant contexts for the diversification of rural tourism activities. Although preliminary, the proposed approach confirms the usefulness of GIS tools for identifying territorial patterns and supporting agro-tourism planning at landscape level. Spatial Multi-Criteria Evaluation (SMCE) through GIS addresses also user conflicts in public recreation, by balancing the needs of agricultural machinery, wildlife, and tourists. GIS enables prioritization of factors like biodiversity protection and recreational access, resulting in Zoning Maps, that designate areas for active recreation and "*quiet zones*" for agroecological practices. This proactive planning fosters social sustainability between local farmers and visitors. GIS serves also as a monitoring tool to assess landscape resilience, integrating remote-sensed data to track agroecosystem health and recreational use, allowing for adaptive management to mitigate issues like soil compaction and erosion.

Conclusion

GIS has revealed as a powerful tool, able to transform the goals of agroecology into a tangible spatial strategy. By layering environmental health, visual beauty, and human accessibility, GIS ensures that landscape protection is not just about "*keeping people out*", rather about inviting them into a resilient,

productive, and beautiful ecosystem. Through these tools, public recreation becomes a catalyst for supporting agroecological transitions, rather than a threat to them. The integration of statistical data within a GIS environment proved to be a vital decision-support tool for territorial planning and identifying strategic clusters. By mapping ecosystem services and using iterative geodesign, this research demonstrated how rural communities can achieve adaptive resilience. In conclusion, balancing economic gains with environmental conservation through spatial analysis allows agro-tourism to evolve into a multifunctional system, that preserves biodiversity while offering authentic, sustainable visitor experiences.

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Souhrn

Propojení agroekologie s technologií GIS umožňuje udržitelný rozvoj agroturistiky prostřednictvím analýzy krajiny jako dynamického ekosystému, jak dokládá případová studie z italské Basilicaty. Tento přístup umožňuje určit vhodnost půdy, zmapovat ekosystémové služby a poskytuje nástroje pro odolnost vůči klimatickým změnám a diverzifikaci turistické nabídky. Zmapováním ekosystémových služeb a uplatněním iterativního geodesignu tento výzkum ukazuje, jak mohou venkovské komunity dosáhnout adaptivní odolnosti. Studie dochází k závěru, že vyvážení ekonomického růstu s ochranou životního prostředí prostřednictvím prostorové analýzy umožňuje agroturistice fungovat jako udržitelný systém, který zachovává biologickou rozmanitost a zároveň nabízí autentické zážitky pro návštěvníky.

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INDUSTRIAL RUINIFORM LANDSCAPES BETWEEN DEGRADATION AND TOURISM RECONVERSION: CASE STUDY THE STEELWORKS OF CĂLĂRAȘI MUNICIPALITY, ROMANIA

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Abstract
Post-socialist cities in Central and Eastern Europe are characterized by extensive industrial legacies and rapid post-1990 deindustrialization, resulting in brownfields, demographic decline, and functional restructuring. This paper investigates the municipality of Călărași (Romania) as a representative case of a medium-sized industrial city undergoing post-industrial transition. The study aims to assess the potential of industrial heritage—particularly the former steel platform and associated canal–port infrastructure—for tourism development.
A mixed-method approach is employed, combining desk-based research, spatial analysis, demographic data, and comparative benchmarking with Central European cases (Dolní Vítkovice, Ostrava; Nowa Huta, Kraków). The results indicate that Călărași exhibits a significant industrial heritage base, including a large-scale anchor site (approximately 650 ha), alongside a demographic decline of approximately 24% between 1992 and 2021, consistent with patterns of urban shrinkage. However, the absence of formalized interpretive infrastructure and institutional coordination limits its current tourism potential.
The paper argues that industrial heritage tourism can function as a complementary strategy for urban regeneration and identity reconstruction, provided that it is supported by safety management, interpretive frameworks, and integration into broader territorial strategies

Key words: industrial heritage; post-socialist cities; urban shrinkage; industrial tourism; territorial regeneration.

Introduction

The transformation of post-socialist cities represents a major theme in contemporary urban and economic geography. Following the collapse of centrally planned economies, many industrial urban systems in Central and Eastern Europe experienced rapid restructuring, leading to widespread deindustrialization, infrastructural abandonment, and demographic decline (Stanilov, 2007; Turok and Mykhnenko, 2007). Within this context, former industrial areas have frequently evolved into brownfields or ruinous landscapes, generating socio-economic challenges while simultaneously offering new opportunities for heritage-based redevelopment. Increasing attention has been paid to the role of industrial heritage as a resource for tourism-led regeneration, particularly in regions with strong industrial identities (Edwards and Llurdés, 1996; Hospers, 2002). The municipality of Călărași provides a relevant case study of a medium-sized post-socialist industrial city facing structural decline. Its large-scale steel platform and associated infrastructure continue to shape the urban landscape, despite significant functional contraction. This paper aims to (i) identify key industrial heritage assets, (ii) evaluate their tourism potential, and (iii) situate the case within a comparative Central European framework.

Material and methodsResearch Design

The study adopts a mixed-method approach, integrating qualitative and quantitative data sources in order to ensure methodological triangulation and analytical robustness (Creswell, 2014).

Data Sources

The analysis is based on:

- Secondary data, including media reports and historical documentation (Adevărul, Digi24, Jurnalul);
- Demographic data from national censuses (1992–2021);
- Spatial data used for the identification and classification of industrial heritage assets. Demographic trends indicate a steady population decline from 76,952 inhabitants in 1992 to 58,211 in 2021, corresponding to an overall decrease of approximately 24%.

Spatial Inventory and Classification

A multi-criteria framework was developed to assess industrial sites according to:

- Functional status (active, partially active, abandoned);

- Accessibility (open, restricted, unsafe);
- Heritage value (high, medium, low);
- Integration potential into tourism routes;
- Safety risk levels.**Comparative Analysis**

A benchmark analysis was conducted using two well-documented Central European cases: Dolní Vítkovice (Ostrava) and Nowa Huta (Kraków). The comparison focuses on governance structures, safety management, interpretive infrastructure, branding strategies, and integration into tourism networks (Hospers, 2002; Xie, 2015).

Fig. 1: The ruins of the power battery of the steel plant in Călărași

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Fig. 2: The ruins of the steel production laboratories at the Călărași Steel Plant

Survey Design

A standardized questionnaire (n ≈ 200–400) was developed to assess local perceptions of industrial heritage, willingness to engage in tourism activities, perceived risks, and preferred tourism products. Although results are not statistically reported here, the instrument provides a framework for future empirical validation.

Results

Industrial Heritage Assets

The analysis identifies the former steel platform as a primary anchor site with significant spatial and symbolic value. Covering approximately 650 hectares, the platform is complemented by a canal–port system that constitutes a distinctive territorial asset. Secondary industrial sites, including former food-processing facilities, contribute to the diversification of the industrial landscape and support the potential development of multi-site tourism routes.

Fig. 3: The ruins of a drawbridge at the water cooling plant at the Călărași Steel Plant.

Demographic Dynamics

Population data reveal a sustained decline between 1992 and 2021, confirming the classification of Călărași as a shrinking city. This demographic contraction is consistent with broader post-industrial restructuring processes observed across Central and Eastern Europe (Turok and Mykhnenko, 2007).

Comparative Insights

The comparative analysis highlights significant differences between Călărași and benchmark cases:

- In Ostrava, the Dolní Vítkovice complex has been successfully converted into a curated heritage site through infrastructure securitization, guided tours, and cultural programming;

- In Kraków, Nowa Huta has been integrated into tourism circuits through narrative-based interpretation of socialist urbanism and industrial history.

In contrast, Călărași lacks formalized visitor infrastructure, coherent interpretive strategies, and institutional coordination mechanisms.

Discussion

The findings support the argument that industrial heritage can serve as a viable resource for tourism development in post-socialist contexts. However, the transition from ruinous landscape to curated heritage requires a set of enabling conditions.

First, **accessibility and safety management** are essential prerequisites for visitor engagement. Industrial sites often present significant risks, necessitating controlled access and infrastructure investments.

Secondly, the development of **interpretive frameworks** is crucial for transforming industrial remnants into meaningful cultural assets. As demonstrated in Nowa Huta, narrative construction plays a central role in shaping visitor experience and reinforcing place identity.

Thirdly, the integration of sites into **thematic tourism networks** enhances territorial cohesion and economic viability by creating multi-destination experiences.

The case of Călărași illustrates an intermediate stage between abandonment and structured valorization. Its unique canal–port infrastructure provides a distinctive opportunity for developing route-based tourism products, including a potential fluvial component not present in many comparable cases.

Fig. 4: The ruins of a vessel from the water cooling plant at the Călărași Steel Plant

ConclusionThis study contributes to the literature on post-industrial urban transformation by examining the potential of industrial heritage tourism in a medium-sized post-socialist city. The findings indicate that Călărași possesses significant material and symbolic assets, but remains at an early stage of tourism development.

Industrial heritage tourism should be understood as a **complementary**, rather than substitutive, strategy for urban regeneration. Its successful implementation depends on institutional capacity, strategic planning, and integration into broader territorial policies.

Future research should focus on empirical validation through survey data, as well as on the development of spatial planning scenarios for the integration of industrial heritage into regional tourism systems.

Fig. 5: Recreational area converted from the ruins of the Călărași Steel Plant

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Souhrn

Tato studie zkoumá životaschopnost cestovního ruchu zaměřeného na průmyslové dědictví v Călărași, postsocialistickém středně velkém městě, a dochází k závěru, že ačkoli zde existují významné hmotné i symbolické hodnoty, rozvoj v této oblasti v současné době stagnuje. Pro mezinárodní literaturu má tento výzkum mimořádný význam, protože přesouvá pozornost od dobře zdokumentovaných západních měst k jedinečným výzvám menších východoevropských měst. Kriticky hodnotí cestovní ruch zaměřený na kulturní dědictví jako doplněk, nikoli jako úplnou náhradu za zaniklý průmysl, a zdůrazňuje, že úspěšná regenerace souvisí s institucionální kapacitou a regionální integrací. Představuje nezbytný nástroj pro novou městskou politiku založenou na datech.

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INFLUENCE OF RESILIENT MODULUS AND SOIL SHEAR PARAMETERS ON THE DESIGN OF FOREST AND RURAL PAVEMENTS

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Abstract
The recreational and touristic potential of landscapes depends not only on their natural components, but also on the functionality and safety of the associated road infrastructure, particularly forest and rural roads. This study evaluates, from an engineering perspective, the soils and aggregates used in the structural layers of such pavements, with special emphasis on their deformational and strength properties, which are essential for proper design.
The analysis focuses on determining the resilient modulus through laboratory cyclic loading tests that realistically simulate traffic and service conditions. This parameter is considered key for assessing the bearing capacity and long-term stability of unbound granular layers. In parallel, cohesion and internal friction angle obtained from direct shear tests are analysed and incorporated into numerical modelling using the finite element method.
The results highlight the need for a combined evaluation of strength and deformational properties to ensure pavement durability, reduce structural damage, and minimize erosive processes, thereby contributing to the sustainable management of both infrastructure and landscape.

Key words: Low Volume Road; Resilient Modulus; Finite elements; Cyclic CBR; Shear Parameters.

Introduction

Low Volume Roads (LVR) play an essential role in the territorial articulation of rural and forest areas, where they form the basis of economic, social and environmental connectivity. These infrastructures provide access to agricultural and forestry operations, facilitate natural resource management and, increasingly, support recreational and tourist activities in the natural environment. Although their traffic volume is low compared to the main networks, their design cannot be considered simplified, as the geotechnical and environmental conditions in which they are located are often particularly demanding.
In the context of forest and rural roads, the mechanical behaviour of the subgrade soil is of crucial importance. Unlike conventional roads, where design typically relies on more robust structures and thicker pavement layers, on LVRs structural performance depends largely on the bearing capacity and deformation response of the natural ground. In this context, the cyclic resilient modulus (MR) has established itself as a key parameter for characterising the elastic response of the soil under repeated loads, providing a more realistic representation of the service conditions to which the pavement is subjected.
However, structural analysis cannot be limited only to resilient behaviour. The soil's shear strength parameters, obtained from shear and consolidation tests, are essential for assessing the overall stability of the system, particularly in environments with significant slopes. The slope directly influences the stresses that the ground must withstand; therefore, if the soil does not have sufficient shear strength, it could collapse. This relationship makes it essential to calculate the parameters of cohesion, angle of internal friction and edometric modulus for the correct characterisation of the material and assessment of the soil's resistance to shear stresses. At the same time, only this set of parameters is sufficient for numerical and simulation analyses when using finite element method (FEM) tools (Ševelová L., Kozumplíková A. 2010)
For all these reasons, understanding the combined influence of the resilient modulus and soil shear parameters on the design of forest and rural road pavements is essential for optimising construction solutions, improving infrastructure durability, and ensuring adequate safety and service conditions, with due consideration and respect for the impacts on surrounding ecosystems (Ševelová, L., Arias, P.F., Šlezingr, M. 2020) This paper addresses precisely this interaction, proposing an integrated analysis that will enable progress towards more efficient and sustainable designs tailored to the specific characteristics of low-volume roads in rural and forest environments.

Material and methods

Both materials represent characteristic subgrade conditions in the given region for the construction of Low Volume Roads (LVR) and were therefore analysed in accordance with the criteria established by

the American Association of State Highway and Transportation Officials (AASHTO). This study therefore focuses on assessing the influence of the resilient modulus and shear parameters of these materials in the design of forest and rural road pavements.
To determine the properties of the materials used, several classification tests have been carried out in accordance with European and Czech standards. Moisture content has been determined by the moisture test (CSN EN ISO 17892-1), the particle size distribution of the material has been determined by granulometric and aerometry tests (CSN EN ISO 17892-4), and the plasticity of the soil has been determined by the Atterberg limit test (CSN EN ISO 17892-12). These tests have made it possible to classify the materials on the basis of their particle size distribution and plastic properties; these classifications have been carried out in accordance with the Unified Soil Classification System (USCS) (CSN EN ISO 14688-2). In addition, a Proctor standard test was carried out to determine the optimum moisture content and maximum dry density of the materials (CSN EN ISO 13286-2).
With regard to the mechanical behaviour of the material, the resilience modulus, which describes the soil's elastic response to repeated loads, has been determined using the cyclic California Bearing Ratio (CBR) test (Ševelová, L., Florian, A., Žák, J. 2021) (De Zarate Gorka O., Ševelová, L. 2015). This test is a variation of the standard CBR test (CSN EN ISO 13286-47), in which the strength and deformability of the soil under repeated loads are assessed. Unlike the conventional CBR, where the applied load is static, in this test the soil is subjected to cycles of loading and unloading, in this case 210 kPa, in order to simulate real traffic conditions, this CBR test is a patented methodology developed by Mendel University and is exclusively conducted in its laboratory facilities (PV 304642). In addition to the resilience modulus, this test also yields parameters such as resistance to permanent deformation or the accumulative deformation of the material.

In addition, consolidation and shear tests have been carried out on the selected materials in order to determine the cohesion, angle of internal friction and edometric modulus. To carry out these tests, the material must first be consolidated by applying a vertical load of 25 kPa, 50 kPa or 100 kPa for 1 hour and 10 minutes, and the vertical displacement data is recorded to determine the consolidation. Once the consolidation test is complete, the shear test must be carried out, in which a shear rate of 0.05 mm/min is applied to the consolidated sample until a total shear displacement of 20 mm is reached; this test provides the cohesion and internal friction angle of the material.

Results

The classification results indicate that Material 1 is a medium-plasticity clay (F6-CI) and Material 2 is a sandy clay (F3-MS), which have an optimum moisture content of 20.8% for the F6-CI material and 12.8% for the F3-MS material.
On the one hand, tests were carried out to determine the modulus of resilience (MR in MPa) and the deformations of material F3-MS under different moisture conditions, its tests were carried out at the optimum moisture content (w_opt in %) and another 2% higher than the optimum. The next graph (Fig. **3**) shows four different results: the one labelled 'min' is the less compacted side, which has received 56 impacts, the one labelled 'max' is the more compacted side, which has received 56 impacts on three occasions and on each of these faces of the sample, 20 and 40 loading and unloading cycles were carried out. Furthermore, the moisture and MR limits of the tests carried out can also be seen; in the case of moisture content, it can be seen that this ranges from 11.09% to 16.61%, whilst the MR values range between 25 MPa and 400 MPa, indicating that although the variation in a material's moisture content is low, 5.5% in this case, the MR values can vary significantly depending on the soil moisture content.
In the next graphs, it can be observed the dependence of Resilience Modulus (MR_max and MR_min) on moisture (Fig. **4**a) and dry density (Fig. **4**b), of material F3-MS.
In this case, it can be seen that the Resilience Modulus decreases significantly in tests conducted at moisture contents of approximately 15% compared to those carried out at moisture contents of around 13%, indicating a loss of elastic recovery under conditions of higher moisture (Fig. **4**a). The highest MR values are observed at around 12%, indicating the optimum moisture content for achieving maximum soil strength. Higher MR values are obtained on the more compacted side of the samples, but no significant differences are observed between the trends on the less and more compacted sides of the sample. In the case of tests carried out over 20 cycles, the results obtained are very similar to those in this case.
The modulus of resilience values increases as the dry density increases, with the highest MR values occurring at around 1840 kg/m³ (Fig. **4**b), suggesting that this could be the optimum density at which the material exhibits the best mechanical properties.

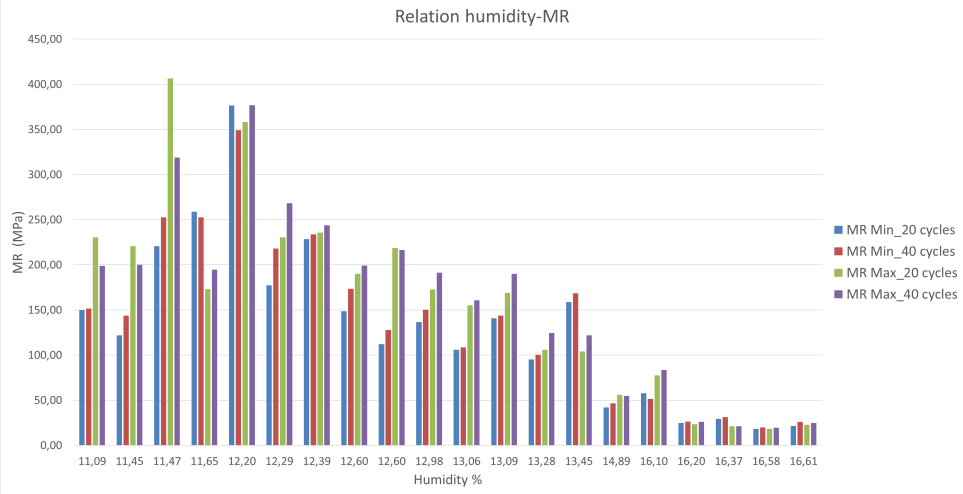

Fig. 3: Influence of humidity in MR in all cases

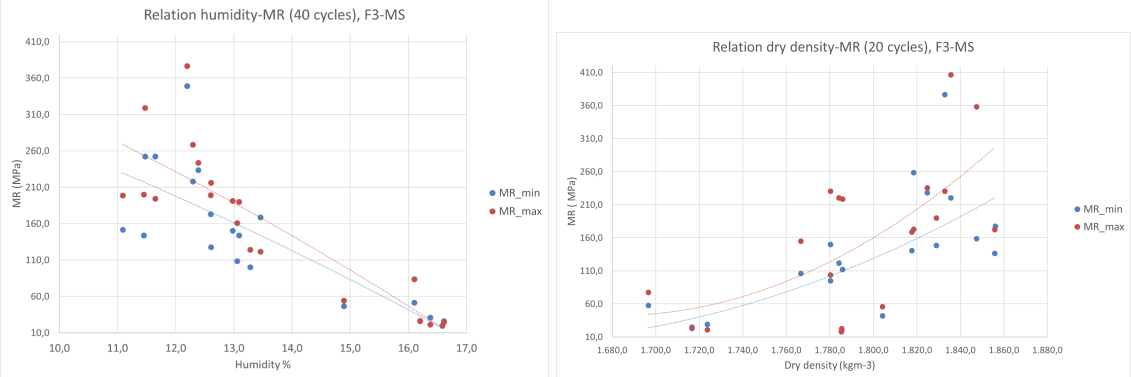

Fig. 4a: Dependence of MR on moisture after 40 cycles, b: Dependence of MR on dry density after 20 cycles

In the other hand, consolidation and shear tests were carried out to determine the cohesion (c), the angle of internal friction (º) and the edometric modulus (Eoed in MPa) of the F6-CI material. Firstly, the relationship between the edometric modulus and moisture content was analysed (Fig. **5**), and it can be seen that it tends to decrease as moisture content increases, indicating that an increase in the material's moisture content enhances its consolidation capacity. Furthermore, a more pronounced trend is observed when greater loads are applied to the sample.

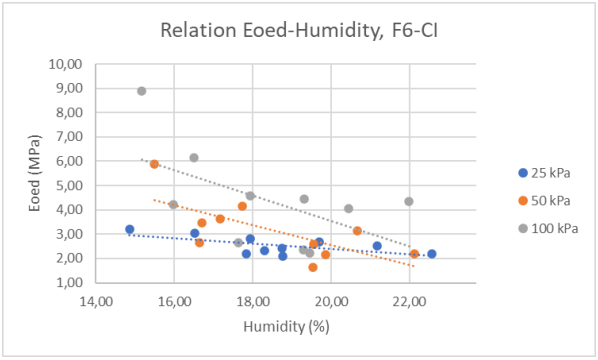

Fig. 5: Relationship between the edometric modulus and moisture content

Subsequently, the influence of moisture on the material's cohesion was analysed (Fig. **6**a). It can be seen that as moisture content increases, cohesion also increases, showing an upward trend; this indicates that, in this case, an increase in the material's moisture content enhances the bonding strength between the particles.

Finally, the relationship between moisture content and the material's angle of internal friction was analysed (Fig. **6**b). In this case, a clear downward trend in the values of the angle of internal friction can be observed as moisture content increases, indicating that the higher the moisture content of the material, the lower the friction between its particles.

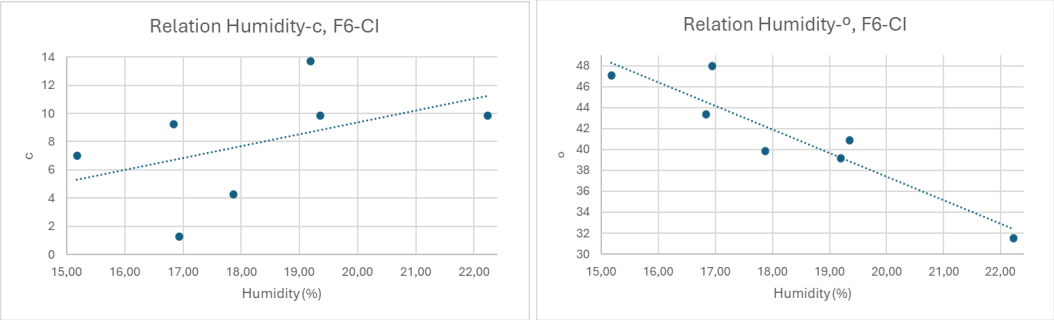

Fig. 6a: Influence of moisture on the material´s cohesion, b: Relationship between moisture content and the material's angle of internal friction

Conclusion

For the design and construction of high-quality and durable Low Volume Roads (LVR), which are used not only for transportation but also for recreational and leisure activities, the use of local natural materials is appropriate. However, these materials are highly sensitive to moisture conditions and the degree of compaction, which fundamentally affects their mechanical behaviour. As demonstrated by the results of this study, all evaluated parameters—particularly the resilient modulus, the angle of internal friction, and the edometric modulus—respond to increasing moisture content with a significant decrease in their absolute values. This trend clearly indicates a reduction in the bearing capacity of the material and a deterioration of its deformation response under higher moisture conditions. Conversely, an optimal moisture regime and adequate compaction lead to improved mechanical properties and enhanced structural stability. These findings highlight that, in LVR design, it is essential to carefully consider the moisture conditions of the subgrade and ensure appropriate compaction practices in order to achieve the required durability, safety, and performance of the pavement under real service conditions.

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Souhrn
Rekreační a turistický potenciál krajiny závisí nejen na jejích přírodních složkách, ale také na funkčnosti a bezpečnosti související silniční infrastruktury, zejména lesních a venkovských komunikací. Tato studie z inženýrského hlediska hodnotí půdy a kamenivo používané ve konstrukčních vrstvách těchto vozovek, přičemž klade zvláštní důraz na jejich deformační a pevnostní vlastnosti, které jsou nezbytné pro správný návrh.
Analýza se zaměřuje na stanovení modulu pružnosti pomocí laboratorních cyklických zátěžových zkoušek, které realisticky simulují provozní a provozní podmínky. Tento parametr je považován za klíčový pro posouzení únosnosti a dlouhodobé stability nespojených zrnitých vrstev. Souběžně s tím jsou analyzovány soudržnost a úhel vnitřního tření získané z přímých smykových zkoušek a začleněny do numerického modelování pomocí metody konečných prvků.
Výsledky zdůrazňují potřebu kombinovaného hodnocení pevnostních a deformačních vlastností s cílem zajistit trvanlivost vozovky, omezit poškození konstrukce a minimalizovat erozivní procesy, čímž přispívají k udržitelnému řízení infrastruktury i krajiny.

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INNOVATION TRANSFER IN ECOTOURISM: THE TANZANIAN MANAGEMENT MODEL AND ITS APPLICABILITY IN SLOVAKIA

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Abstract
Ecotourism in Tanzania represents an inspiring model for Slovakia on how to transform nature conservation into a primary pillar of the national economy and regional development. Tanzania has successfully implemented principles that channel revenue directly to local communities and the maintenance of protected areas. Lessons from Tanzanian practice for Slovakia are evident in the economic value of 'untouched' wilderness. Tanzania demonstrates that preserving ecosystems yields higher long-term value than their industrial exploitation. A direct link to local communities is also crucial. Cultural tourism programs in Tanzania allow visitors to experience the lives of local inhabitants, with profits directly funding the development of village schools and infrastructure. Furthermore, the regulation of visitor numbers through higher added value is essential; Tanzania's long-standing focus on quality over quantity ('high value, low impact') protects sensitive areas from over-tourism. Ecotourism in Tanzania is not merely about observing nature but about understanding ecological cycles, which enhances the environmental awareness of tourists. The study data were obtained through participant observation during a 45-day mobility in Tanzania, supplemented by semi-structured interviews with local tourism managers. In Slovakia, these best practices from Tanzania could manifest in social impact, biodiversity conservation, and the enhancement of ecosystem services.

Key words: sustainable development, community-based tourism, biodiversity, visitor management

Introduction

Ecotourism integrates biodiversity conservation with community prosperity, transforming protected areas into active pillars of regional development (Samal, Dash, 2022). Tanzania leads in this field through its "High Value, Low Impact" model, which utilizes strict visitor regulation and participatory management to ensure direct tourism benefits for local residents (Honey, Gilpin, 2009).
Conversely, Slovakia struggles with unsustainable resource exploitation (MŽP SR, 2025; Považan et al., 2020), habitat fragmentation, and minimal local involvement in tourism profits (ŠOP SR, 2023a; CKO, 2024). Adapting Tanzanian innovations could redefine Slovak wilderness as a high-value economic asset surpassing returns from industrial landscape exploitation (Mgonja et al., 2015; Gajić et al., 2025). This study utilizes participant observation and expert interviews to analyze Tanzanian mechanisms and propose strategic solutions for the socio-economic stability of Slovakia's rural regions.

Material and methods

The research was conceived as a comparative case study focused on the transfer of innovations in ecotourism between selected UNESCO biosphere reserves (BRs) in Tanzania (East Usambara, Ngorongoro) and Slovakia (Poľana). Primary data were obtained during a 45-day scientific mobility in Tanzania (Erasmus+ project) using the method of participant observation of interactions between tourists, guides and communities. The knowledge obtained was subsequently compared with the current status and care programs for BR Poľana (ŠOP SR, 2023b; NCAA, 2014; MNRT, 2001). Data synthesis took place in the form of a SWOT analysis, which identified the potential for the application of Tanzanian innovations, as well as institutional and socio-economic barriers to their transfer. The resulting comparison reflects the specifics of these sites as "world laboratories", where the balance between biodiversity protection and the prosperity of the local population is a priority.

Results

Quality Over Quantity
A key innovation is the transition to "High Value, Low Impact" management. The Tanzanian reserves of Ngorongoro and East Usambara have successfully used this model for decades to protect nature

while financing local communities through exclusive experiences. This approach represents an opportunity to increase revenue from a smaller number of visitors, thereby enhancing conservation efficiency without the need for massive infrastructure that would degrade the landscape.

Fair Revenue Sharing

Another vital element is the institutionalized Revenue Sharing system, where a fixed portion of entry fees goes directly to adjacent villages for infrastructure development. Linking ecotourism profits directly to municipal projects would create a strong incentive for local governments to actively protect the landscape, which serves as the primary draw for tourists.

Tradition-Based Experiences

Cultural Tourism Programs (CTP) in Tanzania effectively integrate ethnographic heritage with nature conservation. The innovation lies in moving from passive agritourism to participatory programs where visitors become active participants in traditional ecological cycles. This not only diversifies rural income but also raises environmental awareness through authentic education.

Low-Impact Accommodations

Tanzanian practice also offers inspiration for low-infrastructure accommodation, such as glamping or eco-lodging, which utilizes natural materials and renewable energy sources. They allow for the sensitive opening of the reserve's peripheral areas, strengthening the socio-economic impact on the region while respecting the carrying capacity of the natural environment.

Guides as Nature Interpreters

A fundamental pillar is the transformation of environmental education into an attractive product. Here, professional guides function not just as navigators, but as certified "interpreters" of the ecosystem. In Slovakia, this offers an opportunity to replace static information boards with "living education" in the field. BR Poľana is already a leader in this regard, turning expert-led tours into an exclusive service that naturally fosters responsible behavior among tourists.

Visitor Involvement in Conservation

Innovation is also evident in the direct involvement of tourists in nature protection projects (Conservation Tourism), such as species monitoring. Implementing similar programs in Slovakia, such as volunteer weekends focused on meadow management or wetland protection, would create a new target group of conscious visitors. This approach moves environmental education from theory to practice, building a deep emotional connection to the locality and social responsibility.

Science via Mobile Applications

The synergy between scientific knowledge and local experience opens space for modern digital interpretation. Through "citizen science" mobile applications, tourists can record species sightings or habitat conditions during their hikes. This integration of technology and tourism provides valuable data for protected area management while educating the public about the importance of biodiversity and ecosystem services in real-time.

Professionalization and Community Rangers

A fundamental element is the transformation of nature guards from a purely repressive force into educated interpreters and guides. By involving local residents in a system of "community rangers," social acceptance of conservation measures increases and new jobs are created. Thanks to their local knowledge, these workers effectively resolve conflicts and serve as a vital link between state administration and local communities.

Technology and Smart Management

Modern management utilizes digital cartography and real-time monitoring, involving rangers directly in applied research. Digital platforms for "smart reservations" allow for the dynamic regulation of visitor numbers in critical areas and the dispersal of tourist pressure. This prevents habitat degradation and the disturbance of wildlife in overcrowded tourist centers.

Green Initiatives and Micro-financing

A strict zero-waste tourism policy and plastic bans encourage the growth of local circular businesses and the deep ecological transformation of services. Another innovative feature is the use of voluntary conservation fees integrated directly into product prices. This "direct micro-financing" model creates a stable flow of funds for local projects, turning visitors into active investors in the restoration of the landscape.

The SWOT analysis evaluates the applicability of the Tanzanian ecotourism management model (based on experiences from East Usambara and Ngorongoro) within the context of the Poľana Biosphere Reserve (Table 1).

Tab. 1:

Strengths	Weaknesses
Existence of unique ecosystems and "untouched" wilderness as an economic asset.	Prevailing model of mass tourism with high anthropogenic load.
Strong tradition of rural management and crafts (potential for cultural tourism). High expert and scientific base in the field of biodiversity and ecosystem services.	Passive approach to agritourism and lack of participatory programs for visitors. Prevalence of the repressive function of nature guards over educational and guiding functions.
Developed network of protected areas and biosphere reserves.	Conflicts between nature conservation and the economic interests of local communities.
Opportunities	**Threats**
Transition to the "High Value, Low Impact" model – higher revenues with fewer tourists.	Resistance of the local population to nature conservation due to lack of direct benefits.
Introduction of Revenue Sharing to finance the development of municipalities within the parks.	Continued massive construction of hotel infrastructure at the expense of natural values.
Professionalization of rangers into certified interpreters and ecotourism guides.	Abuse of the ecotourism concept (greenwashing) without a real impact on conservation.
Implementation of Citizen Science through digital platforms and mobile applications.	Environmental degradation of the area due to unsuccessful regulation of visitor numbers.
Development of low-infrastructure accommodation (eco-lodging and glamping).	Lack of political will to change the institutional setting of park management.

Discussion

Implementing the Tanzanian "High Value, Low Impact" model offers a solution to anthropogenic pressure in exposed Slovak locations such as the Tatras or Slovak Paradise (ŠOP SR, 2023a). While Tanzanian Revenue Sharing systems motivate communities to protect biodiversity (Nelson, 2012), Slovak national parks still face the barrier of being perceived as restrictive zones (IEP, 2022). The key to success is a shift from mass sports-oriented use of the mountains toward ecotourism, where visitors directly finance landscape regeneration through exclusive guided experiences (Spenceley et al., 2017). However, essential conditions include the institutional reform of nature guards into educated interpreters and technological adaptation that views innovation as a tool for prestige, not just cost savings. Ngorongoro serves as a warning that without carrying capacity regulation and transparency, there is a risk of marginalizing community interests and degrading ecotourism into a mere marketing label for mass exploitation (Gayo, Katonga, 2025). Successful application of Tanzanian know-how thus requires a systemic management change prioritizing the protection of ecosystem services (UNESCO, 2024).

Conclusion

The Tanzanian model offers a comprehensive framework for the systemic transformation of Slovak protected areas, particularly the Poľana Biosphere Reserve, moving from mass tourism toward sustainable ecotourism based on quality and exclusivity. The key to success lies in a paradigm shift that views nature conservation as a strategic economic asset, where regional prosperity is achieved through direct revenue sharing with communities, the professionalization of personnel in landscape interpretation, and the minimization of the ecological footprint. The implementation of these innovations—ranging from "high value, low impact" strategies to participatory science and zero-waste policies—represents a path toward harmonizing biodiversity protection with rural socio-economic development, enabling Slovak reserves to become modern pillars of sustainability within the European context.

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Souhrn
Zjištění potvrzují, že slovenský management chráněných území může dosáhnout vyšší efektivity přijetím tanzanského modelu, který upřednostňuje kvalitativní parametry před kvantitativními. Pokud bude masový turismus nahrazen exkluzivními službami a bude zavedeno spravedlivé sdílení zisku s obcemi, ochrana divoké zvěře přestane být vnímána jako překážka a stane se motorem regionálního rozvoje. Tento přístup, postavený na profesionálních průvodcích a citlivé infrastruktuře, může proměnit přírodní dědictví ve stabilní ekonomický aktivum, které chrání ekosystémy a zároveň zajišťuje prosperitu místních komunit.

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INTEGRATED APPROACH TO THE USE OF GEOHERITAGE AND GEODIVERSITY IN GEOTOURISM

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Abstract
This paper investigates the role of geoheritage and geodiversity in the context of geotourism and proposes an integrated approach to their sustainable utilisation within regional development frameworks. Existing research is often fragmented, primarily focusing on geosite assessment, geopark development, and interpretation strategies. Geoheritage is defined as the significant component of geodiversity that constitutes the abiotic foundation of landscapes and ecosystems, bearing scientific, educational, cultural, and socio-economic importance. Geotourism is conceptualised as a place-based form of tourism that links Earth's heritage with biodiversity, cultural landscapes, and local identity. The study introduces the ABC framework (Abiotic–Biotic–Cultural) as a conceptual approach for synthesising these dimensions. It underscores a paradigm shift from site-specific approaches toward territorial systems and highlights the critical need for coordinated management and interpretation to promote sustainable geotourism development.

Key words: geoheritage, geodiversity, geotourism, ABC framework, sustainability

Introduction

Geoheritage, geodiversity and geotourism have become central themes in both academic research and territorial development. Tourism increasingly recognises landscapes, geological features, and Earth's history as resources for education, interpretation, and destination development. These concepts are no longer regarded solely as scientific categories but are now seen as elements that support conservation, environmental awareness, and local economies.

Despite extensive research on geosites, geoparks and interpretation, the literature remains fragmented. Many studies concentrate on specific aspects rather than exploring how geoheritage and geodiversity can be utilised sustainably within broader regional contexts.

This paper proposes an integrated framework for the sustainable utilisation of geoheritage and geodiversity, based on the ABC concept (Dowling, 2013). The framework extends its application from interpretative approaches to a territorial-scale model of geotourism and regional development.

The paper clarifies the concepts of geodiversity, geoheritage and geotourism, followed by an analysis of their value dimensions and recent applications. The core section develops an integrated ABC-based framework and discusses its relevance for sustainable geotourism and regional development.

Conceptual Framework

The concept of geodiversity refers to the natural variety of the abiotic environment, including rocks, minerals, fossils, soils, landforms, sediments, hydrological features, and the processes that form and transform them over time (Gray, 2013). Just as biodiversity denotes the diversity of living nature, geodiversity captures the complexity and variability of non-living nature. Importantly, geodiversity is not limited to spectacular or rare features; it includes both outstanding and ordinary abiotic elements that together form the physical basis of landscapes and ecosystems. It is therefore fundamental not only for geological science but also for environmental management, landscape planning, ecological functioning, and cultural development.

Within this broad domain, geoheritage can be understood as the subset of geodiversity that has been recognised as having particular value and significance. Geoheritage may possess scientific, educational, aesthetic, cultural, ecological, or socio-economic importance and is often represented through specific geosites, geosystems, or broader geological and geomorphological landscapes (Brilha, 2016; Reynard & Brilha, 2025). Geoheritage includes not only “classical” geological sites such as stratigraphic sections, fossil localities, caves, volcanoes, and tectonic structures, but also geomorphological forms such as canyons, karst systems, waterfalls, glacial landscapes, and coastal cliffs. In many cases, the value of geoheritage lies not only in its scientific rarity but also in its capacity to tell stories about Earth history, environmental change, and the long-term interaction between nature and human society.

Geotourism is the tourism expression of this relationship. Although definitions vary, most contemporary understandings agree that geotourism is a form of tourism that focuses on geological and geomorphological features, landscapes, and Earth processes, while also emphasising interpretation, conservation, and visitor learning (Hose, 2012). However, modern geotourism should not be reduced to “tourism to rocks” or a narrow specialist niche. Rather, it is increasingly recognised as a broader landscape-based form of tourism in which geo(morpho)logy remains central but is interpreted in relation to ecology, culture, and place identity (Dowling, 2013; Dowling & Newsome, 2018). This distinction is crucial. Geotourism is geoheritage-centred, but it should not be geoheritage-isolated. When approached in this way, it becomes compatible with sustainable tourism principles and capable of contributing to regional development beyond the boundaries of individual geosites.

Results

Geoheritage and geodiversity are resources with multiple, mutually interconnected values relevant to their use in geotourism (Reynard & Brilha, 2025).

Their scientific value lies in their importance for understanding geological processes and the history of the Earth, thereby serving as a fundamental basis for their identification and conservation. Concurrently, they possess considerable educational value, as they facilitate the dissemination and interpretation of phenomena such as landscape evolution, climate change, and geomorphological dynamics to a broader audience.

Aesthetic value plays an important role in tourism attractiveness, as many visually appealing landscapes are directly shaped by geological structure. In addition, geodiversity has ecological value, providing the abiotic foundation for ecosystems and influencing biodiversity patterns. This highlights the need to consider ecological relationships in geotourism development.

Geoheritage is also associated with cultural value, as geological conditions influence settlement, land use, architecture, and local traditions. In many cases, it forms part of cultural landscapes and contributes to regional identity. Moreover, it possesses socio-economic potential, particularly in supporting diversification within the tourism sector and facilitating local development when employed sustainably.

Regarding application, the use of geoheritage in tourism has evolved from a focus on individual geosites towards more comprehensive territorial approaches. Earlier research primarily concentrated on geosite inventories and assessments, establishing methodological frameworks for evaluating tourism potential.

Recent perspectives emphasise geotourism as an integral component of territorial systems, where geological, ecological, and cultural elements are interconnected. This paradigm shift is exemplified by the geopark concept, which integrates conservation, education, and regional development (Gordon, 2018; Pásková et al., 2021). Concurrently, geotourism is increasingly understood as an interpretive and experience-based form of tourism.

Nonetheless, current methodological approaches, publications and research results are often fragmented, focusing separately on geosites, interpretation, or (geo)tourism products. Despite these advancements, a comprehensive, fully integrated territorial framework that links geoheritage, geodiversity, and geotourism within regional development strategies remains limited.

Discussion

The results suggest that geoheritage and geodiversity cannot be effectively utilised in geotourism if regarded solely as isolated attractions or individual tourism resources. Their sustainable utilisation necessitates a broader perspective that reflects their multiple values and their function within interconnected territorial systems.

In this context, the ABC framework offers a valuable conceptual basis for interpretation and planning. It emphasises that geoheritage constitutes the abiotic foundation of landscapes, which is closely interconnected with ecological systems and cultural processes. This approach helps avoid overly narrow, geology-focused interpretations and superficial tourism applications that reduce geoheritage to a purely promotional element lacking deeper meaning.

From an abiotic perspective, effective utilisation of geoheritage demands systematic identification, evaluation, protection, and interpretation. Not all geosites are equally suitable for tourism, and their management must consider scientific significance, vulnerability, and capacity to accommodate visitors. This entails adopting differentiated approaches, ranging from strict protection to regulated visitor access and educational utilisation.

The biotic dimension underscores the relationship between geodiversity and biodiversity. Geological structures, relief, and hydrological conditions influence habitat diversity and ecological processes. Consequently, the development of geotourism must account for environmental sensitivity and avoid

detrimental impacts on ecosystems. Simultaneously, incorporating ecological interpretation can enrich the visitor experience and expand the relevance of geotourism.
The cultural dimension highlights the importance of linking geoheritage with human activities, traditions, and local identity. Geological conditions have historically shaped settlement patterns, land use, and cultural landscapes. Their inclusion in interpretation enhances the significance of geotourism and fosters stronger connections between visitors and place. It also elevates the potential for local community involvement in tourism activities.
The integration of these three dimensions has direct implications for regional development. When implemented in a coordinated manner, geotourism can contribute to economic diversification, education, and local participation, particularly within rural or peripheral regions with limited development opportunities. However, this potential can only be realised through integrated planning, stakeholder cooperation, and long-term management rather than isolated or short-term tourism initiatives.
Overall, the proposed conception (Figure 1) suggests that geotourism should be understood as an integrated, place-based approach rather than merely a collection of individual attractions or products. The ABC framework offers a practical structure for establishing links between geoheritage and geodiversity with ecological and cultural systems, thereby facilitating their sustainable utilisation within tourism and regional development.

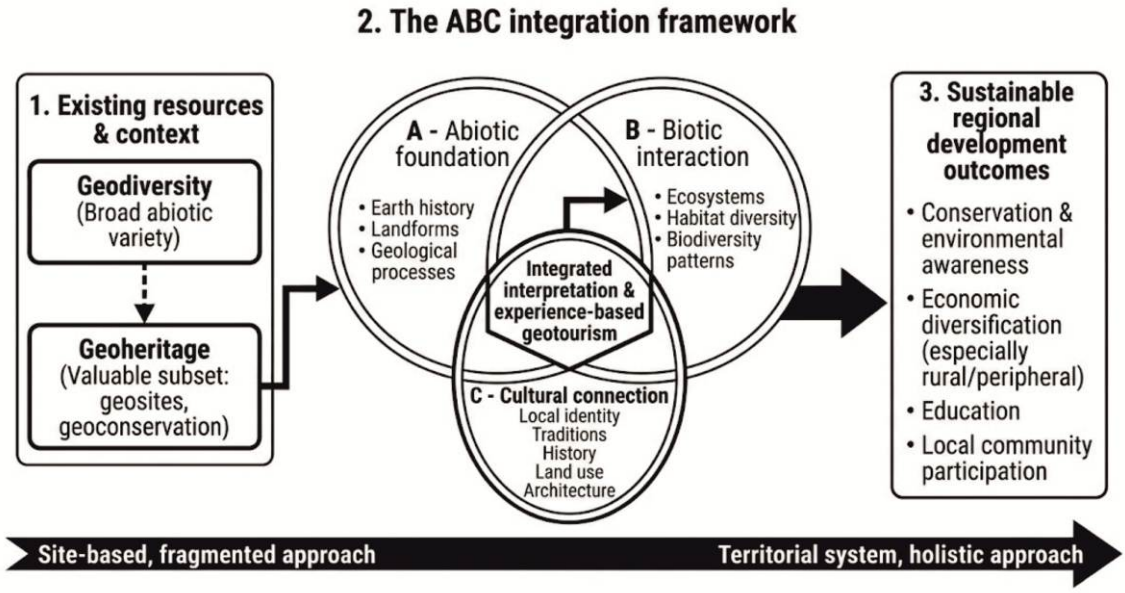

Fig. 1: Conceptual diagram of integrated approach to the use of geoheritage and geodiversity in geotourism

Conclusion

The paper demonstrates that the sustainable utilisation of geoheritage and geodiversity in geotourism necessitates a shift from a site-based, product-oriented perspective to an integrated territorial approach. Despite notable advances in research, their application remains fragmented across geosite assessment, interpretation, and tourism development.
The principal contribution is the utilisation of the ABC framework, which emphasises geoheritage as the abiotic foundation of landscapes interconnected with ecological and cultural systems (Dowling, 2013; Gordon, 2018; Pásková et al., 2021). This perspective supports a more coherent understanding of geotourism.
Geoheritage and geodiversity possess multiple values—scientific, educational, aesthetic, ecological, cultural, and socio-economic—that must be collectively considered in the development of tourism.
Therefore, geotourism should be developed as an integrated, place-based approach that links conservation, interpretation, and regional development, particularly in rural and peripheral regions. The ABC framework offers a practical structure for this integration and for fostering the sustainable utilisation of geoheritage and geodiversity.

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Souhrn
Příspěvek se zabývá využitím geoheritage a geodiverzity v geoturismu a jejich rolí v regionálním rozvoji. Přestože jsou tyto koncepty v odborné literatuře etablované, jejich aplikace zůstává roztříštěná mezi hodnocení geolokalit, interpretaci a tvorbu turistických produktů. Cílem článku je proto představit integrovaný přístup, který tyto oblasti propojuje v širším územním rámci. Geologické dědictví je chápáno jako hodnotná část geodiverzity tvořící abiotický základ krajiny, úzce propojený s biotickými a kulturními systémy. Tyto složky vykazují vzájemně provázané vědecké, vzdělávací, estetické, ekologické, kulturní a socio-ekonomické hodnoty, které je nutné vnímat komplexně. Článek sleduje vývoj geoturismu od zaměření na jednotlivé lokality k integrovanému územnímu přístupu. Moderní geoturismus je chápán jako komplexní forma turismu propojující přírodní a kulturní složky krajiny, což se odráží například v koncepci geoparků. Klíčovým přínosem je aplikace konceptu ABC (Abiotic–Biotic–Cultural), který umožňuje systematicky propojit jednotlivé složky krajiny a lépe porozumět vztahům mezi geodiverzitou, biodiverzitou a lidskou činností. Tento rámec podporuje udržitelný rozvoj geoturismu v rámci regionálních systémů. Z praktického hlediska je nezbytné zdůraznit, že geoturismus by neměl být redukován na izolované produkty či jednotlivé lokality, ale měl by být rozvíjen jako integrovaný, místně specifický přístup propojující ochranu přírody, interpretaci a zapojení místních komunit. Závěrem lze konstatovat, že geoturismus může významně přispět k udržitelnému regionálnímu rozvoji, zejména ve venkovských a periferních oblastech, pokud je založen na koordinovaném a kontextově citlivém využívání geoheritage a geodiverzity.

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INTEGRATING NATURE INTO HIGHER EDUCATION: FOREST BATHING

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Abstract

With the advances in technology, people are increasingly moving away from nature. This situation also leads to negative consequences in terms of mental health. It has become necessary to correct this and increase interaction with nature. In addition to the positive aspects of individuals spending more time in nature in terms of health, contact with nature also increases innovative and creative thinking. In addition, the intertwining of nature and education contributes to the development of positive attitudes towards the environment.

This project, which includes benefiting from nature, contributes to the development of people's emotional skills, increases individuals' communication skills, and supports well-being by discovering their creative sides. Our project provides a perspective on how individuals can benefit from nature to overcome emotional crises. In addition, trainings help to support the formation of a bond with nature by increasing the effectiveness of both education and training between educators and students. In addition, it is expected to directly contribute to the wellbeing of women and the elderly, who are among the disadvantaged groups.

Key words: Moodle, students, study materials, nature benefits

Introduction

INHEF (Integrating Nature into Higher Education) is a project carried out within the scope of Erasmus+ KA220-HED. Its main goal is to incorporate nature-based practices into higher education curricula across various interconnected disciplines. The main goal is to integrate nature-based practices into higher education curricula across various interconnected disciplines. The initiative strives to increase environmental awareness and enhance the long-term physical and mental health of individuals in partner countries and across Europe by promoting nature-based learning approaches. A crucial focus is also placed on ensuring that these initiatives leave a lasting impact on higher education.

INHEF aims to promote a healthy lifestyle for the community while supporting sustainable tourism. Through a research and practice-based approach, it focuses on creating positive impacts on the physical and psychological well-being of its target audience, strengthening their connection with nature, and raising environmental awareness. This project brings together universities from five European countries to design online learning modules, forest bathing guides, and interactive exercises. Furthermore, trainer training sessions are a key component of INHEF, facilitating the transfer of knowledge beyond the initial beneficiaries and encompassing the entire community. Moreover, INHEF also includes vulnerable groups such as women and the elderly.

Needs Analysis

While the healing effects of spending time in nature on human health have been observed for centuries, scientific research on the subject is relatively recent. The concept of shinrin-yoku (forest bathing), conceptualized in Japan in 1982, has become the most comprehensive research agenda in this field. Shinrin-yoku refers to forest bathing, which is practiced by immersing one into a forested area in Japan (Oh et al., 2017). This therapeutic activity, which involves the active use of the senses, has recently gained popularity due to its stress-reducing and health benefits (Krala-Szkaradowska et al., 2024). An increased amount of literature on the positive impacts associated with forest bathing has been documented (Paletto et al., 2024). Interdisciplinary studies have included forestry and other

areas of study (Doimo et al., 2020). Although empirical data have identified various psychological and physiological benefits associated with forest bathing, no single approach is currently adopted worldwide (Satyawan et al., 2022). However, more research needs to be needed on the benefits of forest bathing for psychological and physiological health (Antonelli et al., 2021). Forest therapy became a national health program in Japan in 1982 (Kasalak et al., 2024). This therapy involves a purposeful immersion into forests in order to feel nature through all five senses to gain benefits from the stimulus obtained from the surroundings (Yin et al., 2025; Yau & Loke, 2020).

Li and colleagues (2008) demonstrated that a two-day experience in a forest environment increases natural killer cell activity and that this effect lasts for a week. Park and colleagues (2010) found that forest bathing significantly reduces cortisol levels, heart rate, and sympathetic nervous system activity. Bielinis and colleagues (2018), in experimental studies conducted under winter conditions in Central Europe, determined that just 15 minutes of forest exposure decreased stress, depression, and fatigue while increasing subjective vitality and positive mood.

The majority of these studies have progressed within the framework of clinical and health sciences. However, the picture is quite different in the context of higher education: there are very few studies on how nature-based interventions, such as forest bathing, can be integrated into university curricula. The INHEF project is precisely fueled by this gap. The project approaches forest bathing not only as an improvement practice but also as an integrated pedagogical tool with sustainable tourism and environmental education, aiming to contribute both to practice and to the academic literature (UNWTO, 2019).

Technological progress and urbanization in today's society have resulted in breaking the age-old link that existed between people and nature, thus causing Nature Deficit Disorder. The constant strain of modern life, coupled with extensive use of digital devices and sedentary lifestyle, has been found to be related to reduced psychological well-being and an increased prevalence of mental disorders amongst academia and general population. The INHEF project is designed as a solution to such problems by incorporating nature-based approaches within the domain of higher education.

Shinrin-Yoku, which underpins the project, is a therapeutic practice that encourages spending time in nature by consciously using the five senses. Based on scientific literature and the evidence provided by the project, it has been proven that this practice significantly reduces cortisol levels, the stress hormone, activates cells that support the immune system, and increases mental clarity. INHEF combines this scientific reality with an academic discipline to propose a new curriculum in higher education.

Work Packages

The project operates through the completion of five separate work packages in a logical and systematic order. Work Package 1 relates to scheduling, quality assurance procedures, and reporting. The key point here is that this work package goes much further than mere administration –it represents the very backbone of the project which ensures its success and sustainability in terms of the cooperation involved. As part of work package 2, there will be a production of a guidebook related to forest bathing and other nature-oriented activities. The guidebook will be developed based on literature and best practices of similar projects in Europe as well as the actual field experience in order to make sure that it contains scientifically validated and applicable information. As part of work package 3, which concentrates on training. Specifically, a training programme will be introduced in order to train trainers so that they can successfully conduct the techniques utilized within the project. Once the materials are developed, they will be distributed among students. The phase will involve preparation and assessment of the used approaches.

The project concludes with work package 5, dedicated to dissemination. Through academic publications, digital platforms, and international networks, the aim is to share the project's findings and tools as widely as possible. The work of a five-country partnership will become a resource for the wider European community and beyond.

Kick-Off Meeting

The INHEF project officially started with an inauguration ceremony organized by the Eskişehir Osmangazi University on 15 January 2026. The project coordinator is Eskişehir Osmangazi University (Turkey), while it takes place in the context of an international cooperation between the following universities: University of Basilicata (Italy), Mendel University (Czech Republic), Lithuanian Engineering College (Lithuania) and Warsaw University of Life Sciences (Poland).

The audience of the inaugural ceremony included representatives of various sectors, thus confirming the project's wide spectrum. Attendees consisted of academic personnel and university administration members, students and student unions, NGOs helping vulnerable social groups (i.e. elderly people

and women), members of the Ankara Tour Guides Chamber of Commerce, representatives of travel agencies and the hotel sector (Fig. 1).

Fig.1: Kick-Off Meeting

At the kick-off event, project goals, expected outputs, and the international partnership structure were shared with participants, and the importance of collaboration among academia, the tourism sector, and civil society was emphasized. It is expected that the project will make lasting contributions in both education and societal well-being by offering an innovative, inclusive, and sustainable approach in higher education. Within the scope of the project, the integration of a nature-based practice called forest bathing (shinrin-yoku) into the higher education curriculum, as well as the development of education models focused on sustainable tourism and well-being, will be implemented under different work packages. The project also aims to examine the positive effects of nature on individuals' physical and mental health at an academic level. The day after the project's kick-off meeting, all partners participated in a forest bathing practice at ESOGU campus forest (see Fig. 2).

Fig 2: Forest Bathing Practice

Conclusion - Sustainability and Quality Control

The success and sustainability of the project are secured through three fundamental mechanisms structured according to Erasmus+ standards.

- Project outputs will be subjected to quality inspection by an impartial expert from start to finish.
- The developed digital modules and guides will be permanently incorporated into the existing course curricula of universities.
- Budget management has been allocated according to each work package leader's area of expertise and has been monitored through monthly financial reporting forms.

The INHEF project redefines higher education not only as a center for knowledge transfer but also as a holistic ecosystem for well-being and sustainability. By transforming the *Shinrin-Yoku* practice into a scientific discipline, the project serves its goals and paves the way for building healthier, more

inclusive, and nature-based societies in line with European Union values. INHEF elevates inter-university knowledge transfer into a ‘well-being’ movement, setting the academic standard.

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Souhrn

S technologickým pokrokem se lidé stále více vzdalují přírodě. Tato situace má také negativní dopady na duševní zdraví. Je proto nezbytné tuto situaci napravit a posílit kontakt s přírodou. Kromě pozitivních zdravotních aspektů, které plynou z toho, že lidé tráví více času v přírodě, kontakt s přírodou také podporuje inovativní a kreativní myšlení. Navíc propojení přírody a vzdělávání přispívá k rozvoji pozitivního přístupu k životnímu prostředí. Tento projekt, jehož součástí je využívání přírody,

přispívá k rozvoji emocionálních dovedností lidí, zvyšuje komunikační schopnosti jednotlivců a podporuje jejich duševní pohodu tím, že jim pomáhá objevit jejich kreativní stránku. Náš projekt nabízí pohled na to, jak mohou jednotlivci těžit z přírody k překonání emocionálních krizí. Školení navíc pomáhají podporovat vytváření pouta s přírodou tím, že zvyšují efektivitu vzdělávání i školení mezi pedagogy a studenty. Očekává se také, že přímo přispěje k duševní pohodě žen a seniorů, kteří patří mezi znevýhodněné skupiny.

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INTEGRATING WATER FEATURES INTO A RECREATIONAL SPACE

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Abstract
The paper focuses on the possibilities of applying water design elements in a recreational park space with an emphasis on capturing, retaining and reusing rainwater through blue-green infrastructure elements. The implementation of water elements in recreational spaces contributes not only to more effective rainwater management, but also to environmental education of the public and to promoting awareness of the importance of protecting water resources. The paper aims to highlight the potential of integrating blue-green infrastructure elements through landscape architectural solutions in a newly built recreational space, prepared as a design assignment for the Západoslovenská vodárenská spoločnosť. It also aims to emphasize their benefits for the public in terms of environmental sustainability, recreational quality and long-term stability of the urban environment.

Key words: recreation, landscape architecture, water design, environmental education

Introduction

Water features represent an important compositional and functional tool that allows connecting aesthetic, ecological and social aspects of public space. Elements such as rain gardens, retention ponds, infiltration strips or vegetation ditches are among the current measures for solving the water cycle in the landscape, fulfilling an important role of natural regulatory systems (Miklášová et al., 2024). Their appropriate placement and dimensioning requires an interdisciplinary approach (Čibik et al., 2022, Hus et al., 2021), which takes into account the hydrological, pedological and vegetational conditions of the area (Tóth, 2022, Rózová et al., 2023). Contemporary landscape architectural approaches emphasize the creation of adaptive and resilient public spaces that can respond to changing environmental conditions (Čibik et al., 2022). Water design and vegetation management thus become a means of not only a technical solution, but also a carrier of educational potential, allowing park visitors to directly perceive the water cycle in the landscape and understand its significance (Kuczman, 2025). In this context, a participatory approach to design also plays an important role (Kuczman et al., 2022, Bechera et al., 2022, Čibik 2024), which supports the public's relationship with the space and increases the acceptance of innovative solutions.

Materials and methods

The subject of the study is the unused area of the Západoslovenská vodárenská spoločnosť (ZVS) in Nitra with an area of approximately 19,200 m², situated in the peripheral part of the operating area in direct contact with the open landscape. The location is currently without active use, which creates the potential for its transformation into a functional and attractive public space. The area under study is located in the valley of the Nitra River, which played a significant role in the historical development and current functioning of the city of Nitra (Fig. 1 & Fig. 2). The location is located northeast of the city center, on the border of the built-up area and the open landscape, which gives it a specific transitional character and at the same time a significant landscape potential. The area is currently located on the edge of the urbanized structure, while showing significant links to the existing technical infrastructure and green areas. In terms of transport accessibility, it is a suitably connected area, especially in relation to the city districts of Zobor (with Zobor Hill - 587 m. above sea level) and Staré Mesto. An important element of the area is the existence of the Nitra - Drážovce cycle route, which directly passes through the planned area and ensures its safe and smooth connection with the surrounding localities for cyclists and pedestrians. This mobility line also represents significant potential for the integration of the area into the wider recreational and landscape-urban context of the city. The cadastral territory of the city of Nitra is mainly located in a warm climate area, specifically in the area of the Danube Plain and on the edge of the Tríbeč Mountains. The territory of the Nitra district belongs to the West Carpathian and Pannonian areas, where elements of the Pre-Carpathian and Eupannonian xerothermal flora meet. Significant vegetation units are Tribeč, Nitrianska pahorkatina and Žitavská niva, which affect the diversity of the flora in the region. A dendrological survey was carried out in the area in question, where 27 woody plants were identified, with a relatively high species diversity. Specifically, 8 taxa were identified (*Cerasus avium* (L.) Moench, *Rhamnus cathartica* L., *Robinia pseudoacacia* L., *Fraxinus excelsior* L., *Juglans regia* L. LC., *Populus alba* L., *Populus nigra* L., *Salix*

fragilis L.). The most abundant was the European Ash (*Fraxinus excelsior* L.) and the tree with the largest trunk circumference of 179 cm was the Crack Willow *Salix fragilis*. From a compositional point of view, the trees in the studied area occurred mainly as solitary trees or in smaller groups. Many individuals showed damage to the trunks and crowns, which occurred as a result of mechanical interventions related to land clearing.

Fig. 1:, left: View of the cycle path leading along the developed area enclosed by blue fencing (Kuczman, G., 2025). Fig. 2, right: Visual connection of the planned area with the cultural and historical landmark - Nitra Castle (Kuczman, G., 2025).

The study applied the research by design method, which focuses on identifying and formulating key design principles, which are subsequently verified in a specific landscape-architectural solution. This approach allows theoretical starting points to be linked with practical design activities and at the same time reflects the specifics of the area being addressed. The solution process was divided into two main phases. The first, analytical phase, included a comprehensive processing of broader relations of the area, with emphasis on functional-spatial analysis, landscape analysis and dendrological survey. The initial stage also included identifying the needs and expectations of residents in relation to the proposed recreational space, which were supplemented by the requirements of the management of the ZVS in Nitra as the main client. The second, design phase, represents the landscape-architectural solution of the area itself. The study process involved second-year students in the Landscape Design Studio, Landscape Architecture Department, from the Institute of Landscape Architecture, SPU in Nitra, to develop design ideas within research-led teaching, using research through design. The studio created five design solutions with different implementations of water activities and elements.

Results

The design integrates water elements with recreational and social functions, which are based on the main requirements of the client ZVS in Nitra, with the intention of making the issue of water in the landscape and its importance in the urbanized environment more visible. At the same time, it reflects the principles of sustainable management of rainwater and supports their practical application within the landscape-architectural solution. Special emphasis is placed on ensuring the continuity of blue-green infrastructure within the city and on creating a high-quality public space that supports the environmental, aesthetic and social values of the area. The results of the creative process were integrated into a concept called: "KoloBeh vody", in which movement, play and water are naturally interconnected as basic thematic and spatial elements (Fig.3). The design concept works with multifunctional use of the area, while the entrance part of the area is designed as an intensive space intended for children's activities and interactive water games, the rear part of the area takes on a calmer, landscape character, where the space freely develops in the spirit of the river flow and serves for the movement of cyclists and visitors. Specific design solutions include the implementation of the polygon element, which is based on one of the basic requirements of the client, ZVS. This element is designed as a multifunctional area intended for social, educational and presentation activities, reflecting the professional focus and thematic orientation of the client. The polygon serves as a space for organizing events, workshops or interactive programs focused on the issue of water, its management and importance in the landscape. At the same time, it represents an important compositional node of the area, which connects the individual functional zones and supports the social interaction of visitors.

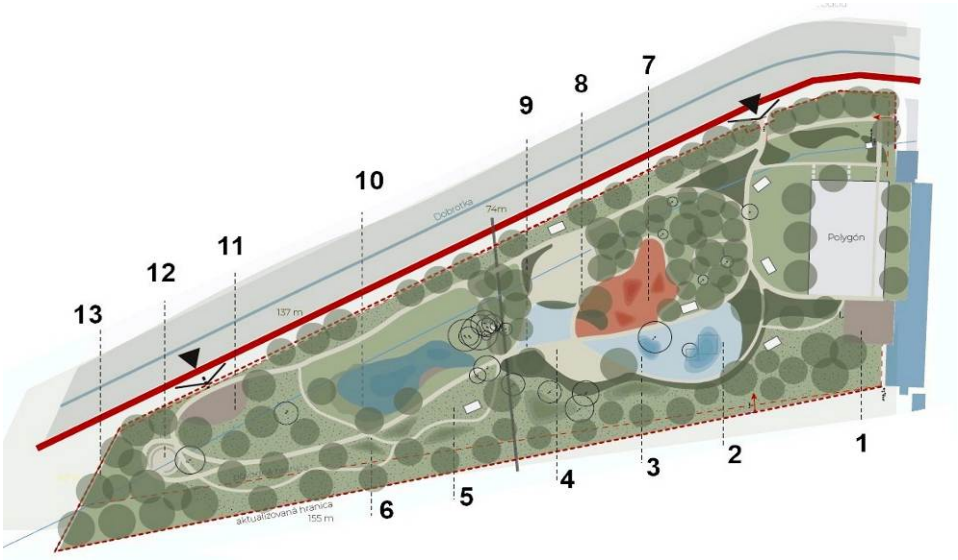

Fig. 3: Design solution for the ZVS complex with the main design philosophy of the Cycle of Water with the implementation of water elements. Overview of proposed elements and activities: 1) zone for social events, 2) well, 3) water playground, 4) relaxation zone, 5) terrain modeling, 6) fruit trees, 7) dry playground, 8) relaxation zone, 9) water playground, 10) wetland with a pond, 11) cycling hub, 12) viewpoint, 13) natural habitat (authors: T. Havrila, T. Ravasová, F. Tkáč, L. Vavrová, supervisor: G. Kuczman & V. Paganová, 2024-2025).

Access to the area is provided by footpaths and a cycle path. The extensive part is open to the public continuously, while the intensive part has a modified operating regime to protect the proposed technical water features. The extensive part of the area represents an open space based on natural elements and with low maintenance requirements. The dominant feature of this part is the cyclohub, the main base of cycling routes in Nitra, which provides a place to stop, rest, safely store bicycles and transition to the pedestrian zone. The area is complemented by a bicycle shelter, a gazebo, a fireplace, a yoga zone, a lookout and a pier by the lake. Natural meadow vegetation, terrain modeling and a biotope create an environment for relaxation, walks and ecological observation. Architectural interventions respect the natural character of the area and work with natural materials without the need for intensive maintenance. The design of the vegetation structure includes four thematic groups of trees: insulating, fruit, solitary and multi-stem trees. Insulating trees ensure the separation of noisy spaces, fruit trees support biodiversity and provide benefits, while solitary and multi-stem trees complete the aesthetic and spatial character of the landscape space. The main skeleton of the proposed trees consists of the following species: *Carpinus betulus, Quercus robur, Ulmus minor, Fraxinus angustifolia, Acer campestre, Salix, Prunus avium, Pyrus communis, Betula utilis* 'Jacquemontii', *Sorbus aria* 'Lutescens' and fruit trees: *Prunus avium, Pyrus communis, Prunus domestica, Prunus armeniaca, Cerasus avium, Castanea sativa, Amelanchier lamarckii.* The intensive part of the area is supplemented with perennial-grass plantings to ensure year-round visual attractiveness and its use. A significant habitat in the area is the wetland by the lake, which thematically completes the space and fulfills an important ecological function by retaining water and improving the microclimate in the area(Fig. 4, 5).

Fig. 4, 5: Visualization of part of the proposed recreational area (authors: T. Havrila, T. Ravasová, F. Tkáč, L. Vavrová, supervisor: G. Kuczman & V. Paganová, 2024-2025).

The result of the design process is a newly built recreational space, where water acts as a supporting compositional element that connects individual functional zones, but also fulfills an educational and symbolic role. It becomes not only a source of inspiration, but also a means of conveying knowledge about natural processes in the landscape.

Discussion

In the context of increasing manifestations of climate change, such as extreme precipitation, droughts, and increasing temperatures in urban environments, integrated water management is becoming increasingly important (Vinczeová et al., 2025). The discussion is therefore increasingly focused on the role of water features in recreational and public spaces, which can represent an effective tool for adapting to these changes (Bihuňová, et al., 2017, Bellérová & Hus, 2025). Their implementation contributes not only to more effective management of rainwater, for example by retaining it and gradually infiltrating it, but also to improving microclimatic conditions in the area. At the same time, it supports increased biodiversity and strengthens the overall ecological stability of the environment. Despite these benefits, it is also necessary to take into account the limits and challenges associated with their design, implementation, and maintenance, which opens up space for further research and the search for optimal solutions in specific local conditions.

Conclusion

The solutions created within the studio work represent a set of analyses and proposals aimed at making the issue of water in the landscape and its importance in the urbanized environment of the city of Nitra visible. The studio outputs reflect the principles of sustainable management of rainwater and point to their potential for practical application in landscape and architectural solutions. The proposed approaches connect technical and ecological aspects with artistic representation, through integrated artistic elements emphasizing the theme of water, as well as vegetation solutions close to nature.

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Souhrn
Předmětem studie je nevyužívaný areál Západoslovenské vodárenské společnosti v Nitře, situovaný v periferní části provozního území v bezprostředním kontaktu s otevřenou krajinou. Návrh integruje vodní prvky s rekreačními a sociálními funkcemi, které vycházejí z hlavních požadavků zadavatele ZVS v Nitra, se záměrem zviditelnit problematiku vody v zemi a její význam v urbanizovaném prostředí. Do procesu studie byli zapojeni studenti druhého stupně studia, v rámci předmětu Ateliér krajinářské tvorby, oboru krajinná architektura z Ústavu krajinné architektury SPU v Nitře, aby rozvíjeli návrhové myšlenky v rámci výuky vedené s výzkumem, s využitím výzkumu prostřednictvím návrhu. V ateliéru vzniklo pět návrhových řešení s různými implementacemi vodních aktivit a prvků, které představují inspiraci pro realizaci prostoru.

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INTERGENERATIONAL LEARNING AS A TOOL FOR ENVIRONMENTAL EDUCATION AND SUSTAINABLE LANDSCAPE CONSERVATION

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Abstract

This paper analyses the potential of intergenerational learning (IL) as a specific tool in the field of environmental education and sustainable landscape conservation. The theoretical framework of the article responds to current demographic changes and the weakening of traditional bonds, which require new models of experience-sharing. The paper synthesises findings obtained from the analysis of 20 case studies from the Czech Republic and Slovakia (e.g. the MENDELU Intergenerational University or the Three-Generation Nature School in Prievaly), which were identified as part of the 'Intergenerational STEAM University' project.

The results show that environmental programmes taking place in authentic settings (arboreta, school forests, wetlands) effectively link scientific knowledge with the historical memory of the landscape. Intergenerational interaction in these "living classrooms" leads to a strengthening of environmental responsibility among the younger generation, whilst simultaneously reducing the social isolation of older people by restoring their role as bearers of traditional knowledge. The article concludes that the integration of intergenerational dialogue into public recreation activities represents a sustainable model of environmental education that contributes to social cohesion and more sensitive care for the landscape heritage.

Key words: intergenerational learning, environmental education, landscape conservation, social cohesion, sustainable development

Introduction

Contemporary society is undergoing profound demographic, social and cultural transformations that are fundamentally altering the ways in which different generations meet and interact. A key factor is the demographic ageing of the population, with the number of older people beginning to exceed that of younger members of the population for the first time in history (Newman & Hatton – Yeo, 2008). This trend is accompanied by changes in family structures, increasing geographical mobility and the weakening of traditional intergenerational ties, which previously enabled the natural transfer of experience and values within the family and local community (Kamanová et al., 2026). As a result of these changes, there is an urgent need to create new opportunities for intergenerational dialogue and the mutual sharing of knowledge.

In this context, intergenerational learning appears to be a strategic tool for social cohesion and sustainable development (Sanchéz, 2006). The academic literature defines it as a specific learning process that arises as a result of interaction between people belonging to different generations, whereby generational differences (different experiences, perspectives and life paths) serve as the very source of learning (Rabušicová, Kamanová & Pevná, 2011; Rabušicová et al., 2016). Unlike a mere intergenerational encounter, intergenerational learning is a planned process based on reciprocity, meaningful cooperation and shared reflection (Waight & Waight, 2025; Kamanová et al., 2026).

The significant potential of intergenerational learning is particularly evident in the field of environmental education and landscape conservation. Authentic natural environments, such as botanical gardens, arboreta or school forests, create a natural space for intergenerational interaction, where theoretical knowledge is linked with practical experience. Programmes such as the 'MENDELU Intergenerational University' or the 'Three-Generation Nature School' demonstrate that nature can serve as a shared 'classroom' in which the older generation passes on knowledge about landscape cycles, plant cultivation or the historical memory of a place, whilst the younger generation brings new energy, curiosity and modern technological skills.

This synergistic relationship not only leads to the development of participants' individual skills but also has broader community impacts. It contributes to reducing age-related stereotypes, strengthens environmental responsibility and builds a connection to the locality through an understanding of the continuity of landscape development. The aim of this article is to demonstrate, based on an analysis of

selected programmes from the Czech Republic and Slovakia, that linking public recreation with intergenerational education represents a sustainable model of landscape stewardship that respects the needs of all generations whilst protecting natural heritage for the future

Materials and methods

This article is based on data and methodological approaches gathered as part of the international project 'Intergenerational STEAM University' (supported by the Erasmus+ programme), the results of which were published in 2026. The aim of the methodological approach was to identify, analyse and synthesise models of good practice in the field of intergenerational education in the Czech Republic and Slovakia. The analysis was based on secondary research (desk research), which was conducted simultaneously in both countries. Existing initiatives were identified using keywords (e.g. 'intergenerational course', 'intergenerational dialogue', 'intergenerational relationships'). The final analysis included only those activities in which intergenerational learning was specifically planned and structured as an educational environment, rather than merely as a chance encounter between different age groups. A total of 137 intergenerational programmes were identified in this way (87 in the Czech Republic and 50 in Slovakia).

Selection and analysis of case studies: 20 examples of good practice (10 from each country) were selected from the identified database using a purposive sampling method. The selection criteria were diversity in terms of objectives, type of organisation and content, to ensure the representativeness of various contexts of intergenerational learning. Semi-structured in-depth interviews were conducted with the implementers of these programmes directly within the authentic environment of their organisations.

For the purposes of this article on environmental education, programmes taking place in natural environments or thematically focused on landscape conservation were identified from the sample of 20 case studies and subjected to an in-depth comparative analysis. Specifically, these were:

- The MENDELU Intergenerational University, utilising facilities such as the Křtiny Field School, arboreta and themed gardens.
- The Three-Generation Nature School in Prievaly, focused on biodiversity observation and wetland conservation.
- Connecting Generations in Harmony, working with the concept of herb gardens.

In assessing the impacts of these programmes, MacCallum's (2006) typology of benefits was used, which distinguishes between individual, relational and community outcomes.

Results

An analysis of 20 selected examples of good practice from the Czech Republic and Slovakia showed that intergenerational learning (IL) in natural environments generates specific benefits at the individual, relational and community levels. Environmentally focused programmes utilise authentic settings such as arboreta, school forests, botanical gardens and wetlands, which serve as 'living classrooms'.

Programmes such as the MENDELU Intergenerational University (CZ) demonstrate the effectiveness of experiential learning in the field. During field exercises in arboreta (e.g. Křtiny, Řícmanice), participants learn together about the life cycle of plants, the cultivation of medicinal herbs or the rearing of farm animals. The results suggest that the younger generation gains a deeper insight into ecosystem processes through practical observation, rather than solely from textbooks. Through mentoring and the sharing of experience, older people strengthen their sense of usefulness and their own competence. In the Three-Generation Nature School programme in Prievaly (SK), there is effective sharing of knowledge on biodiversity (ornithology, mycology) and ecological innovations, such as home composting. A significant outcome of intergenerational environmental activities is the renewal of a relationship with the local landscape through shared memory. In the **'Stories of Our Neighbours'** project (CZ) and in the programmes in Prievaly (SK), older people reflect on how the character of the landscape has changed over time.

Sharing stories about what the landscape used to look like (e.g. the location of nests, original wetlands) helps build a connection to the place and a sense of local identity among the younger generation. Programmes such as 'Connecting Generations in Harmony' (SK) use the creation of herb gardens in raised beds to develop seniors' fine motor skills and provide practical education on beekeeping.

Analysis confirms that intergenerational learning in nature reduces age-related stereotypes. In programmes taking place in the authentic setting of school forest enterprises (e.g. ŠLP Křtiny), a transformation of attitudes occurs. Children begin to value the life experiences of older people, whilst older people are surprised by the children's energy and technological proficiency. Joint care for natural elements (e.g. planting herbs, tending gardens) leads to a strengthening of environmental

responsibility and social inclusion. The implementation of programmes in informal outdoor settings (e.g. the Intergenerational Camp in the Vysočina Region) reduces communication barriers and creates space for an equal partnership between generations.
To summarise the results, it can be stated that linking public recreation with intergenerational education creates a sustainable model of environmental education that harnesses the synergy between the historical experience of the older generation and the active approach of young people.

Discussion
The results of the analysis of environmentally focused programmes in the Czech Republic and Slovakia confirm that intergenerational learning represents a significant yet, in the field of landscape conservation, hitherto underappreciated tool. A key finding is that authentic natural environments (botanical gardens, arboreta, wetlands) do not merely serve as a passive backdrop, but as an active 'third educator' that facilitates the breaking down of communication barriers and fosters natural reciprocity.
In line with the theory of intergenerational learning, it appears that environmental education within an intergenerational group transcends the limitations of formal schooling by linking **instrumental content** (knowledge of flora and fauna) with broader themes such as respect for traditions, the historical memory of a place, and environmental responsibility. Programmes such as the 'Three-Generation Nature School' or the 'MENDELU Intergenerational University' demonstrate that collaborative learning in the field leads to a deeper sense of belonging to the landscape, which is a fundamental prerequisite for its sustainable conservation.
However, any discussion of the effectiveness of these programmes must also take into account the identified risks. A common problem in practice is an imbalance of roles, where the senior is perceived merely as a 'fountain of wisdom' and the child as a 'passive listener'. For successful environmental education, it is essential that reciprocity is maintained – for example, a situation where a senior teaches a child about medicinal herbs, whilst the child helps the senior document their findings using modern technology.
Another challenge is the logistical and physical accessibility of natural sites. Whilst more demanding excursions (e.g. to wetlands) are a welcome adventure for the younger generation, they can present a barrier for older people with reduced mobility. A solution appears to be the use of accessible sites (e.g. the Křtiny Nature Education Centre) and sensitive facilitation that can adapt the pace of activities to the capabilities of both groups without separating them.
Combining recreation in the countryside with intergenerational dialogue creates 'bridges of understanding' that help resolve conflicts between the needs of different age groups of landscape users and strengthen respect for our natural heritage. Intergenerational learning in nature is not merely a 'leisure activity', but a method for building the public's relationship with the landscape.

Conclusion
Based on an analysis of programmes from the Czech Republic and Slovakia, this study has demonstrated that intergenerational learning represents a highly effective yet low-cost strategy for environmental education and sustainable landscape conservation. It appears that authentic natural environments, such as arboreta, school forests or themed gardens, do not merely serve as a passive backdrop, but as an active 'third educator' that facilitates the transfer of traditional knowledge and values.
A key finding is that intergenerational interaction within public recreation leads to a strengthening of environmental responsibility among the younger generation, whilst simultaneously reducing the social isolation of older people by restoring their role as bearers of experience and the 'memory of the landscape'. However, the success of these programmes is not automatic; it requires conscious work on objectives, sensitive facilitation and the creation of space for reciprocity, where generations learn not only 'from one another' but, above all, 'together'.
Future development should focus on more systematic links between university departments (e.g. the Křtiny Field School) and local communities in the creation of educational trails that respect the needs of all generations and foster a deeper appreciation of our natural heritage.

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Souhrn
Tento článek zkoumá potenciál mezigeneračního učení (IL) v kontextu ochrany přírody a environmentální výchovy. Mezigenerační učení je definováno jako specifický vzdělávací proces vyvolaný interakcí různých generací, přičemž generační rozmanitost – zahrnující odlišné životní zkušenosti a historické perspektivy – slouží jako primární zdroj učení. Článek shrnuje poznatky z 20 případových studií osvědčených postupů identifikovaných v České republice a na Slovensku na základě sekundárního výzkumu 137 existujících iniciativ. Výsledky naznačují, že environmentální programy mezigeneračního učení realizované v autentickém prostředí, jako jsou botanické zahrady, lesní podniky (např. Masarykův les Křtiny) a mokřady, nabízejí jedinečné přínosy na individuální, vztahové i komunitní úrovni. Konkrétně mezigenerační učení usnadňuje předávání tradičních ekologických znalostí (jako je využívání léčivých rostlin nebo historické obhospodařování krajiny) od starších lidí k mladým, zatímco mladší účastníci vnášejí energii a moderní technologické dovednosti k dokumentaci těchto poznatků. Programy jako „Mezigenerační univerzita MENDELU" nebo „Třígenerační škola přírody v Prievalách" dokazují, že kolektivní učení v terénu posiluje hlubší pocit sounáležitosti s krajinou a zvyšuje environmentální odpovědnost všech účastníků.
Z diskuse vyplývá, že aby byl mezigenerační dialog účinný, nesmí se omezovat pouze na pouhá mezigenerační setkání. Vyžaduje odborné vedení, které zajistí vyváženost rolí a vzájemnost a zabrání situacím, kdy jedna generace zůstává pasivním příjemcem. Kromě toho je pro zohlednění fyzických schopností jak dětí, tak seniorů zásadní přizpůsobit tempo a přístupnost aktivit v přírodě.
Závěrem lze říci, že začlenění mezigeneračního dialogu do veřejných rekreačních aktivit a osvětových programů v oblasti životního prostředí představuje udržitelný model pro rozvoj komunity a ochranu krajiny. Tím, že tyto programy podporují vzájemný respekt a sdílenou odpovědnost za životní prostředí, přispívají k budování soudržnější a odolnější společnosti, která si cení svého přírodního dědictví očima všech generací.

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LANDSCAPE TRANSFORMATION IN THE AREA OF THE HRIŇOVÁ RESERVOIR DURING 1764–1971

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Abstract
This study focuses on the analysis of landscape changes in the area of the present Hriňová Water Reservoir from 1764 to the present, using historical maps and GIS tools. By evaluating historical road networks, watercourses, railways, bridges, and culverts, we identified significant changes in land use, particularly during the period before and during the construction of the reservoir (1952–1971). The most notable changes were observed in the lengths of roads, watercourses, and the number of bridges: before the reservoir was built, 13 bridges were recorded in the area, whereas after its construction there were none. The results highlight the substantial human impact on the landscape due to the implementation of the water structure, which today serves as a source of drinking water and represents an important feature within the boundary of the Poľana Biosphere Reserve.

Key words: water tank, historical map, change

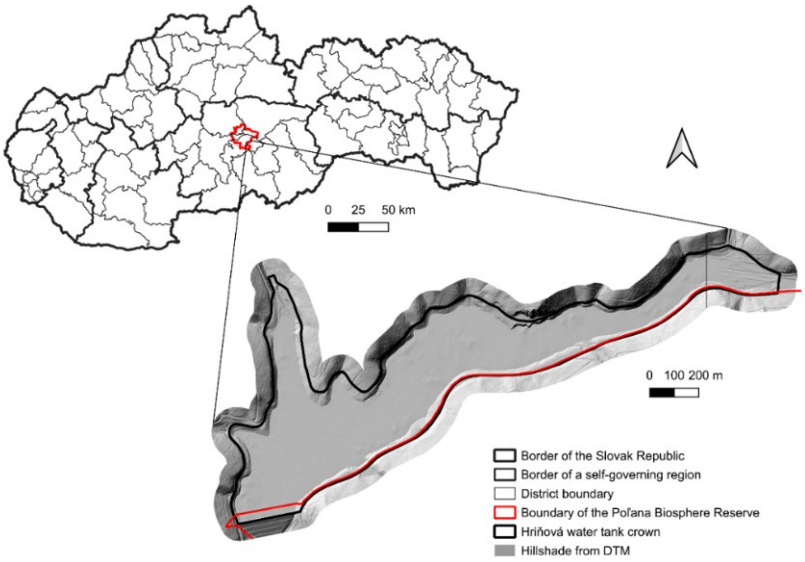
Introduction
Reservoirs are vital for water supply, flood protection, and recreation (Verdhan, 2025). Above the town of Hriňová, the Hriňová water reservoir has been in place since 1964, serving as a high-capacity source of drinking water (ESDPM, 2020). Failure to maintain proper work discipline during construction—particularly in some important details such as filter placement—caused operational problems for the water structure. These issues appeared immediately after the reservoir began to be filled. Local seepage accompanied by landslides and subsequent remediation recurred for more than 20 years. Only extensive rehabilitation of the dam carried out between 1988 and 1992 finally resolved the long-standing problems of the water facility (SNCLD, 2025).
Because the reservoir serves as a source of drinking water, recreational use is not permitted (ESDPMH, 2020). The area is popular with tourists due to its location in the Poľana Protected Landscape Area (Trenčiansky et al., 2025). The Hriňová reservoir is a traditional destination for hikers, cyclists, photographers, and mushroom pickers (SBTZ, 2025).
Our aim was to assess changes in the territory based on historical maps dating back to 1764 in the area now affected by the Hriňová reservoir.

Area of interest
The Hriňová water reservoir is located in the Banská Bystrica Region, in the Detva District, within the cadastral territory of Hriňová, forming the southeastern boundary of the Poľana Biosphere Reserve, with a total area of 67.52 hectares (Map 1).
The dam crest elevation is 567.60 m a.s.l.; the crest width is 5.50 m; the dam height above the valley floor is 41.50 m; the permanent storage volume is 226,64 m³; the total reservoir volume is 7,379,77 m³; and the inundated area at the maximum allowable water level is 555,00 m² (SWMC, 2025).

Methods
The basis of the methodology was the approach of Dostál and Havlíček (2025). In their research, the authors used GIS (ArcGIS 10.6) founded on the interpretation of historical map documents. To define the historical road network, they used a set of state and district maps issued by the Ministry of Technology of Czechoslovakia in 1947, as well as historical orthophotos from the early 1950s. The authors Švoňová et al., 2024 focused on the state and changes in landscape structure based on the analysis of remote sensing data (1949, 2003 and 2018), as well as field research and a review of archival photographs.
Prochádzka and Pišút (2015), in their study on the regulation of the channel of a lowland meandering watercourse during the period 1782–1900 (using the example of the Váh River in the Sereď–Komárno section), used a map from the Second Military Survey as their main reference. Based on this map, they performed vectorization and supplemented the base with additional features such as cut-off meanders, identified using more recent maps that captured changes occurring after the creation of the historical map.

We adapted and adjusted the authors' methodologies to suit our study area, focusing on landscape changes within the Hriňová water reservoir and its immediate surroundings. We monitored changes in the length of roads, field roads, railways, intermittent streams and permanent watercourses, as well as changes in the number of bridges and culverts.

Map 1:Area of Interest – Hriňová Water Reservoir



Source: PABR, 2025; ALS, 2024

We used maps from the First Military Survey, Second Military Survey, and Third Military Survey, as well as military topographic mapping from 1952–1957, military topographic mapping from 1957–1971, and contemporary mapping. For each analysed period, we created vector and point layers of landscape elements, specifically roads, field roads, watercourses, intermittent watercourses, railways, bridges, and culverts. Subsequently, in the QGIS software, we calculated lengths in meters using the attribute table and its field calculator with the function "$length / 10.000".

Result

Between 1764 and 1787, we recorded total changes in length of 1.56 km; between 1810 and 1869, 6.12 km; between 1875 and 1884, 6.03 km; between 1952 and 1957, as much as 11.57 km; and between 1957 and 1971, 3.17 km. Regarding changes in bridges and culverts, we recorded a total of 2 bridges in the period 1810–1869, 2 bridges in 1875–1884, as many as 13 bridges in 1952–1957, and only one culvert in 1957–1971 (Table 1).

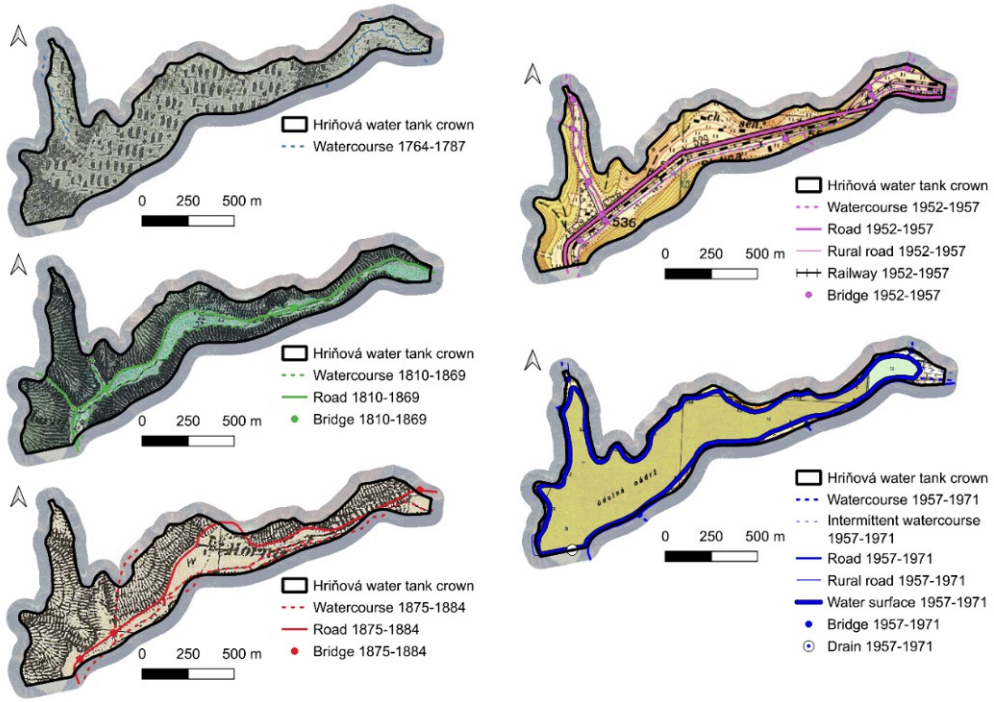
Tab. 1: Changes in the length of linear elements

Year	Road (km)	Rural road (km)	Railway (km)	Intermittent watercourse (km)	Bridge	Drain	Watercourse (km)
1764-1787	-	-	-	-	-	-	1,56
1810-1869	2,83	-	-	-	2	-	3,29
1875-1884	2,55	-	-	-	2	-	3,48
1952-1957	2,47	2,43	2,50	-	13	-	4,17
1957-1971	2,36	-	-	0,18	-	1	0,63

Source: ALS, 2024; 1MM, 2022; 2MM, 2021; 3MM, 2022; TM1, 2022; TM, 2022

Specifically, in the years 1764–1787 there were 1.56 km of watercourses; in 1810–1869 there were 2.83 km of roads and 3.29 km of watercourses; in 1875–1884, 2.55 km of roads and 3.48 km of watercourses; in 1952–1957, 2.47 km of roads, 2.43 km of field roads, 2.50 km of railways, and 4.17 km of watercourses; and in 1957–1971, 2.36 km of roads, 0.18 km of intermittent watercourses, and 0.63 km of watercourses (Map 2).

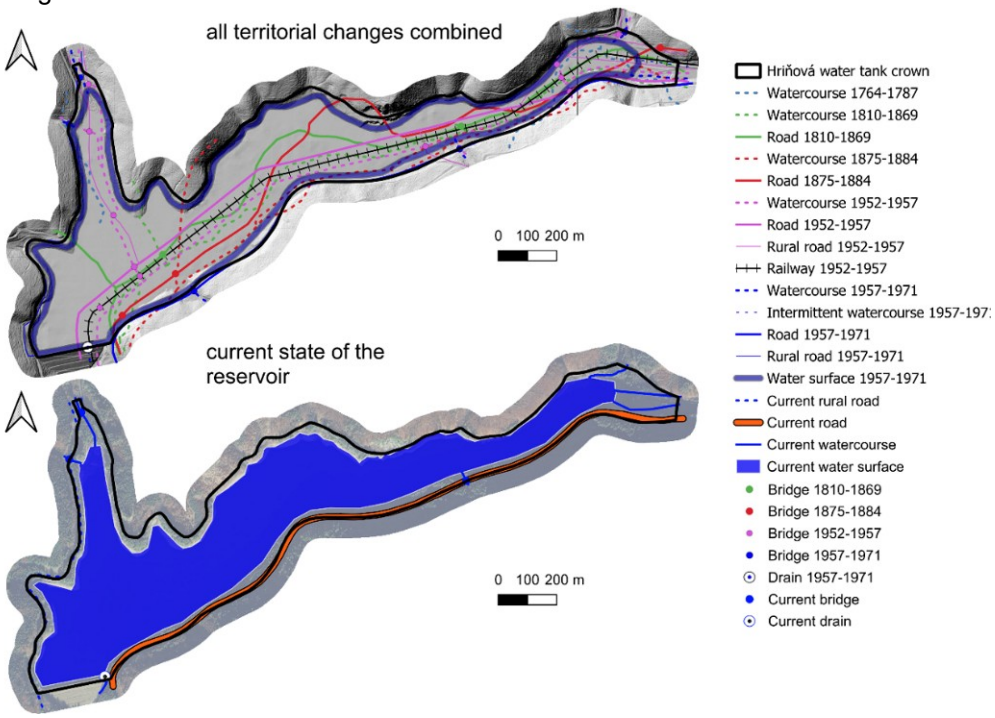
Map 2: Change Across Individual Periods



Source: ALS, 2024; 1MM, 2022; 2MM, 2021; 3MM, 2022; TM1, 2022; TM, 2022

In Map. 3, we observe the overall changes across all monitored periods within the Hriňová Water Reservoir area from 1764 to the present.

Map 3: Change Across All Periods in the Water Reservoir Area



Source: ALS, 2024; 1MM, 2022; 2MM, 2021; 3MM, 2022; TM1, 2022; TM, 2022

Conclusion

The greatest changes are observed between 1952 and 1971. This period reflects the years before the reservoir was built compared with the years during the construction and completion of the Hriňová Water Reservoir. During this time, we see a significant change particularly in the number of bridges: between 1952 and 1957 there were 13 bridges in the area of the present reservoir, while between 1957 and 1971 there were none. We also observe the most substantial changes during these years in

the lengths of roads, field roads, railways, and watercourses. Today, the reservoir serves as a source of drinking water.

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Souhrn

Práce analyzuje změny krajiny v oblasti Vodní nádrže Hriňová od roku 1764 do současnosti pomocí historických map a GIS. Hodnotili jsme historické silniční sítě, vodní toky, železnice, mosty a propustky, přičemž nejvýraznější změny nastaly v období před a během výstavby nádrže (1952–1971). V tomto období došlo k významným změnám v délce komunikací, vodních toků a počtu mostů – před výstavbou bylo v území 13 mostů, po jejím dokončení již žádný. Výsledky ukazují výrazný

lidský zásah do krajiny v důsledku realizace vodního díla, které dnes slouží jako zdroj pitné vody a je významným prvkem na hranici Biosférické rezervace Poľana. Práce zdůrazňuje důležitost historických map a GIS při monitorování a hodnocení změn krajiny v čase.

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LANDSCAPE-ARCHITECTURAL PROPOSAL OF MONOTHEMATIC EDUCATIONAL PATH – WATER AS A MAIN TOPIC

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Abstract
The Paper presents the landscape architectural proposal of educational walking route located city of ’s-Hertogenbosch (Den Bosch) in the Netherlands. The low-lying country in Northwestern Europe known for its advanced water management systems, rich cultural heritage, and strong connection between urban environments and surrounding landscapes. Within the Netherlands, the site lies in the province of North Brabant, a southern region characterized by agricultural landscapes, historic towns, and extensive wetland areas. The project focuses on the capital of North Brabant and one of the oldest medieval cities in the country’s - Hertogenbosch, officially founded in 1185. Its urban structure is defined by a dense medieval layout, narrow streets, and a strong relationship with water. The landscape-architectural proposal suggested the trail connecting the city and the open landscape, which several great perception points and fluent connection between nature and urban area.

Key words: Recreational activities, landscape architecture, design of walking route, interpretation, The Netherlands

Introduction

Open landscape and also urban environment with their different forms and structures offer the possibility to build different types of the trails: walking, hiking, cycling trails, educational paths, scenic routs, sport trails, rehabilitation trails, horseback riding trails (Supuka, Bihuňová, 2018). Recreational and educational trails can wind through various types of environments—from urban areas (Čibik et al. 2022), public green spaces (Bihuňová et al. 2017), and suburban zones to open countryside or forested areas (Vavrouchová et al., 2024). Key aspect of trail design is aimed at the choosing of the road(s), based on their length, gradient and the way landscape is experiences (Bell, 2001). Rossman, Schlatter (2008) emphasize that program for the recreation is a designed opportunity for leisure experience to occur. Educational trails could be a platforms for disseminating different types of knowledge (environmental awareness, nature protection, cultural and historical heritage, human interaction with landscapes…) (Juško, Azor, Rozkopál, 2025). Simon Bell (2001) added that the trail should be designed to raise expectations continuously and fulfil those expectations in unexpected ways.

Material and methods

The project area is located in the Netherlands, a low-lying country in Northwestern Europe known for its advanced water management systems, rich cultural heritage, and strong connection between urban environments and surrounding landscapes. Within the Netherlands, the site lies in the province of North Brabant, a southern region characterized by agricultural landscapes, historic towns, and extensive wetland areas.
It focuses on the city of ’s-Hertogenbosch (Den Bosch), the capital of North Brabant, with approximately 161,500 inhabitants, the city developed at the confluence of several rivers, giving it a strategic role as a trading and defensive center throughout history. Its urban structure is defined by a dense medieval layout, narrow streets, and a strong relationship with water.
The walking route is located along the southern edge of the city, within the Bossche Broek, a protected wetland nature reserve directly connected to the urban core. This exceptional location allows visitors to experience a rapid spatial transition from the compact historical city to an open polder landscape within just a few minutes of walking. The area plays an important role in flood management while simultaneously offering high ecological and recreational value. The Paper presents semestral work, which was elaborated for the subject: Recreational Spaces Design taught at Slovak Uniersity of Agriculture in Nitra.

Results

The walk begins along the elegant Stationsweg, continue to the historical centre then continues into the intimate Molenstraat, a narrow and characteristic street lined with small boutiques and cafés. At the end of the street, Saint John's Cathedral suddenly rises above the surrounding buildings. From this point, the long route of 14.7 kilometers gradually leads you away from the urban core and into the surrounding landscape. The path moves toward the Moerputten nature reserve. The Moerputten Bridge lifts you high above the wetlands, offering wide and tranquil views across water, reeds, and sky. The elevated position creates a sense of distance from the city, allowing you to experience the landscape from a new perspective. After crossing the bridge, the route follows quiet, winding paths back toward the city, guiding you gently through the landscape. Westerpark provides a soft transition between nature and city. Water features, green lawns, and tree-lined paths create a calm and reflective atmosphere. The route then leads to the Bastionder, a remarkable underground space that reveals the hidden layers of the city's fortifications. The journey continues across the Paleisbrug, a modern pedestrian bridge that spans the railway and links the historic center with the contemporary Paleiskwartier district. From this vantage point, you can see both the old city skyline and the renewed urban landscape shaped by modern infrastructure. A short final stretch brings you back to the Stationsweg. For those seeking a shorter route, the walk remains closer to the city after visiting Saint John's Cathedral. Instead of heading toward the Moerputten, the path follows the canal directly toward Westerpark. This shorter route still offers a rich experience of water, greenery, and history.

Fig. 1: Analyses of the potential and limits of the area. PROS: 1. The walking route passes through the train and bus station, making it easily accessible, 2. Not everyone is familiar with the history of ´s Hertogenbos, 3. The culture of ´s Hertogenbos is rich, 4. Refreshment is available at the trail, 5. The presence of the water in different forms, 6. Variable environment, which you can pass through. CONS: 1. The history of this locality is not well known, 2. Different surfaces on the trail, 3. One part of the trail is alongside the road.

The information boards are primarily designed for an adult audience, as the content focuses on historical context, landscape processes, and spatial relationships. However, the design also considers accessibility for children by using clear layouts, visual elements, and readable compositions. This approach ensures that the boards remain engaging for a broader audience while maintaining their main focus on adult visitors.

The content of the educational boards are: 1. Water as a Weapon, 2. Working with Water, 3. Fortress City & City Landscape Relationship, 4. The Bossche Broek Today, 5. From Defense to Landscape, 6. Emptiness with a Function, 7. The Wet Landscape.

Bossche Broek stands as a living example of this long transformation. It functions simultaneously as a nature reserve, a recreational landscape, and a crucial component of the city's water system. Walking through the area offers insight into how history, water management, and landscape design are deeply intertwined. The route concludes by emphasizing balance: between city and countryside, control and natural processes, past and future. Visitors leave with a deeper understanding of how water continues to shape both the landscape and the life of 's-Hertogenbosch.

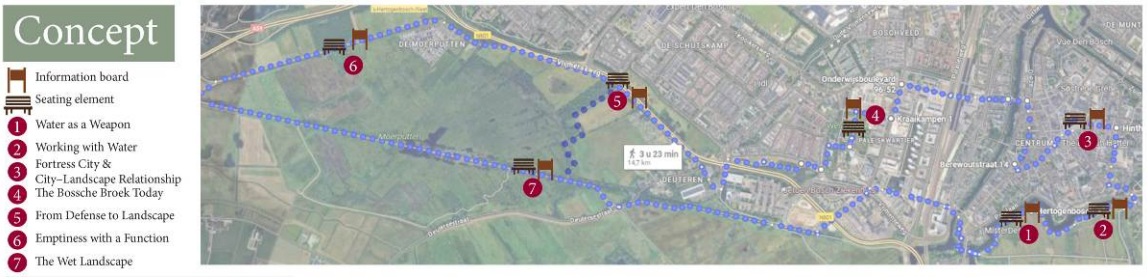

Fig. 2: Landscape- architectural proposal of the recreational and educational route

Discussion and Conclusion

There are several publications, which present the cooperation between the minucipalities (Bihuňová, Pomahačová, 2024), scientific institutions Tóth et al., 2018), Land association (Paganová, Kuczman, 2025) or others and Institute of Landscape Architecture FHLE SUA Nitra. Every cooperation gives a unique experience and motivation not only for students but also for teachers.

Presented landscape-architectural proposal of the walking route through ’s-Hertogenbosch offers a varied and accessible experience that combines urban life, culture, and landscape. One of the main strengths of the route is its excellent accessibility: it passes directly through the train and bus station, making it easy to reach for both residents and visitors. Along the route, the culture and identity of ’s-Hertogenbosch are strongly present, with historic streets, landmarks, and characteristic urban spaces that reflect the city’s rich history.

The route provides many opportunities to pause and enjoy the city. Terraces, cafés, and restaurants are located along the way, allowing walkers to take breaks and enjoy food and drinks. In addition, the variety of shops creates an active and lively atmosphere, offering additional recreational opportunities beyond walking alone. The presence of water plays an important role in the experience of the route, as it introduces continuous changes in the landscape, enhances spatial diversity, and prevents monotony during the walk.

Overall, the walking route presents a balanced experience in which accessibility, cultural richness, landscape variation, and recreational opportunities outweigh the challenges. With clear information and careful design, the route successfully connects city and countryside while offering a diverse and engaging walking experience.

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Souhrn
Pěší trasa vedoucí oblastí Bossche Broek se odvíjí jako souvislý příběh o vodě, krajině a proměňujícím se vztahu mezi městem ’s-Hertogenbosch a jeho okolím. Hned od prvních kroků do otevřené polderové krajiny se návštěvníci seznamují s územím formovaným vodou. Vlhký a rovinatý charakter této oblasti určuje nejen její ekologii, ale také její historickou roli jako ochranného nárazníkového pásma kolem města. Sezónní záplavy, vysoká hladina podzemní vody a otevřené obzory odhalují krajinu, která se neustále mění a je plná života. Voda se jeví nejen jako přírodní síla, ale také jako strategický nástroj. V minulosti proměnily řízené záplavy okolní mokřady v obranný systém a z vody se stala zbraň, která chránila pevnostní město. Bossche Broek funguje jako zásobárna vody, která absorbuje přebytečné srážky a chrání město před povodněmi. To, co se jeví jako nevyužitý prostor, je ve skutečnosti pečlivě zachovaná krajina, která umožňuje přirozeným procesům, aby se odehrávaly. Absence budov se stává záměrnou a zásadní designovou volbou.

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LANDSLIDE SCARPS, AS EXEMPLIFIED BY RECREATIONAL URBAN AREAS IN EUROPE AND SOUTH AMERICAN COASTAL CITIES

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Abstract

Landslide scarps are steep landforms formed at the top of a landslide, where a mass of earth or rock has separated from a stable subsurface. Their presence in cities poses a significant engineering challenge and a hazard to residents, given the availability of these dangerous areas for recreation and tourism. In Poland, in the Gdańsk and Sztutowo areas, the sand slopes of beach recreational areas are protected by retaining walls and an erosion-control plant (*Rosa rugosa*). Roses also serve a decorative function and are part of the protected landscape of Pomerania. In Lima, South America, slate slopes are protected by metal or linen nets that shield pedestrians, cyclists, and public transport. This is also a suitable habitat for groundcover plants, which can cover the drab landscape, but require irrigation, a pressing need in a country with limited water resources and the development of tourism in the Milaflores district due to picturesque ocean landscapes and the coastline offering beach leisure activities. This paper demonstrates climatic, cultural, and recreational differences and explores how landscape architecture and ecological engineering can address slope stabilisation in cities while simultaneously ensuring human well-being, the development of coastal leisure facilities, and the quality of recreation, as well as strengthening the role of tourism in protected landscapes in urban areas.

Key words: nature protection, recreation, cover plants, Lima, Gdańsk

Introduction

Landscape architecture and ecological engineering techniques in European and South American coastal cities differ significantly based on geological substrate, climatic challenges, and resource availability (Alexander, 1989; Begemann, 1999; Pike et al., 2003; Schuster & Highland, 2007; Latrubesse, 2009; Morino et al., 2022). This applies especially to places with different substrates and environmental conditions. Coastal towns often serve as places for recreation and tourism. However, they are not always adapted to the needs of visitors, e.g., unsecured or improperly sloped cliffs make it impossible for tourists to move around and engage in active recreation on beaches and squares, and consequently, there is a risk of injuries and, as a result, an economic decline in the region. This article brings the topic of managing land development in places with different substrates – stable and unstable soil- closer. Thanks to our research at the intersection of landscape architecture and ecological engineering, as well as recreation and tourism, we can obtain various examples and methods of stabilising slopes, which may provide a response to climatic events and El Niño, which destroy the landscape and economic resources of the area that require ongoing maintenance, post-warranty repairs, or revitalisation.

Material and methods

The study utilised materials collected during field research conducted by the team in the capital, Lima, and the Milafolres European district (Peru), and in the cities of Gdańsk and Sztutowo (Poland) in 2024-2025. The research employed a mixed-methods design (Alexander, 1989; Begemann, 1999; Niezabitowska, 2014; Morino et al., 2022), grounded in a literature review of slope stabilisation and recreational needs in coastal leisure areas. The research questions are as follows:

1) What are the differences in slope stabilisation between Gdańsk and Lima?
2) How does landscape architecture combine safety with tourism needs?
3) What is the role of ground cover vegetation in protecting cities from landslides?

Results

The coastal landscape of Pomerania (Poland) consists of sands that form dunes through changes in the landscape, weather, and storms. Recreational beaches look different each time. The permeable soil is a good place for shrubs such as roses (Rosa rugosa) and Scots pine (Pinus sylvestris), which naturally occur in this landscape (Figure 1).

The Miraflores district in Lima (Peru) is a European-style capital attracting many tourists. Maintaining these areas requires significant financial outlays, including irrigation and fertilisation, which are crucial in this part of South America. The area is abundant, with a large waterfront featuring playgrounds, soccer fields, and natural-surface pedestrian and cycle pathways. Active leisure zones are surrounded by grassy areas, shrubs, and ornamental trees typical of tourist resorts, which withstand the subtropical climate and serve decorative functions, influencing the local microclimate. From the Pacific Ocean side, a long beach stretches, with spaces for beach games, separated from the built-up area by a steep cliff mechanically shaped for the development of an expressway. The physical properties also require securing the steep and rugged slopes of the parent rock shale (Figure 2).
In European cities like Gdańsk and Sztutowo, selected for case research, stabilisation efforts are primarily aimed at sand slopes in beach recreational areas. The key issue is engineering methods (Begeman, 1999) that protect the slopes through a combination of retaining walls and erosion-control plants. However, an important issue in designing and protecting the site's landscape is vegetation selection, with the primary plant being the rugosa rose (*Rosa rugosa*). The roses serve a dual purpose: they provide structural stability while also serving as a decorative element considered an integral part of the protected landscape of Pomerania. These areas, although separated by a fence, are unfortunately common places for informal toilets because there are not enough toilets or they are not paid for. Recreation therefore takes place directly on the beach, close to the sea, where one can set up recreational equipment, as well as by enjoying the landscape on the pier, which is a common part of walks, especially on weekends (Figure 1).

Fig. 1: Development of the waterfront in Gdańsk and Sztutowo (Pomerania, Poland) – natural coastal vegetation protecting the slopes: pines (*Pinus sylvestris),* sedges (*Carex sp*.), dogwoods (*Cornus mas*), and rugosa rose (*Rosa rugosa*), a natural beach shaped by dunes and sea waves for active and passive recreation (used mostly in the summertime), and a wooden pier popular with tourists (all seasons). Photos by. A.Długoński, 2024.

In contrast, cities like Lima face slate slopes, requiring different technical interventions to manage a "drab landscape" and ensure public safety. Engineering methods based on stabilization (Morino et al.,

2022), which is achieved through the installation of metal or linen nets. These structures are vital for protecting pedestrians, cyclists, and public transport from potential rockfalls or landslides. While groundcover plants are used on these nets to improve aesthetics, they require artificial irrigation. This creates a significant engineering and environmental challenge because Peru has limited water resources. Looking at the Urban Context design methods in South America, they are often driven by the need to support rapidly developing tourism in coastal districts like Miraflores, where picturesque ocean landscapes have to be balanced against high geological risk (Figure 2).

Fig. 2: Development of the slope (multifunctional sports and walking park) in the Milaflores district (Lima, Peru). Photo by DJI Mini 4K Drone, Andrzej Długoński, 2025.

The Peruvian example is therefore a good result achieved by the designers on a relatively small area and with limited development possibilities. Recreation is possible, and the varied forms of recreation

offer sports in the evening due to lighting availability and residents' and tourists' free time. These elements make the slope area decorative and accessible to users both in winter and summer.
It is worth noting that South American techniques must account for extreme climatic events, such as the El Niño effect, which can trigger intense rainfall, floods, and landslides, placing immense pressure on coastal infrastructure. In many South American cities, rapid urbanisation has pushed informal settlements onto steep, hazardous slopes, making complex drainage systems and landslide mitigation a matter of critical life safety rather than just landscape aesthetics.

Discussion

Differences in slope stabilisation between Gdańsk – Sztutowo and Lima result from different geological and climatic conditions and available resources. In Pomerania, Poland, the sandy slopes of recreational areas near beaches are protected with retaining walls and erosion-control vegetation. The main species used to reinforce the slopes is *Rosa rugosa*. This plant, besides its stabilising function, serves a decorative purpose and is considered part of the protected landscape of Pomerania. In Lima, South America, slate slopes are secured using metal or linen nets. These solutions primarily aim to protect pedestrians, cyclists, and public transport. Ground cover plants are planted on the nets to improve the aesthetics of the 'grey landscape. However, unlike in Pomerania, vegetation in Lima requires artificial irrigation, which poses a significant challenge given the country's limited water resources.
The review of sources and our observations, however, do not mention specific plant species used in the capital of Peru. They only point to a significant challenge related to their maintenance: due to Peru's dry climate and limited water resources, these plants require artificial irrigation. In comparison, in the case of Gdańsk, sources precisely indicate the use of rugosa rose (*Rosa rugosa*). Linen nets support vegetation on slopes primarily by creating a suitable habitat for ground cover plants. It is, however, worth remembering that in dry conditions (as in Lima), the net alone is not enough for vegetation to survive – artificial irrigation is also required, which constitutes a major challenge due to limited water resources in Peru.

Conclusions

In summary, while Polish examples focus on the natural integration of vegetation into the protected landscape, Peruvian examples rely on technical solutions (nets) and face difficulties maintaining greenery in a dry climate. However, both studied cases share the aim of ensuring safety in areas of intense tourist and recreational traffic.
Our results indicate that plants with anti-erosion properties effectively protect unstable coastal soils. The rugosa rose (*Rosa rugosa*) is considered effective in coastal protection, primarily responsible for stabilising sandy slopes. It is used to protect sandy embankments in recreational areas near beaches (e.g., in Gdańsk and Sztutowo), often in conjunction with technical solutions, such as retaining walls that separate the recreational area from areas protected for natural plants. Thanks to natural reinforcements, the recreational landscape is not destroyed and remains decorative. Anti-erosion plants are therefore a good solution for sandy shores to preserve recreation and the protected natural landscape of Pomerania.
In Lima, rocky soils make it difficult to plant plants that improve the region's landscape aesthetics and tourism in Peru. On metal or linen nets securing the slopes in Lima, ground-cover plants are planted to enhance aesthetics and cover the grey landscape. Their primary function is to ensure safety and protect users of urban spaces, including pedestrians, cyclists, and public transport users, from hazards resulting from the proximity of shale slopes. An important role is to cover the "grey landscape" and improve the aesthetic qualities of the coastline. On steep slopes and rocky terrain, ropes and nets with climbing vegetation work well, which allows for safe recreation, and this is a commonly used method in mountainous areas.

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Souhrn
Tento výzkum ukazuje, jak se krajinářská architektura a ekologické inženýrství využívají ke stabilizaci pobřežních svahů náchylných k sesuvům půdy v různých městských prostředích za účelem aktivní i pasivní rekreace a cestovního ruchu. Porovnáním případových studií z Gdaňsku a Sztutowa (Polsko) a Limy (Peru) poukazujeme na to, jak odlišné geologické a klimatické podmínky určují různé stabilizační strategie. V Polsku jsou písčité náspy zpevňovány kombinací opěrných zdí a rostlin bránících erozi, jako je růže rugosa (Rosa rugosa). Naopak břidlicové útesy v Limě vyžadují technické zásahy, jako jsou kovové nebo lněné sítě, které chrání dojíždějící a turisty před padajícími kameny. Zatímco obě oblasti usilují o posílení cestovního ruchu a veřejné bezpečnosti, případ Peru poukazuje na další výzvu, kterou představuje udržení zeleně uprostřed závažného nedostatku vody a podpora udržitelné rekreace a místní ekonomiky.

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LEARNING GAINS AND STUDENT RESERVATIONS: EVALUATING A GPT-BASED AI ASSISTANT IN GEOGRAPHY TEACHING

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Abstract
This study examines the educational potential of a GPT-based AI assistant designed to support university geography students in practising geographical relationships, developing geographical thinking, and improving their ability to explain geographical topics clearly and accurately. The assistant was implemented in an experimental teaching setting involving four seminar groups: two received access to the AI tool, while the remaining two followed standard instruction without it. Student performance was evaluated through a pre-test/post-test design. The results indicate that students who used the AI assistant achieved significantly better learning outcomes than those in the control group. At the same time, the findings reveal an important tension between effectiveness and acceptance: despite improved performance, 54% of students using the AI assistant reported a preference for conventional teaching. This apparent paradox suggests that measurable learning gains do not automatically translate into positive student attitudes toward AI-supported learning. The study discusses two possible explanations for this result: first, the relational and affective dimensions of teaching, including teacher friendliness, empathy, and interpersonal support; and second, the AI assistant's strictness, particularly its tendency to reject imprecise or insufficiently accurate answers.

Key words: geography education, GPT-based AI assistant, geographical thinking, learning outcomes, student perceptions

Introduction

Artificial intelligence (AI), particularly generative AI based on large language models, has become a prominent topic in higher education due to its capacity to generate explanations, respond interactively, and provide scalable academic support across diverse learning tasks. At the same time, its expansion has raised concerns regarding reliability, academic integrity, student dependency, and the changing role of teachers (Milano, McGrane & Leonelli, 2023; Lee et al., 2024). A key advantage of AI-supported learning lies in its ability to offer immediate, flexible, and partly personalised assistance, including repeated practice, adaptive explanation, and formative feedback, which makes it relevant not only as an information source but also as a tutoring tool (Chan & Hu, 2023). Students often value generative AI for brainstorming, writing support, idea clarification, and personalised feedback, while recent reviews highlight its growing role in personalised learning pathways in tertiary education (Fortuna et al., 2025).

However, the educational significance of generative AI cannot be understood solely in terms of efficiency. Student perceptions remain ambivalent, combining appreciation for speed and convenience with concerns about accuracy, bias, privacy, ethics, and over-reliance on machine-generated responses (Chan & Hu, 2023). This tension is particularly relevant in geography education, where learning depends not only on factual recall but also on understanding relationships between phenomena, interpreting spatial complexity, and explaining causal links in a clear and structured manner (Drápela, 2023). Although AI tools may therefore support the development of geographical reasoning, geography teaching also relies on guidance, dialogue, and the gradual formation of disciplinary thinking in a social learning environment (Lee et al., 2024; Chan & Tsi, 2024). Current debates likewise stress that, despite their interactive capacities, generative AI tools cannot replace the relational and affective dimensions of teaching that shape engagement and trust (Kim et al., 2025). Student–teacher rapport, empathy, and interpersonal support remain central to meaningful learning, which is why teachers are unlikely to become obsolete even in AI-supported education (Sybing, 2019; Zhou, 2022). Against this background, the present paper examines a GPT-based AI assistant developed for university geography students to support the practice of geographical relationships, the development of geographical thinking, and the formulation of clear and accurate explanations. Using an experimental design with four seminar groups, two with access to the assistant and two following standard instruction, the study evaluates both its effect on learning outcomes and the extent to which positive student acceptance accompanies improved performance.

Material and methods

The experiment was conducted in the course Economic Geography, in which 160 students were originally enrolled. Of these, 138 students completed the course and were included in the final evaluation. The experimental group consisted of two seminar groups totalling 78 students. These students were instructed to use the GPT-based assistant during the semester, and their use of the tool was encouraged and monitored. The control group consisted of 60 students from seminar groups that did not have access to the assistant.

At the beginning of the semester, a pre-test was administered to determine students' initial knowledge level. The results showed no statistically significant differences between the experimental and control groups, indicating a comparable starting level.

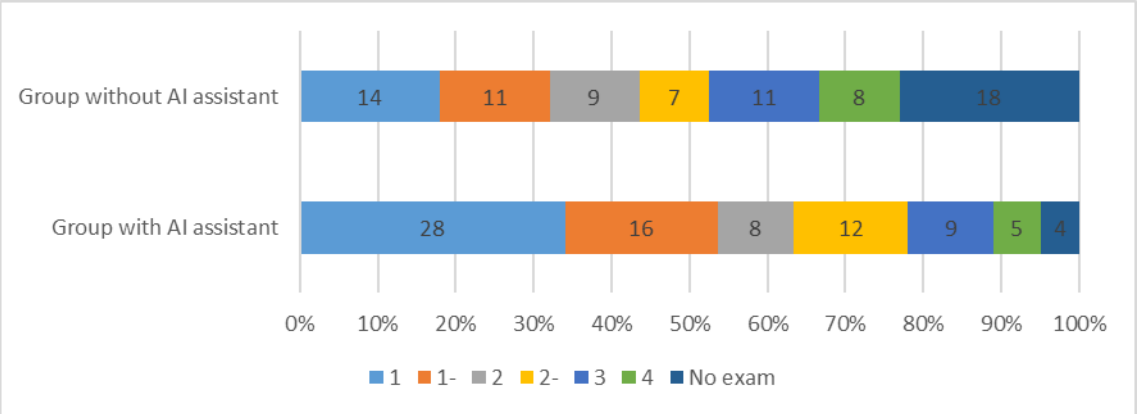
The intervention was based on a custom GPT model created by the course instructor under the title "Tutor of Economic Geography." The model was developed on the ChatGPT platform and built on course materials, including the course textbook, lecture presentations, and additional supporting materials. The assistant was designed to examine students on the subject matter covered in the course. In cases of incorrect or incomplete answers, it provided hints leading students toward a correct response. At the same time, it was able to generate questions of varying difficulty and to focus selectively on particular parts of the curriculum.

At the end of the semester, student performance on the final test was evaluated to assess whether access to the assistant affected learning outcomes. In addition, students in the experimental group completed a short questionnaire reflecting on their experience with using the AI assistant.

Results

Table 1 presents a comparison of the final test results between the group required to use the AI assistant and the group without access to it. The difference is immediately apparent: students in the experimental group achieved markedly better outcomes. More than half of the students in the experimental group received grades of 1 or 1−, whereas fewer than one-third of the students in the control group did. The results also indicate a substantial reduction in the semester failure rate, defined here as a student not taking the final examination.

Tab. 1: Final exam results for the experimental and control groups



At the same time, the results reveal a striking paradox. Although the AI assistant appears to have contributed to significantly better learning outcomes, student attitudes towards it remained rather reserved. In the final questionnaire, 54% of students (42) who used the assistant stated they still preferred conventional teaching, while only 29% (23) evaluated the assistant positively. Interestingly, the analysis of responses to the open-ended question, in which students were invited to describe their experience with the AI assistant in their own words, showed that only a very small number explicitly mentioned factual or technical errors, even though such limitations were in fact present, for example, in tasks involving numerical calculation or ordering. Instead, the dominant criticism concerned the assistant's interaction style. Students frequently described it as overly strict in its evaluation of answers, insufficiently empathetic, and lacking the human element they associate with effective learning. Some responses also suggested that repeated failure to provide a fully correct answer led to frustration and even feelings of inadequacy. On the other hand, students also identified several clear advantages of the tool, particularly the possibility of using it anytime and anywhere via their own mobile phone, the conversational format of interaction, the ability to turn repetitive revision into a relatively engaging activity, and an overall appreciation of having such a support tool available.

Discussion and Conclusion

The findings point to an apparent paradox: measurable learning gains do not automatically translate into positive student attitudes towards AI-supported learning. Although students who used the GPT-based assistant achieved significantly better academic results, a majority still preferred conventional teaching. This suggests that the effectiveness of an educational tool cannot be evaluated solely through performance outcomes. Students may benefit cognitively from a particular form of learning support while simultaneously perceiving it as less attractive, less comfortable, or less motivating than traditional teacher-led instruction.

One possible explanation lies in the relational and affective dimension of teaching. Learning is not only a cognitive process, but also a social and emotional one. In conventional classroom settings, students are accustomed to forms of support that include teacher friendliness, empathy, encouragement, and interpersonal understanding. These qualities help create a sense of safety and trust that can be highly important for motivation and willingness to engage with challenging content. Even if an AI assistant improves performance, it cannot fully replicate the human dimension of interaction that many students continue to value as an essential part of the educational experience.

A second explanation may be found in the assistant's strictness, especially in its tendency to reject imprecise or insufficiently accurate answers. From a pedagogical point of view, this strictness may have contributed to better learning outcomes by forcing students to formulate their responses more precisely and to engage more carefully with the subject matter. At the same time, however, such an approach may have been experienced as frustrating. In the Czech educational context, many students have become accustomed to a system in which demands are often softened, grading is moderated, and insufficiently precise answers are frequently tolerated to some extent. The AI assistant did not operate in this way. Instead, it consistently insisted on correctness and precision, which may have left students feeling academic strictness they found uncomfortable or discouraging. In this sense, the negative reactions to the assistant may reflect not only its technological nature, but also a broader tension between rigorous feedback and student expectations shaped by prior educational experience.

In conclusion, these findings suggest that the future educational use of AI should not be understood simply in terms of whether it improves results, but also in terms of how students experience its mode of interaction. If AI tools are to be more widely accepted, their design may need to combine cognitive rigour with a more supportive and emotionally sensitive style of communication.

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Souhrn
Tento článek analyzuje vzdělávací potenciál asistenta s umělou inteligencí založeného na modelu GPT, který je navržen tak, aby podporoval vysokoškolské studenty geografie v procvičování geografických souvislostí, rozvíjení geografického myšlení a zlepšování jejich schopnosti jasně a přesně vysvětlovat geografická témata. Asistent byl implementován v experimentálním výukovém prostředí zahrnujícím čtyři seminární skupiny, z nichž dvě měly přístup k nástroji s umělou inteligencí, zatímco zbývající dvě skupiny absolvovaly standardní výuku bez něj. Výkon studentů byl hodnocen pomocí pretestu a posttestu. Výsledky naznačují, že studenti, kteří používali asistenta s umělou inteligencí, dosáhli výrazně lepších studijních výsledků než studenti v kontrolních skupinách. Zároveň zjištění odhalují důležité napětí mezi efektivitou a akceptací: navzdory zlepšenému výkonu 54 % studentů používajících asistenta s umělou inteligencí uvedlo, že dává přednost konvenční výuce. Tento zdánlivý paradox naznačuje, že měřitelné studijní zisky se automaticky nepromítají do pozitivního postoje studentů k učení podporovanému umělou inteligencí. Studie diskutuje dvě možná vysvětlení tohoto výsledku: zaprvé, relační a afektivní dimenze výuky, včetně vstřícnosti učitele, empatie a interpersonální podpory; a zadruhé, přísnost asistenta s umělou inteligencí, zejména jeho tendence odmítat nepřesné nebo nedostatečně přesné odpovědi.

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MINING HERITAGE IN THE CULTURAL LANDSCAPE OF THE VYSOČINA REGION: RESIDENTS' AWARENESS AND PERCEPTION OF TOURISM VALUE

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Abstract
Historical mining activities have significantly shaped the cultural landscape of the Vysočina Region in the Czech Republic. Numerous relics of medieval mining remain preserved and represent an important resource for tourism development. However, residents' awareness and engagement with mining-related sites remain under-explored.
This paper aims to analyse residents' awareness of selected mining heritage sites and their perception of the tourism value of this heritage in the Vysočina Region. The study draws on a questionnaire survey of 996 respondents conducted among residents of the regional centre Jihlava and several smaller municipalities historically connected with mining. The analysis is based primarily on descriptive statistical methods and focuses on residents' awareness, personal visitation of mining heritage sites, and their attitudes toward the use of these sites in tourism. Data were collected between May 2024 and December 2025 through a structured questionnaire distributed online and in person.
The study provides insights into residents' awareness of mining-related sites, including their personal visits, and into how residents perceive mining heritage as a tourism resource across different locations. The results contribute to a better understanding of how local communities relate to mining heritage and may inform destination management, heritage interpretation, and community-based tourism strategies in post-mining landscapes.

Key words: cultural heritage tourism; cultural identity; destination management; residents' attitudes; post-mining sites

Introduction

Historical mining activities shaped the cultural landscape of the Vysočina Region, leaving extensive post-mining sites linked to silver, iron, antimony, and copper extraction since the Middle Ages (Derner et al., 2019). Today, this heritage forms an integrated system of mines, watercourses, and settlements – a key resource for cultural heritage tourism, shifting from production to recreation, education, and regional identity (Conlin & Jolliffe, 2010; Berkenbosch et al., 2022).
Mining heritage strengthens cultural identity and local pride, directly influencing residents' attitudes and their word-of-mouth (WOM) promotion of sites to visitors (Gursoy et al., 2002; Pachrová et al., 2017; Stylidis, 2018;). Residents who are aware of and attached to local attractions are more likely to recommend them, thereby enhancing destination attractiveness through authentic communication.
Although the significance of mining heritage for regional development is frequently emphasized in both academic and policy debates, there remains a relatively limited understanding of residents' awareness and perceptions of specific mining sites (Conlin & Jolliffe, 2010; Sharpley, 2014). In the case of the Vysočina Region, the situation is further complicated by the spatial dispersion of mining sites, varying degrees of their preservation, and diverse levels of tourism development. While some locations are integrated into local projects, regional tourism products, or interpreted within broader historical and landscape contexts, others remain on the margins of public attention and are used mainly at a local scale (Graham et al., 2000; Woosnam & Aleshinloye, 2018; Čihák et al., 2025). Within this context, it is essential to understand the extent of residents' awareness of key mining sites, their personal experience with visiting these places, and how they perceive their tourism value.
This article aims to analyse residents' awareness of selected mining heritage sites and their perception of the tourism value of this heritage in the Vysočina Region, emphasising cultural identity and WOM potential. The results contribute to understanding local community relations and inform destination management, heritage interpretation, and community-based tourism strategies.

Material and methods

The study employed a questionnaire survey among 996 residents of Jihlava and nine smaller mining-linked municipalities in the Vysočina Region. Data were collected from May 2024 to December 2025 via CAWI (Microsoft Forms, disseminated through social media, email, and local newspapers) and complementary PAPI methods in public spaces.

Quota sampling ensured proportional representation of the population by age, gender, and education. Sample distribution is shown in Table 1.

Tab. 1: Sample distribution by municipality and respondents' characteristics

Municipality	Number of respondents
Jihlava	698
Bartoušov	21
Česká Bělá	34
Fryšava	24
Kadov	22
Přibyslav	73
Sněžné	33
Štěpánov nad Svratkou	31
Stříbrné Hory	30
Vyskytná	30
Total	996

Characteristic	%	N
Gender		
Male	46,9	467
Female	53,1	529
Age		
15–19	21,8	217
20–34	13,6	135
35–49	22,3	222
50–64	18,9	188
≥65	23,5	234
Education level		
Primary	25,2	251
Secondary	52,4	522
Higher	22,4	223

The questionnaire featured closed-ended questions: dichotomous (awareness of mining sites), multiple-response (visitation), and two 5-point Likert-scale items (pride in visitors; willingness to recommend). Data were processed in Excel using descriptive statistics, aggregated by Jihlava vs other municipalities, and visualised via stacked bar charts for clarity.
Informed consent was obtained from all respondents, ensuring full anonymity.

Results

This section presents selected results from the questionnaire survey, focusing on residents' awareness of mining heritage sites, their visits to selected locations, and their attitudes toward their use in tourism. The analysis is based on four key survey questions: knowledge of mining-related sites, personal visits, pride in tourism in the area, and willingness to recommend these sites to visitors.
Figure 1 presents the level of residents' awareness of mining-related sites and their reported visits to such sites in Jihlava and other municipalities. In both cases, the results indicate a relatively high level of awareness and visitation. In Jihlava, 80% of respondents reported awareness of mining-related sites, and 93% reported visiting at least one such location. A similar pattern can be observed in other municipalities, where 82% of respondents reported awareness and 88% reported at least one personal visitation.

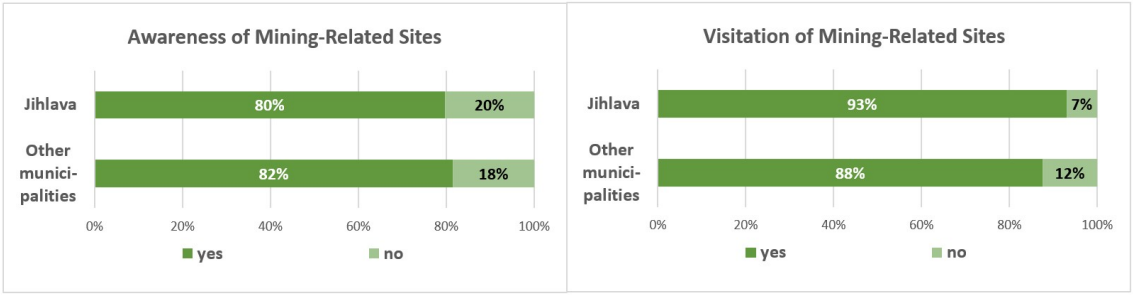

Fig. 1: Respondents' awareness and visitation of mining-related sites

Interestingly, the proportion of respondents reporting visits slightly exceeds those declaring awareness of mining-related sites. This apparent inconsistency may be explained by the fact that some locations (e.g. commonly visited places or museums) are not always consciously perceived by respondents as part of the mining heritage. The results thus suggest that mining-related sites are not only relatively well known among residents, but are also actively used, even if not always explicitly recognised as elements of mining heritage.

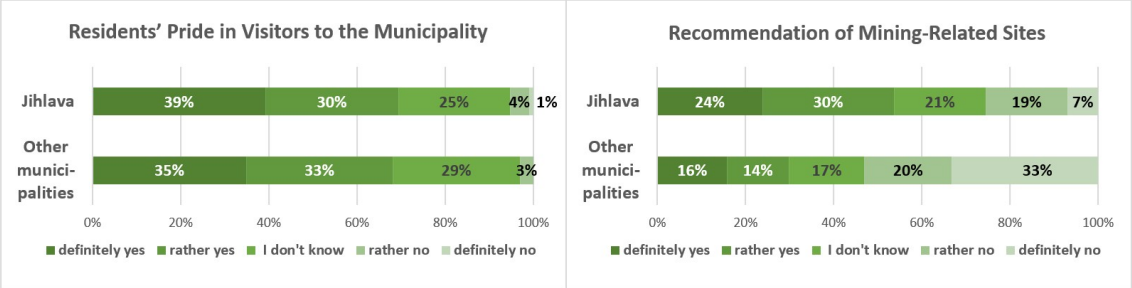

Fig. 2: Residents' pride in visitors and recommendation of mining-related sites

Figure 2 presents residents' attitudes toward tourism, as reflected in their pride in visitors and their willingness to recommend mining-related sites. In both Jihlava and other municipalities, the results indicate a generally positive attitude toward tourism. A substantial proportion of respondents report feeling proud when their municipality is visited, with positive responses (definitely yes and rather yes) prevailing in both groups (Jihlava: 69%, other municipalities: 68%).

At the same time, a more differentiated pattern emerges in the case of recommendation behaviour. While residents in Jihlava show a relatively balanced distribution of responses, with prevailing positive responses (54% definitely yes and rather yes), respondents from other municipalities demonstrate a higher share of neutral and negative answers, including a notably higher proportion of "definitely no" responses (33%). This suggests that although mining heritage is broadly accepted as part of local identity and is associated with positive attitudes toward visitors, this does not automatically translate into active recommendation behaviour.

These findings highlight the importance of cultural identity and personal experience in shaping residents' willingness to promote mining heritage through WOM communication. While pride in place appears to be relatively strong across the region, the readiness to recommend specific sites varies, particularly in smaller municipalities. This may reflect differences in the visibility, accessibility, or perceived attractiveness of individual sites, as well as varying levels of integration of mining heritage into local tourism offers. In this context, Jihlava's role as a regional centre appears particularly significant. The results suggest that mining heritage is more strongly embedded in cultural identity in Jihlava, where higher levels of visitation and recommendations to visit mining-related sites can be observed. This may be related to the more intensive presence of heritage interpretation, cultural activities, and public visibility of mining history, which contribute to residents' everyday experience and the reinforcement of this identity.

Conclusion

This study illuminates residents' high awareness of and visitation to mining heritage sites, alongside their perceptions of these sites as valuable tourism resources, with notable differences between Jihlava and the surrounding municipalities. With great regional pride in visitors (68-69%) yet differentiated recommendation behaviours – higher in Jihlava (54% positive) – the findings reveal how cultural identity and personal experiences shape community engagement. These insights enhance understanding of local relations to mining heritage and offer actionable guidance for destination management, heritage interpretation, and community-based tourism strategies in post-mining landscapes.

The analysis has limitations. It relies on descriptive statistics, precluding deeper variable analysis, and features uneven respondent distribution dominated by Jihlava, limiting local comparisons. Minor inconsistencies between awareness and visitation reflect varying understandings of mining heritage.

Future research should employ advanced statistical methods, target individual municipalities, and examine cultural identity and word-of-mouth in residents' attitudes toward mining heritage tourism, especially for community-based development.

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Souhrn
Historická těžba formovala kulturní krajinu kraje Vysočina a zanechala středověké pozůstatky, které by mohly sloužit jako turistický zdroj úzce spjatý s místní kulturní identitou a postojem místních obyvatel k cestovnímu ruchu. Tato studie zkoumá povědomí a vnímání turistické hodnoty vybraných lokalit hornického dědictví ze strany místních obyvatel prostřednictvím dotazníkového průzkumu mezi 996 respondenty z Jihlavy a devíti menších obcí spojených s hornictvím (květen 2024 – prosinec 2025; CAWI/PAPI). Deskriptivní analýza se zaměřuje na povědomí, návštěvnost a postoje k cestovnímu ruchu. Výsledky ukazují vysoké povědomí a návštěvnost napříč lokalitami (návštěvnost často převyšuje deklarované povědomí, což naznačuje podvědomé využívání dědictví). Obyvatelé vyjadřují velkou hrdost na návštěvníky, ale ochota doporučit je nižší – zejména v menších obcích –, což naznačuje, že pozitivní identita nezaručuje aktivní propagaci formou ústního podání. Jihlava vykazuje silnější integraci kulturního dědictví prostřednictvím vyšší návštěvnosti a doporučení, což zdůrazňuje roli regionálního centra. Zjištění zdůrazňují roli kulturní identity a zážitků při formování postojů a nabízejí poznatky pro management destinací, interpretaci kulturního dědictví a komunitní cestovní ruch v post-těžebních regionech.

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NATURAL HAZARDS WITHIN THE REACH OF IMPORTANT HIKING TRAILS IN THE TATRA MOUNTAINS (SLOVAKIA)

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Abstract

Over the past 40 years, we have observed increased dynamics of processes in all vegetation levels of the Tatras, both in summer and winter. As a result, the risk of endangering hiking trails and ski slopes has increased, which is confirmed by several sudden events with fatal consequences for the lives of tourists. A greater number of sudden events are related to avalanches during the early spring period, while in the summer period there are storms and intense supercell rains. In both cases, there were fatal consequences for people's lives.

The aim of the paper is to point out processes that have a sudden course with an impact on hiking trails, infrastructure and pose a high threat to tourists themselves. On the other hand, knowledge of the dynamics and course of morphodynamic processes is the starting point for strengthening the infrastructure and management of tourism in high mountains.

Key words: Morphodynamic processes, hiking trails, climatic changes, natural hazards

Introduction

The Tatras represent the highest mountain range of the Carpathians, which has provided opportunities for the development of tourism and travel since the 19th century, which was highlighted by the construction of the Czech-Bohumín railway in 1864. The High Tatras region (Poprad and Kežmarok districts) recorded a total of 912 000 accommodated visitors in 2025.

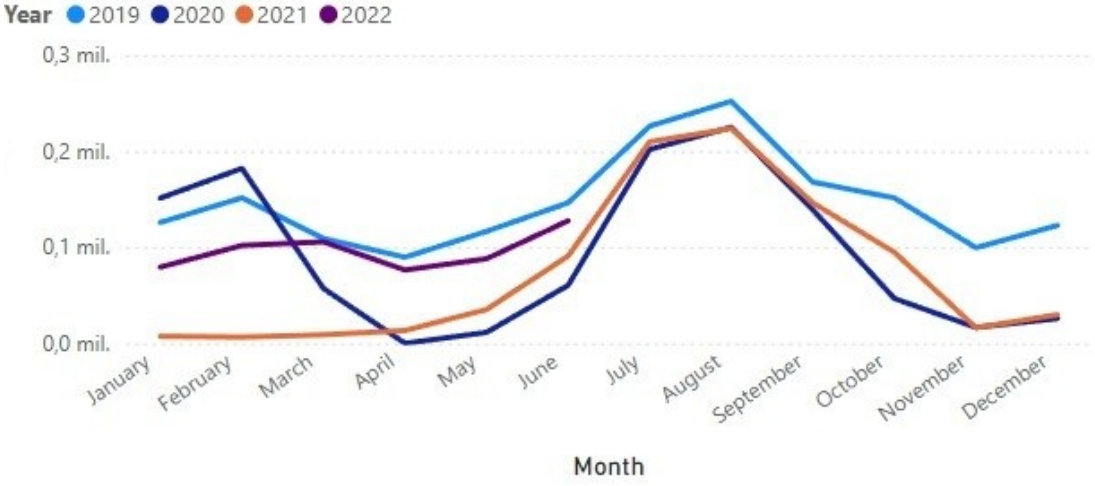

Fig. 1:Overnight stays on a monthly basis (Source: Slovak statistical office and Regional Tourism Organization Region Vysoké Tatry)

As we can see from the data in Figure 1, the number of visitors peaks in two periods of the year, namely in February and August. This indirectly implies the possibility of natural hazards in the summer and winter season to which the occurrence is linked such as flash floods, hydro-gravitational geomorphic processes and snow avalanches.

At the beginning, it should be said that under the term "significant hiking trails" includes trails open year-round, ski touring areas, and trails that lead to tourist huts (cottages). All of these areas represent locations with a certain degree of threat from flash floods, snow avalanches, debris flows and landslides to rock falls and collapses. In this paper, we focused on identifying and classifying the threat of selected tourist areas represented by hiking trails sections, with subsequent proposals for protection against possible risks for tourists and the hiking trails themselves.

Material and methods

The starting point for this kind of focused research is long-term field research and observation of geomorphic processes, including their connection with climatic variables such as local storms or sudden warming of the air. However, these interactions have been the subject of our other studies and articles. A good basis for identifying threats in the vicinity of trails are primarily ground photographs that we conducted during research or that were provided to us by employees of the Tatra National Park Administration and employees of the Mountain Rescue Service. We determined the threat assessment by expert estimation based on the number and frequency of events and their effects on the environment and tourist infrastructure.

Based on these estimations, a set of 9 study areas have been selected (Table 1). These areas are represented by hiking routes sections derived from OpenStreetMap data and processed in ArcGIS Pro 3.6.

Tab. 1: A list of study areas and their characteristics

Site code	*Site name*	*Location*	*Main activity*
RV	Roháčska dolina	Western Tatra Mts. (north)	ski touring, hiking
ZV	Žiarska dolina	Western Tatra Mts. (south)	ski touring, hiking
PPL	Popradské pleso	Mengusovská dolina, High Tatra Mts.	hiking
CPR	Chata pod Rysmi (cottage)	Mengusovská dolina, High Tatra Mts.	hiking
HZC	Hrebienok - Zamkovského chata (cottage)	Studené doliny, High Tatra Mts.	hiking
ZC	Zbojnícka chata (cottage)	Veľká Studená dolina, High Tatra Mts.	hiking, ski touring
TC	Téryho chata (cottage)	Malá Studená dolina, High Tatra Mts.	hiking, ski touring
KP	Kopské sedlo	Zadné Meďodoly, Belianske Tatry Mts.	hiking
PC	Chata Plesnivec (cottage)	Dolina siedmich prameňov, Belianske tatry Mts.	hiking

Results

Based on previous knowledge and published works, we present the basic characteristics of natural threats that have actually affected hiking trails or the infrastructure in their vicinity and in some cases could also endanger tourists.

Avalanche events (AV)

The most significant avalanches, which endangered hiking trails, infrastructure, and even hikers and ski tourists themselves, have occurred since year 2000 in several locations in the Tatras. The first important location of the avalanches we consider the Žiarska valley in the Western Tatras. In the Eastern Tatras (Belianske Tatry Mts.), the most endangered areas Zadné Meďodoly valley and Dolina Siedmich prameňov valley. In the High Tatras, this is primarily the Mengusovská valley and Malá Studená valley.

Debris flows (Df)

Currently, very active debris flows have been observed for a long time in the areas of Mlynická valley, Mengusovská valley, Javorová valley, Zadné Meďodoly valley, Veľká studená and Malá Studená valleys. In the area of Malá Studená valley, we confirmed the current manifestations of a massive debris flow under the walls of Lomnický peak, whose source area begins at an altitude of approximately 2200 m above sea level. Its length in 2014 was approximately 1250 m, which is 50 m more than in images from 2004. Its width in the accumulation zone has also increased from the original 5-12 m to 96 m (Tomko-Králo, 2015).

Rock falls (Rf)

The activity of gravitational processes of rock slopes and walls is predominantly situated in valleys with a large relative elevation of ridges and peaks. A significant factor is the presence of discontinuities of rock massifs in the form of primary separation surfaces, mylonite zones and a secondary network of fractures. The occurrence of rock collapse or falling fragments occurs most often in the spring due to the heating of rock slopes by increased solar radiation and the effects of ice in fracture systems. From the observed events in the last 20 years, we have identified an increased frequency of free falling fragments, but also concentrated collapse in rocky troughs. The falling is also accompanied by forms of rock collapse in the form of massive blocks of 2-5 m in size with identified fresh abrasions on the surface of boulders and grooves with crushed blocks on the surface of often stabilized debris cones. The most recent cases of rockfall occurred on the trail in the area of the mouth of the Studená valley, at the entrance to the Mengusovská valley, and permanent falling of debris is observed above the trail in the Zadné Meďodoly valley to the Kopské sedlo (pass).

Landslides (Ls)

In the Tatras region, we have confirmed an increased incidence of landslides, which are closely related to intense precipitation events in 2010 and 2013, similarly to the case of debris flows. The slopes of moraines, glacifluvial cones and slopes formed by mesozoic rocks are often affected, as is the case in the Belianske Tatry Mts. and Javorová Valley. In many locations, the formation of landslides is initiated after the windstorm events and as a result of the alluvial effect of snowfields. The areas are exposed to erosion processes with the subsequent formation of erosion grooves and potholes. Some of the landslides directly threaten or destroy hiking trails, which causes not only a difficult passability or changes in route alignment, but also total closures of the affected route sections.

Flash floods (Fl)

Flash floods represent an extreme case of surface water runoff, when not only the river floodplain is flooded, but in mountainous areas also the bifurcation of the riverbed and the displacement of large amounts of sediment. We have observed the occurrence of floods in the mountain streams of the Tatras since 2008 – Javorová valley, 2018 – Javorová valley, 2023 – Hlboký potok (creek) – Tatranská Lomnica, 2024 – Monkova valley, Studená valley. In addition, destructions of hiking trails and roads, damaged bridges, underground electrical lines, water sources and water supply infrastructure, and landslides due to bank slopes undercuts have been recorded.

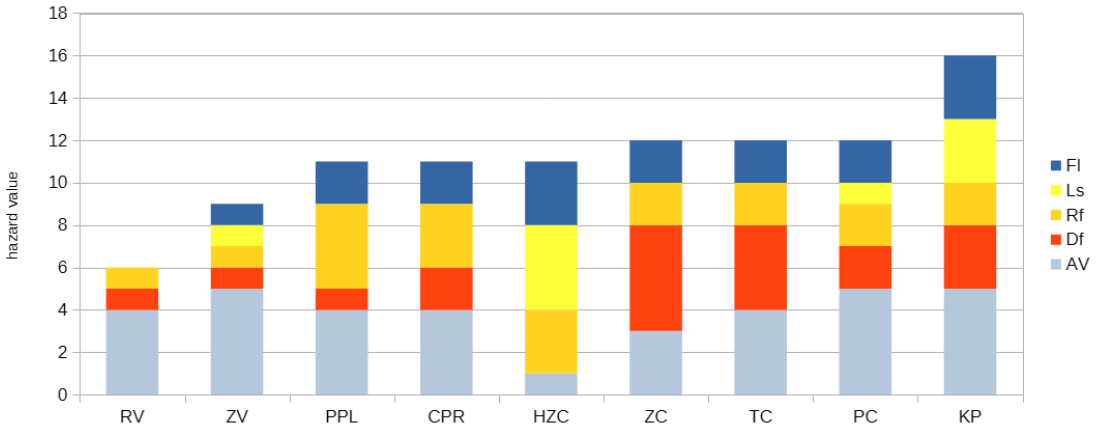

Fig. 2: Evaluation of natural hazards in the last 25 years in selected valleys in the Tatras.

The graph (Figure 2) shows the ranking of sites based on evaluation of each hazard type as well as the cumulative values. Practically all locations show significant threat values, where 12 points and above indicate the extreme threat to hiking trails. The assessment exhibit also regional differences between individual locations, with lower cumulative and individual hazards in the Western Tatras (RV, ZV), except for snow avalanches (Figure 3). The High Tatra and Eastern Tatra regions reflect more diverse abiotic conditions and land cover in higher values and more even proportionality of natural hazards. However, one of the study areas, the hiking trail from Tatranská Javorina to Kopské sedlo in Zadné Meďodoly valley (KP), stands out significantly, with high values of all evaluated hazard types.

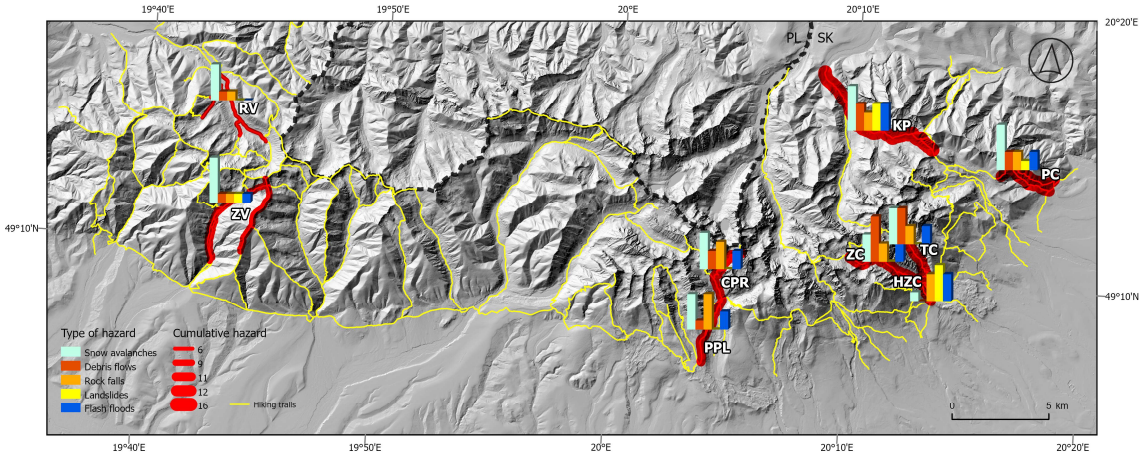

Fig. 3: Location and natural hazard values of the study areas in the Tatras (Basemap: merged hillshaded LiDAR DEMs from Slovak and Polish open data sources – ÚGKK SR; GUGiK)

Discussion

The presented results point to a high degree of morphodynamic potential of the Tatras as the highest mountain range of the Western Carpathians. Natural threats are such an important category of environmental assessment of the territory as pointed out by Drdoš, (1992), Minár et al. (2006), Hreško et al. (2011, 2022), and Krajčí et al. (2019). Climatic factors, especially intense precipitation totals and the aforementioned sudden changes in air temperature, have contributed to the intensity of the processes over the last 20 years. The intensity of extreme precipitation has increased compared to older measurements carried out by Niedźwiedz (2003). As stated by Kotarba (2005), since 1995 we have been observing a transition to a humid climate in the Tatras with the development of fluviation processes, i.e. manifestations of area and concentrated surface runoff in the form of erosional streams and grooves. In accordance with what we stated in the article Bugár, Hreško, Piscová (2025) the mentioned processes create limit conditions for the implementation of tourist activities in the supramontane and alpine stages of high mountains. At the same time, as Pelfini, Brandolini (2010) emphasized that information about natural hazards should be clearly expressed as part of tourist maps, which are such a preventive tool for risk mitigation in the extreme environment of high mountains.

Conclusion

The results show that a significant part of the selected routes, according to the above conditions, have a high probability of being endangered both in summer and in winter. According to the impacts of processes on tourists, tourist trails and the environment, avalanches, water-gravitational processes and floods are most common, and to a lesser extent rockfalls and landslides. Also in this case we point out the cumulative effect of processes, which brings the degree of threat of individual parts of the trails into higher categories.

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Souhrn
V příspěvku jsme navázali na problematiku přírodních hrozeb v okolí turistických stezek Tater s důrazem na významné trasy, které zpravidla směřují k turistickým chatám, mají význam při rychlém nástupu na túry a zároveň plní podmínku celoroční otevřenosti – dostupnosti. Z dosavadních výsledků vyplývá, že podstatná část vybraných tras podle uvedených podmínek má vysoký předpoklad ohrožení jak v letním, tak v zimním období. Podle dopadů procesů na turisty, turistické trasy a prostředí se nejvíce uplatňují laviny, vodně-gravitační procesy a povodně, v menším rozsahu skalní řícení a sesuvy. I v tomto případě však poukazujeme na kumulativní efekt procesů, čímž se stupeň ohroženosti jednotlivých částí chodníků dostává do vyšších kategorií. Podobně jako v předchozím příspěvku Bugár, Hreško, Piscová (2025), význam tohoto výzkumu vidíme především v oblasti managementu turismu vysokohorských oblastí a při návrhu návštěvního řádu TANAP-u.

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NON-FOREST WOODY VEGETATION AS A SIGNIFICANT ELEMENT IN INCREASING ECOLOGICAL STABILITY IN CULTURAL LANDSCAPE

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Abstract
The aim of the contribution is to present the importance of the functions of non-forest woody vegetation (NFWV) in increasing ecological stability in the cultural landscape of Slovakia. Since NFWV fulfils several functions in the cultural landscape, it is important to determine the regions in which this vegetation will help improve the overall ecological state of ecosystems and of the environment quality. We defined the regions based on conflicts of interest and specified landscape-ecological problems such as problems of threat to ecological stability, problems of threat to natural resources and the environment (i). In the proposals, we also took into account the ecological stability value calculated for 2,927 cadastral territories of urban and rural settlements in Slovakia (ii). Based on the criteria defined in this way, we determined the regions with proposed functions of NFWV that will contribute to increasing ecological stability and at the same time to solving problems related to the negative impacts of stress factors on humans, soil, water, forest and biotic resources (iii). The research results can be used in landscape planning for the optimal use of natural capital and the preservation of heritage features and the traditional character of the territory of Slovakia.

Key words: conflicts of interest, landscape ecological problems, vegetation functions

Introduction

The spatial demands of human economic activities carried out in the cultural landscape often lead to conflicts of interest and the emergence of landscape-ecological problems. Very often these problems are associated with threats to ecological stability, threats to the quantitative and qualitative indicators of natural resources, and threats to the quality of the environment. Since ecological stability is considered the basis for assessing all conditions and prerequisites for the use of the cultural landscape by humans, it is important to know where its threat occurs. The landscape-ecological research we carried out in the cultural landscape of Slovakia was focused on evaluating the impacts of human activities on the stability of the landscape, its components and elements, and subsequently on proposing green measures to mitigate the negative impacts of stress factors on humans, biota, water, forest and soil resources. The aim of the assessment was therefore, in the specified regions of landscape-ecological problems, to propose specific functions of NFWV to increase ecological stability and biodiversity and to support green infrastructure. Trees as solitaries, lines or areal elements in the cultural landscape fulfil several functions. To a significant extent, they contribute to the formation of the character of the territory and are an essential part of many processes that take place in the landscape. They are closely linked to many natural and anthropogenic elements in the territory and create with them a connected polyfunctional whole, shaped by cultural development, the method of use and natural conditions. The functionality of trees and stands depends mainly on their location and spatial arrangement in the territory, species and age composition, height structure, quality and quantity (SNC SR, 2024). Non-forest woody vegetation (NFWV) also belongs to landscape elements with a high ecostabilising effect (Špulerová, 2006; Múdry, 1989). It represents a characteristic part of the landscape structure with which it co-creates the image of a specific territory. NFWV affects the microclimatic regime, air quality parameters, hygienic conditions, biotic and recreational potential of the territory, but also the occurrence and consequences of water and wind erosion, etc.

Materials and methods

The basis of the methodological procedure was analyses, syntheses and interpretations, assessments and proposals. The methodological procedure was applied to the territory of the Slovak Republic.
Within the analyses we carried out:

- Specification of selected positive socio-economic phenomena (PSEP) of the character of nature protection, protection of natural and cultural-historical resources and health resources, which increase ecological stability and support green infrastructure.
- Specification of selected negative socio-economic phenomena (NSEP) of the character of primary and secondary stress factors, which by their negative action and barrier effect against

elements of nature and landscape protection disrupt the natural development of ecosystems, threaten ecological stability and biodiversity and threaten green infrastructure.

Syntheses and interpretations were focused on:

- Creation of a territorial system of positive phenomena and a territorial system of stress factors (SF). To define conflict areas between PSEP and SF that threaten humans, the landscape and its individual components and negative effects on elements with a high ecostabilising effect.

Assessments included:

- Calculation of ecological stability values (CES) for cadastral territories of urban and rural settlements in the SR. Definition of regions with different ecological quality and different landscape-ecological problems necessary to define for the proposal of "green" measures implemented to increase ecological stability.

Proposals:

- In regions of specified landscape-ecological problems, propose such a function of non-forest woody vegetation (NFWV) that will support the functionality of the existing green infrastructure (GI) and increase ecological stability especially in areas of intensively agriculturally used land (Fig. 1 and 2) as well as in areas with manifestations of natural risks and hazards and negative impacts of stress factors on the stability of the landscape and human health (Map 1, Tab. 1).

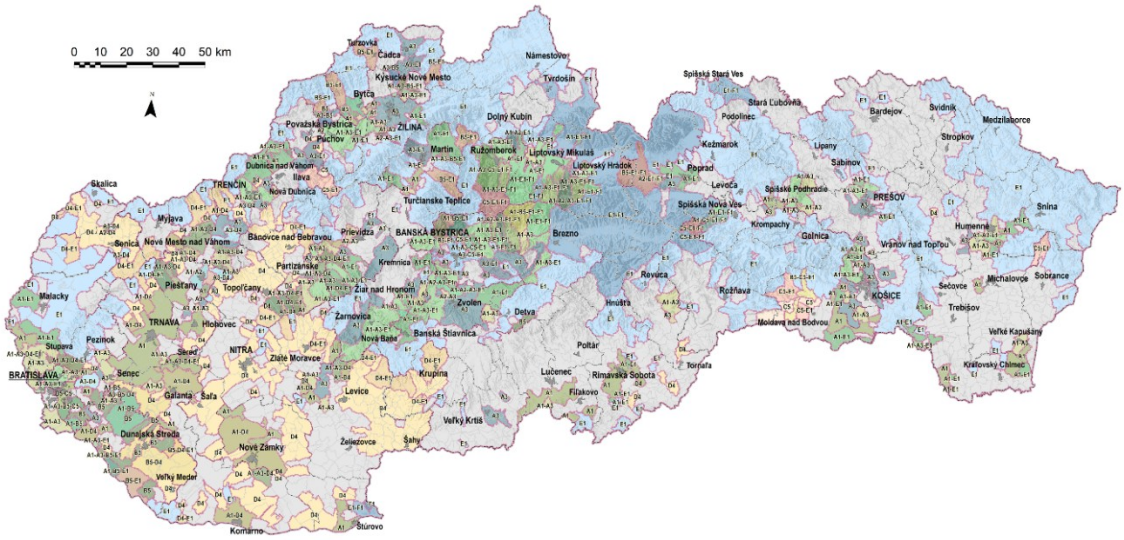
In the research we used data from field research and statistical data, which we subsequently analysed, quantified, statistically evaluated and visualised in a GIS environment. We worked with SEP that represent material and immaterial manifestations of human activities in the landscape and express the demands of society and individual economic sectors on a certain space, ecological and natural conditions (Ružička, 1985; Miklós et al., 1985; Miklós, 1992; Forman, Godron, 1993; Jongman, 1995; Drdoš, 1992; Demek, 1974). To assess the degree of ecological stability we used the coefficient of ecological stability (CES) (Miklós et al., 1985), which we calculated for two time periods – 2018 and 2023. We differentiated settlements on the basis of specified conflicts of interest between PSEP and selected point, line and areal SF. By gradual superposition of individual SEP we obtained a varied mosaic of conflict areas on the territory of Slovakia. On each area we precisely determined which socio-economic phenomena meet there. Some of them mutually excluded, limited, others supported or were neutral. Subsequently we grouped settlements into regions with the same conflicts of interest and specified landscape-ecological problems and proposed "green" measures to increase ecological stability. We precisely spatially localised the problem of threat to ecological stability and proposed such a meliorative function of non-forest woody vegetation so that the ecological state of individual ecosystems is improved and the risks of their threat are minimised. For assigning vegetation functions we proceeded from valid legislation, expert assessment and from the classification of NFWV functions by several authors (Jurko, 1990; Špulerová, 2006; Zachar, 1986; Sláviková, 1987; Supuka et al., 1991; Rakovská, 1998; Rózová, 1994; Múdry, 1990; State Nature Conservancy of the SR, 2024; Ružička, Ružičková, Múdry, 1979 and others). According to authors from various scientific fields who dealt with vegetation functions in the years 1974–2004, up to 58 partial functions of vegetation were recorded (Reháčková, Pauditšová, 2006). Since the understanding of vegetation functions is very broad and depends on the evaluator and the purpose for which the vegetation functions are examined (Reháčková, Pauditšová, 2006), by the function of NFWV we understood the sum of real or potential possibilities of using its effects.

Results

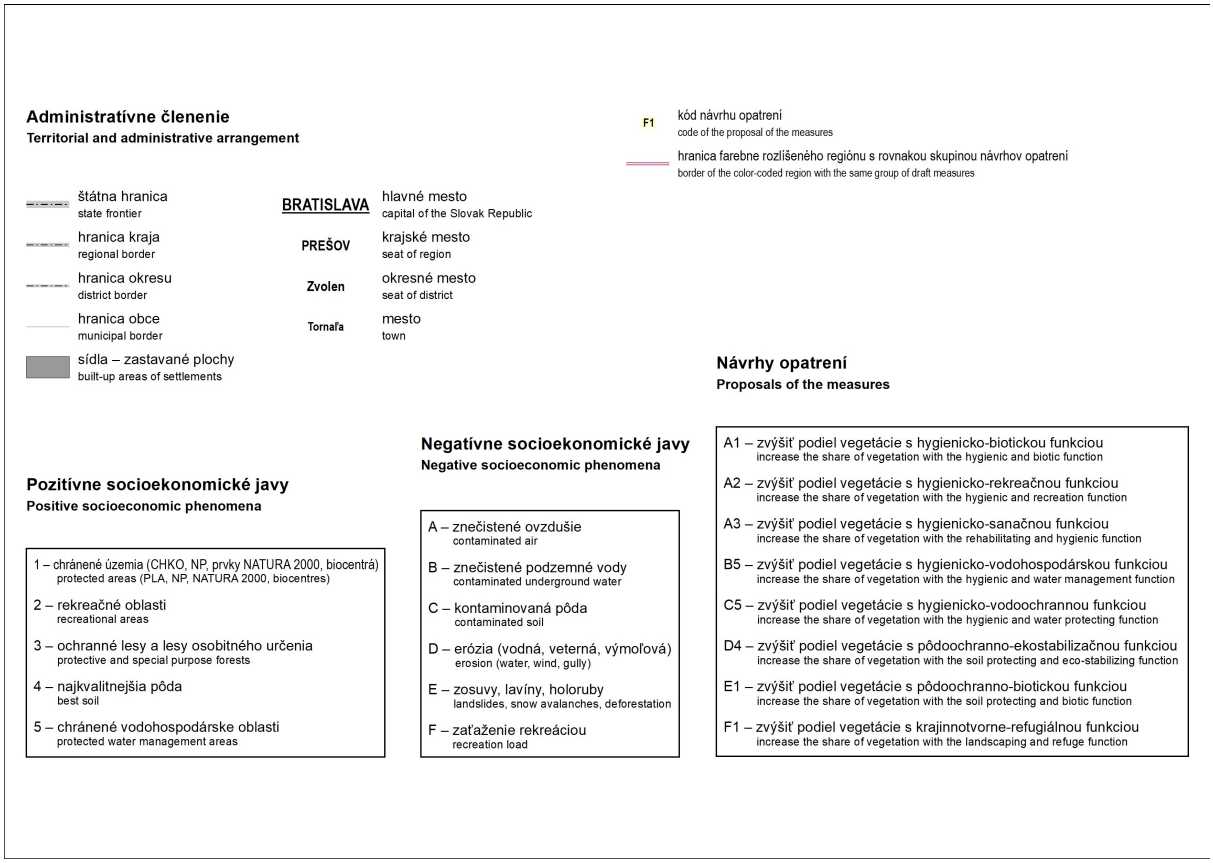
In total we specified 50 types of conflicts of interest within the SR, each of which had its own specificity and required a special measure. The resulting assessment is projected in Map 1: Regions of Slovakia with proposals of NFWV functions according to conflicts of interest and specified landscape-ecological problems. Based on the CES value we classified 2,927 Slovak settlements into 5 stability categories. Subsequently we also classified 79 districts of Slovakia into five quality categories. We also identified settlements in which the CES value increased or, on the contrary, decreased during the years 2018 and 2023. According to a CES value lower than 0.2, 9.74 % of settlements were classified among significantly unstable areas. In these areas it is necessary to implement ecostabilising measures in the form of planting areal and line elements of green infrastructure. The proposed planting should be supplemented by engineering-technical and technological measures. More than 22 % of settlements with a CES value in the interval from 0.2 to 0.4 were classified among unstable areas, 19 % of settlements with a CES value in the interval from 0.4 to 0.6 were classified among partially stabilised areas, 32 % of settlements with a CES value from 0.6 to 0.8 were classified among stabilised areas. The last fifth category with a CES value higher than 0.8 was achieved by a total of 492 settlements,

which is almost 17 % of the total number of settlements in Slovakia. The cadastral territory of these settlements was characterised as significantly stabilised without the need to implement ecostabilising measures. From the landscape-ecological point of view, in all settlements where CES was lower than 0.6 it is necessary to implement measures to increase ecological stability. From the point of view of assessing the degree of ecological quality of the districts of Slovakia, out of the total number of 79 districts the highest percentage of districts (33 %) had a high degree of quality, 22 % of districts had a very low degree of ecological quality, 20 % of districts had a low degree of ecological quality, 15 % of districts had a medium degree and 10 % of districts had a very high degree of ecological quality. In 57 municipalities, which is almost 2 % of the total number of municipalities, a decrease in CES by more than 0.5 % occurred during the 5 assessed years. In 144 municipalities, which is almost 5 % of the total number of municipalities, an increase in CES by more than 0.5 % occurred during the assessed period.

Fig. 1 and 2: Line NFWV vegetation in agricultural landscape (Moyzeová, M., 2025).



Map 1: Regions of Slovakia with proposals of NFWV functions according to conflicts of interest and specified landscape-ecological problems.



In the proposals of NFWV functions as measures to increase ecological stability in the specified regions of Slovakia, we proceeded from the set goals and needs of building green infrastructure (Tab. 1 Proposals of the measures).

Tab. 1: Proposals of the measures.

A) Problems of threat to ecological stability and biodiversity
A1 – threat to protected areas by polluted air occurred in 23 combinations in 213 areas and in 424 settlements within the SR.
Goal: In protected areas preserve the diversity of plant and animal species, the subject of protection and the traditional character of the territory.
Measure: Areas with nature protection threatened by negative impacts of polluted air revitalise by planting NFWV with hygienic and biotic function, with the ability to remove polluting and dust particles from the air.
E1 – threat to protected areas by clear-cuts, landslides and avalanches occurred in 29 combinations in 216 areas and in 963 settlements within the SR.
Goal: In protected areas preserve the diversity of plant and animal species, the subject of protection and the overall character of the territory.
Measure: Revitalise areas of nature protection threatened by clear-cuts, landslides and avalanches by planting NFWV with soil protecting and biotic function. By planting vegetation whose root system stabilises the territory and protects the soil from external destructive processes, create conditions for the existence of biota and its food chain.
F1 – threat to protected areas by excessive recreation occurred in 11 combinations in 29 areas and in 101 settlements within the SR.
Goal: In protected areas primarily preserve the subject of protection and the character of the territory and an attractive environment for recreational purposes.
Measure: Protected areas threatened by excessive recreation revitalise by planting NFWV with landscaping and refuge function. Vegetation with the ability of rapid regeneration will create conditions for the preservation of the gene pool, species diversity of animals, plants and microorganisms and at the same time preserve the recreational character of the territory. Vegetation adjustments should be supplemented by regulation of visitor

numbers in the visiting order of protected areas.
B) Problems of threat to the quality of the environment and human health
A2 – threat to recreational areas of spa towns by polluted air occurred in 10 combinations in 16 areas and in 17 settlements within the SR.
Goal: In recreational areas of spa towns preserve a quality environment for the physical and mental well-being of humans.
Measure: Areas of spa towns threatened by the negative impact of polluted air revitalise by planting NFWV with hygienic and recreation function. Prefer planting biologically rich and aesthetically pleasing vegetation with the ability to remove polluting and dust particles from the air.
C) Problems of threat to natural resources
A3 – threat to forest ecosystems by polluted air occurred in 21 combinations in 164 areas and in 306 settlements within the SR.
Goal: In purpose forests preserve their anti-erosion, water-management and anti-avalanche function.
Measure: Improve the current state in forest ecosystems threatened by the negative impact of polluted air by planting NFWV with rehabilitating and hygienic function, with the ability to remove polluting and dust particles from the air.
B5 – threat to significant water resources by polluted groundwater occurred in 15 combinations in 46 areas and in 96 settlements within the SR.
Goal: In protected water-management areas (PWMA) preserve a quality environment and ensure the protection of qualitative and quantitative indicators of the water resource primarily intended for supplying the population with drinking water.
Measure: In PWMA threatened by polluted groundwater, for improving the current state designate areas for planting vegetation with hygienic and water management function. To improve the qualitative indicators of waters plant vegetation with the ability to filter and capture polluting substances from groundwater. Improve quantitative indicators by vegetation that positively affects water management, the water regime, the regulation of infiltration of atmospheric precipitation and the balancing of the overall water balance in nature.
C5 – threat to significant water resources by polluted soils occurred in 11 combinations in 19 areas and in 26 settlements within the SR.
Goal: In protected water-management areas preserve a quality environment and ensure the protection of qualitative indicators of the water resource primarily intended for supplying the population with drinking water.
Measure: In PWMA threatened by polluted soil, for improving the current state designate areas for planting vegetation with hygienic and water protecting function, with the ability to filter and capture polluting substances from the soil and thereby improve the quality of water primarily intended for drinking purposes.
D4 – threat to the highest-quality soils by erosion occurred in 12 combinations in 110 areas and in 365 settlements within the SR.
Goal: In areas with the occurrence of the highest-quality soils stabilise the territory and preserve the quantity of topsoil, bonity and soil fertility.
Measure: On agriculturally large-scale cultivated soils threatened by external destructive processes caused by water and wind erosion designate areas for planting vegetation with soil protecting and eco-stabilizing function. Increase the stability of the agricultural landscape with a low representation of TSES elements by planting areal and line tree vegetation, whose root system positively affects soil drainage and recultivation. At the same time preserve bonity and soil fertility by using crops with anti-erosion effect.

Discussion

Many tree species, in addition to the hygienic function, also fulfil a number of other functions whose use we indicated in our research. Functions of vegetation, areas of action and forms of implementation necessarily merge, mutually combine and exclude each other (Špulerová, 2006). When designing plantings or interventions in existing stands, taking into account vegetation functions from this aspect is very important. Without their knowledge and use, landscape adjustments would not be comprehensive (Špulerová, 2006). Although various authors classify vegetation functions differently, Zachar (1986), Sláviková (1987), Jurko (1990), Rakovská (1998), Pagan (1996), Machovec, Hrubík, Vreštiak (2000) and others agree that when assessing NFWV functions it is necessary to take into account also the dendrological composition of stands and the structural and biochemical properties of

individual tree species. From the point of view of the results of our research, these statements need to be supplemented also by functions specified on the basis of conflicts of interest and specified landscape-ecological problems. We agree with the statements that from the point of view of NFWV functions in the urbanised environment of settlements, from the categories of natural functions the climatic and biotic function should be preferred in particular, and from the categories of anthropogenic functions – the group of social functions. At the same time, green areas in settlements should be linked to historical and symbolic urban structures such as city parks, monuments, etc., which form the skeleton of so-called intact green areas. On the contrary, in open, natural landscape, replacement planting should primarily supplement the skeleton of territorial systems of ecological stability, protected areas, NATURA 2000 elements and elements of already existing green infrastructure. In connection with the results of landscape-ecological research it is important that when planting NFWV the degree of anthropisation of the territory, conflicts of interest and specified landscape-ecological problems are also taken into account. Because precisely these research results can supplement the missing information on the localisation of NFWV planting with a specific function so that not only ecological stability is supported and increased but at the same time the negative impacts of stress factors on humans and their environment are mitigated.

Conclusion

By landscape-ecological research we assessed the ecological state of regions of Slovakia according to the current state of green infrastructure and its barriers. We specified settlements with different ecological quality and different needs for the implementation of measures to increase ecological stability. By proposing a specific function of NFWV with hygienic and biotic, hygienic and recreation, hygienic and rehabilitating, hygienic and water management, hygienic and water protecting, soil protecting and eco-stabilizing, soil protecting and biotic and landscaping and refuge functions we supported ecological stability in the areas of specified landscape-ecological problems. In 1,324 settlements no landscape-ecological problems were identified. In these settlements no conflicts of interest occurred that would directly threaten ecological stability, natural resources and the environment. When proposing the planting of new NFWV species in the cultural landscape it is important to plant species resistant to local conditions. Accept altitude, exposure and slope inclination as well as geological substrate and pedological conditions. For the territory of Slovakia it is important to prefer autochthonous species of trees and shrubs such as oak, beech, hornbeam, poplar, alder, maple, ash, willow, fir, hazel, elder and others. For the specific specification of tree species it is necessary to proceed from available literary sources focused on dendrology and ecology of trees (Benčať, 2009; Benčať, Modranský, Daniš, 2015; Čaboun, 1996). The results of landscape-ecological research will contribute to the expansion of knowledge where it is important and necessary to consider NFWV planting so that the ecological state of ecosystems is improved and at the same time ecological stability and biodiversity are supported. Tree species that fulfil one or more functions in the territory will also contribute to mitigating the negative impacts of climate change on humans, the landscape and living organisms.

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Souhrn
Realizovaný krajinnoekologický výzkum zhodnotil střety zájmů v katastrálních územích městských a venkovských sídel na Slovensku a specifikoval krajinnoekologické problémy jejichž negativní účinky smírní návrh nelesní dřevové vegetace s funkcí která podpoří ekologickou stabilitu a biodiverzitu v daných ekosystémech a současně minimalizuje negativní vlivy stresových faktorů na člověka a jeho životní prostředí. Výzkum podpořil i celoevropskou iniciativu budování zelené infrastruktury, jejímž cílem je zachování fyzikálních vlastností a identity lokalit, ochraňování a zvelebování přírodního kapitálu a zmírňování rizik přírodních katastrof a negativních vlivů stresových faktorů.

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OCCURRENCE OF TROPICAL DAYS IN CITIES

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Abstract
The urban environment climate is is determined by the specifics of the surface of cities, the number of inhabitants, the area of greenery, etc. This means that cities have a specific climate, different from the natural landscape. The urban environment is not expressed by measurements at climatological stations of the Czech Hydrometeorological Institute (hereinafter referred to as KS). To characterize the urban climate, it is necessary to carry out separate meteorological measurements in the territory of a given city. In the warmest periods of the year, the differences in air temperature between measurements at KS and in the city center are more than 7 °C for the maximum temperature, around 5 °C for the minimum air temperature. Heat waves are more frequent in urban environments (continuous occurrence of tropical days for 3 or more days).On tropical days (maximum is equal to and higher than 30 °C), there are states of considerable discomfort for residents, especially in large unshaded paved areas, such as squares, industrial areas, but also parking lots at shopping centers.

Key words: Urban climate, tropical day, tropical day wave, discomfort

Introduction
Compared to open countryside, cities have a specific climate that develops through the combined effect of the specific active surface of cities, anthropogenic heat energy production, and industrial, transport, and other activities within urban areas. The active surface of cities is formed by rooftops and building walls, artificially surfaced roads, and limited green areas; its characteristics also depend on the type of development, street width, and similar factors, as noted in earlier works (Kopec, 1970; Oke, 1973; Rožnovský, 2019, Střeštík et al. 2014, Rožnovský and Litschmann, 2014 and others).
Evidence of this condition in cities is provided by a large number of publications, e.g. Dobrovolný et al., 2012; Hinkel et al., 2003; Petrovič, 1979; and many others. Particularly during the summer months, elevated air temperatures lead to heat stress among the population and contribute to increased morbidity in elderly people and children. Air pollution in cities also contributes to negative impacts on the health of residents. The effects of the urban environment, including impacts on public health, have received attention from many authors, e.g. Cao et al., 2016; Li et al., 2020.
Based on purpose-specific measurements carried out in the city of Brno, Dobrovolný et al. (2012) report that the deviation in air temperature between the centre of Brno (Mendlovo náměstí) and its surroundings (Tuřany Airport) for minimum air temperatures during the growing season in 2005 was 0.9 °C, for mean temperatures 1.3 °C, and for maximum temperatures 2.5 °C.

Materials and methods
To evaluate the occurrence of extreme air temperatures in urban areas, air temperature measurements were carried out at four locations with differing radiation conditions within the cadastral area of the city of Brno in 2025. The northern peripheral part of the cadastral area is represented by the Starý Lískovec station (hereafter SL), situated in an orchard. Its counterpart is the station in the central part of Brno, located within the grounds of the Augustinian Abbey at Mendlovo náměstí (hereafter MN), representing continuous built-up development. The influence of built-up surroundings is similarly represented by the site within the inner courtyard of the Faculty of Arts of Masaryk University in Brno, though with the additional effect of shading. The influence of greenery in the central part of the city is represented by measurements taken in Lužánky Park (Luz). Continuous measurements at 10-minute intervals were carried out at all of the aforementioned locations. From the individual data, the onset and end dates of summer days (daily maximum of 25 °C or above), tropical days (daily maximum of 30 °C or above), tropical day waves, defined as a sequence of at least 3 consecutive tropical days, and their total count were evaluated. The data were processed using standard statistical methods, including the calculation of mean daily air temperature.

Results

Air temperature is the most frequently used meteorological element, with mean values over various periods, beginning with the daily mean, being the most commonly reported. It should be noted in general that in 2025, temperatures were higher compared to the mean temperatures of the 4th climatological normal, i.e. the period 1991 to 2020. It follows that the number of tropical days was also higher. For the period 1926 to 1950, the publication Podnebí ČSSR–Tabulky (1961) records a mean of 10.2 tropical days for Brno. It should also be noted that during this period, temperatures of 30 °C or above were recorded even in May, albeit amounting to only 0.1 of a day.

The specific occurrences of the first and last summer and tropical days, heat waves, and the total number of tropical days in 2025 are shown in Table 1 for the four aforementioned locations in Brno.

Tab. 1: Occurrence of summer and tropical days at the evaluated locations within the cadastral area of the city of Brno in 2025

Lokalita	Starý Lískovec	Mendelovo náměstí	Filozofická fakulta	Lužánky
First summer day	23. 4.	16. 4.	17. 4.	23. 4.
Last summer day	28. 9.	22. 9.	21. 9.	22. 9.
First tropical day	3. 5.	3. 5.	3. 5.	18. 6.
Last tropical day	4. 9.	21. 9.	29. 8.	4. 9.
Tropical day wave	29. 6. – 3. 7. 13. 7. – 15. 7. 8. 8. – 10. 8. 12. 8. – 16. 8..	22. 6. -6. 7. 13. 7. -15. 7. 8. 8. – 16. 8. 19. 9. – 21. 9.	29. 6. – 3. 7. 8. 8. – 10. 8. 13. 8. – 16. 8.	29. 6. – 3. 7. 3. 8. – 16. 8.
Number of tropical days	29	47	27	26

The occurrence of summer days in 2025 across all locations begins in the centre on 16th or 17th April, and at the periphery of the Brno cadastral area and in Lužánky Park both on 23rd April. The last summer day of the year occurs, surprisingly, at the peripheral location SL on 28th September, whilst at the remaining locations it falls on 21st or 22nd September. Regarding tropical days, the first occurrence is consistently on 3rd May, with the exception of the park, where it does not occur until 18th June. The last tropical day falls on 4th September at both the SL and Luz locations. In the city centre, the pattern differs: at FF it occurs earlier, on 29th August, whilst at MN it is as late as 21st September.

Only two tropical day waves occurred at Luz, totalling 9 days, with 26 tropical days recorded there overall. Three such waves occurred at the FF site, totalling 12 days, with 27 tropical days recorded there in total. Surprisingly, four tropical day waves occurred at the peripheral location SL, totalling 15 days, with an overall count of 29. A markedly higher number of tropical days was recorded at MN, namely 47, with four waves occurring there. The longest was a continuous run of 15 days, with the remaining three again totalling 15.

Fig. 1: Difference between daily mean air temperatures at the Starý Lískovec and Mendel square stations in 2025

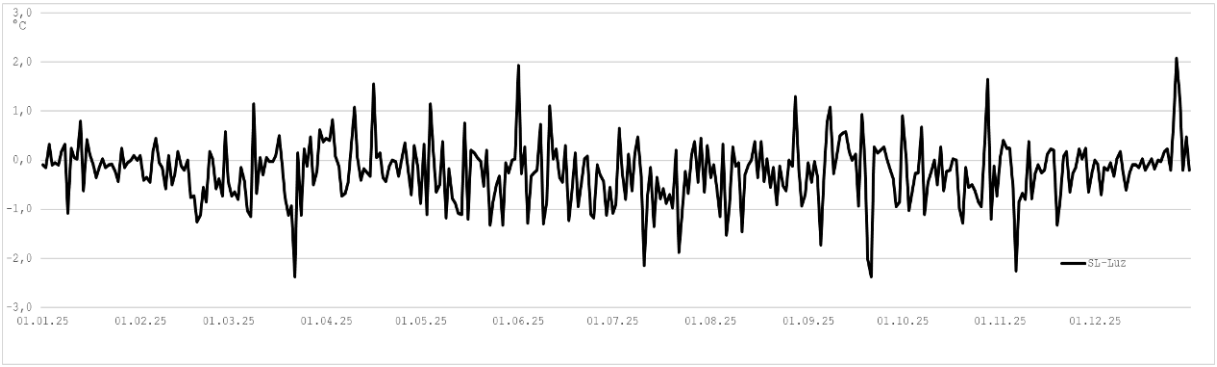

Fig. 2: Difference between daily mean air temperatures at the Starý Lískovec and Lužánky stations in 2025

The course of air temperature expressed as the difference between SL and MN, and between SL and Luz, for daily mean air temperatures, daily minima, and daily maxima is shown in Figs. 1 to 6. The individual courses demonstrate that there are partial differences in the behaviour of daily maxima and minima. In this respect, it should be noted that daily means partly obscure these differences.

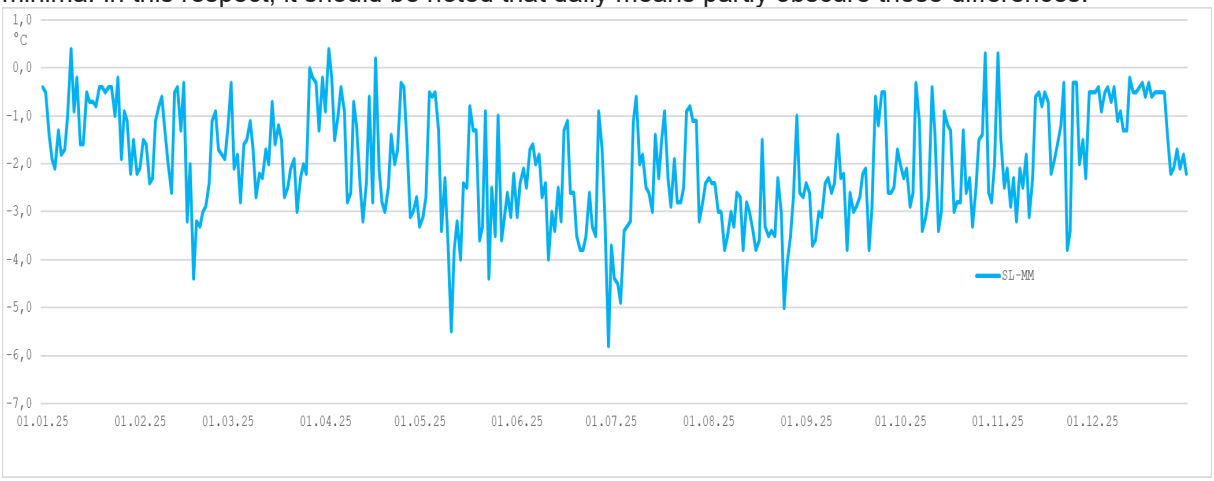

Fig. 3: Difference between daily minimum air temperatures at the Starý Lískovec and Mendel square stations in 2025

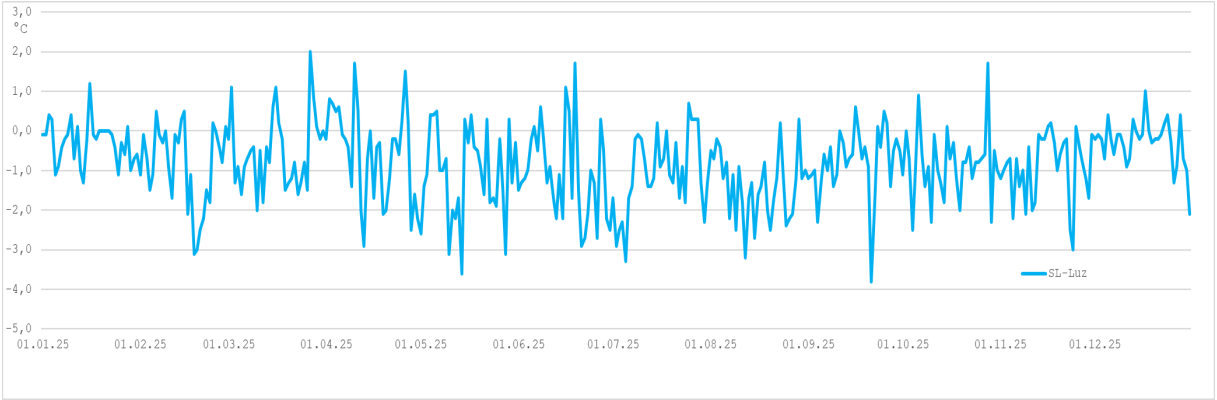

Fig. 4: Difference between daily minimum air temperatures at the Starý Lískovec and Lužánky stations in 2025

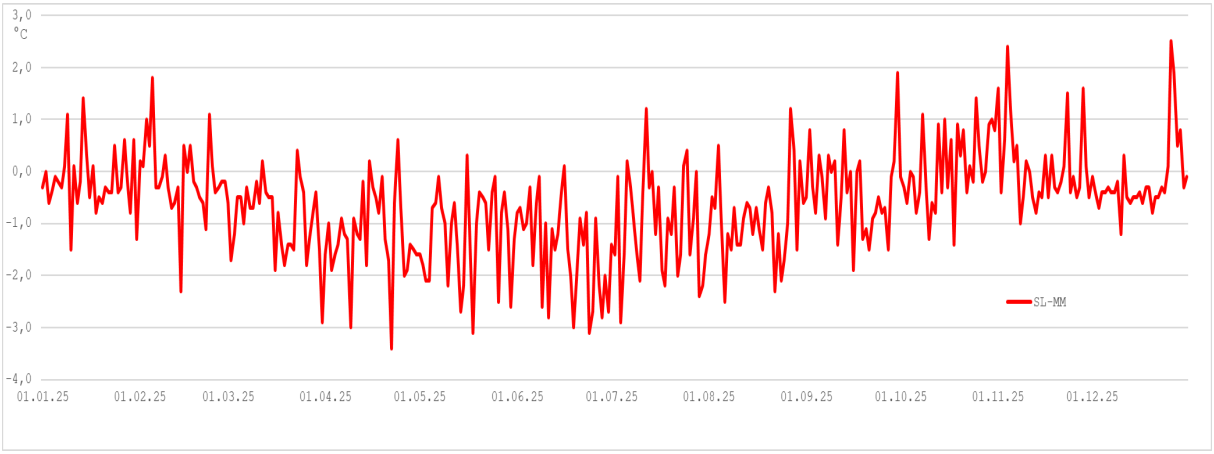

Fig. 5: Difference between daily maximum air temperatures at the Starý Lískovec and Mendel square stations in 2025

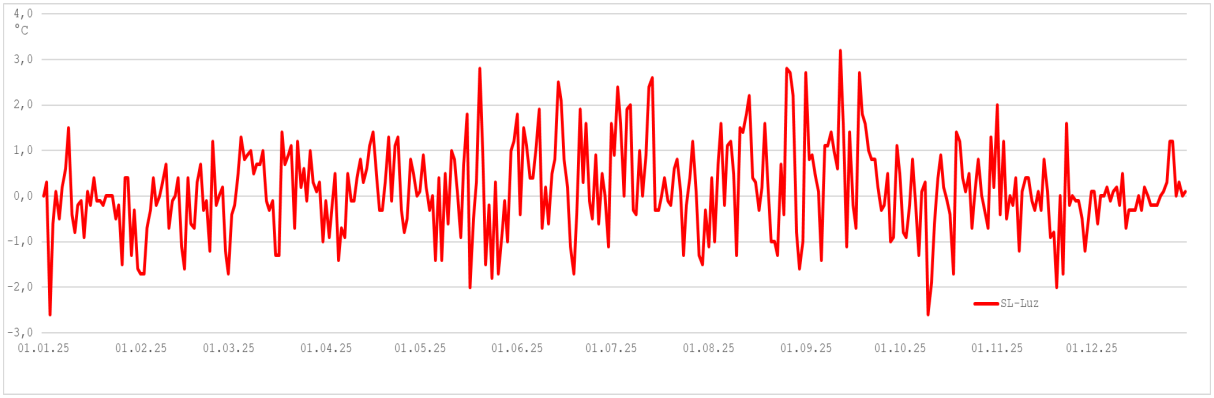

Fig. 6: Difference between daily maximum air temperatures at the Starý Lískovec and Lužánky stations in 2025

Discussion

As is well known from various statistical analyses, air temperature across our territory is rising, both in annual means and across individual seasons and months. In accordance with many authors, our results indicate that whilst the centre of Brno has significantly higher temperatures, thus constituting an urban heat island. This island is not homogeneous, as evidenced by the differences between MN and FF. The significance of continuous green space is demonstrable, with the lowest occurrence of tropical days recorded in the park.

Conclusion

The results presented demonstrate that in order to evaluate urban climate and its various classifications, measurements must be carried out across different parts of the urban environment. It is certainly not appropriate to rely solely on data from the climatological stations of the Czech Hydrometeorological Institute.

It must be emphasised that the high number of tropical days has an impact on the deterioration of the thermal comfort of residents not only in the city of Brno, but across the greater part of our territory. The rise in air temperature has also influenced the values of other meteorological elements, as evidenced by the occurrence of drought, since increasing air temperature induces greater evapotranspiration and thereby a negative moisture balance.

Given the demonstrable rise in air temperature, we must also account for this trend in the future; it is therefore highly probable that the number of tropical days and heat waves will increase. This will in turn bring about changes in our landscape as well as in the urban climate.

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Souhrn
Městské prostředí klima je dáno specifiky povrchu měst, počtem obyvatel, plochou zeleně apod. Tím je dáno, že ve městech je specifické klima, odlišné od přírodní krajiny. Městské prostředí není vyjádřeno měřením na klimatologických stanicích Českého hydrometeorologického ústavu (dále jen KS). Pro charakteristiku městského klimatu je potřebné provádět samostatná meteorologická měření na území daného města. V nejteplejších obdobích roku jsou rozdíly teploty vzduchu mezi měřeními na KS a v centru měst i o více jak 7 °C u maximální teploty, kolem 5 °C u minimální teploty vzduchu. V městském prostředí jsou častější výskyty vlny veder (souvislý výskyt tropických dnů po 3 a více dnů). V tropických dnech (maximum je rovno a vyšší jak 30 °C) dochází ke stavům značného diskomfortu pro obyvatele zvláště v rozsáhlých nezastíněných zpevněných plochách, jako jsou náměstí, průmyslové části, ale také parkoviště u nákupních center.

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OPPORTUNITIES FOR RECREATIONAL AND EDUCATIONAL USE OF THE WATER UTILITY TECHNICAL SITE

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Abstract
Technical sites represent a specific category of urbanized environments traditionally perceived primarily through their production or infrastructural functions. At the same time, these areas may offer considerable potential for the development of public spaces. This paper examines the opportunities for recreational and educational use of the technical facilities of a water utility company located in Nitra, Slovakia. The proposed design applies three key spatial components: an exhibition of technical elements related to water management, a water body with a wetland biotope, and a recreational zone intended to support active forms of leisure. Water serves as the central design motif, functioning as both a landscape-forming and interpretative element. Installations created from authentic water utility components, together with educational features and ecological interventions, communicate the importance of water resources, the functioning of water supply infrastructure, and the need to protect aquatic environments.

Key words: museum, park, sport activities, vegetation, wetland

Introduction

The transformation of industrial sites into public spaces has become a central topic in contemporary landscape architecture and urban regeneration discourse. A dominant strategy is adaptive reuse (Song et al., 2024), aimed at preserving significant physical structures while enabling their functional reinterpretation. Another widely applied approach is the development of multifunctional public landscapes (Lu & Nasir, 2024), where former industrial sites are reprogrammed to support recreation, environmental education, and community activities. In this context, ecological restoration and landscape regeneration also play a crucial role, particularly through the implementation of green infrastructure, ecosystem restoration, and the improvement of environmental quality. Overall, current research indicates that successful transformations rely on integrated, multidisciplinary approaches combining heritage preservation, ecological design, and recreational programming.
The aim of this study is to explore the possibilities of transforming the technical infrastructure of a water utility site in Nitra into an open recreational and educational landscape, while preserving its historical and functional identity.

Material and methods

The study area of the water utility site is located in the city of Nitra (Figure 1), within the cadastral area of Staré Mesto, in proximity to the Sihoť urban park and a football stadium. The site is directly connected to the Nitra–Dražovce cycling route and the R1A expressway, ensuring good accessibility within the city as well as the wider region.
From an urban planning perspective, the area represents a development zone designated for the construction of a new urban district (City of Nitra, 2018).
Future development is expected to involve the gradual expansion of the urban area and its transformation into a fully urbanized zone with new functions and infrastructure.
The site contains three water supply wells. Soil conditions are influenced by fluctuations in the groundwater table, which increases the ecological value of the area and its importance for water resource protection. Clay-rich soils prone to waterlogging are present due to the high groundwater level. The natural vegetation is represented by ash–elm–oak floodplain forests (*Ulmenion*), typical of alluvial habitats affected by flooding and groundwater dynamics.
In 1950, the area was predominantly used as arable land (Figure 2, right). Over subsequent decades, changes in land use led to natural succession, resulting in the restoration of meadows and the gradual development of floodplain communities (Figure 2, center and left), as well as the recovery of habitats for wildlife.
Climatically, the area belongs to a warm lowland region characterized by long, warm, and dry summers and short, moderately warm to dry winters. The mean annual temperature is 10.05 °C, the annual precipitation ranges from 500 to 600 mm (Lapin et al., 2002).

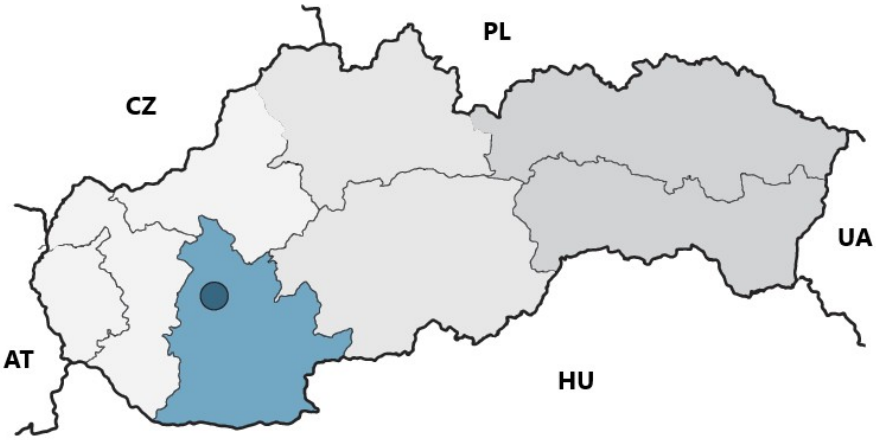

Fig. 1: Location of town Nitra (dark circle) in the Nitra Self-Governing Region (blue) in Slovak Republic

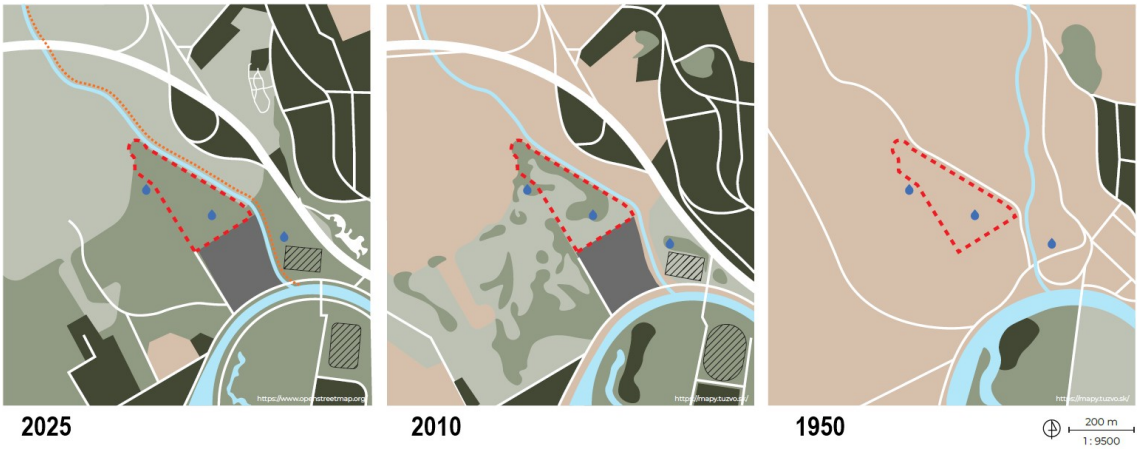

Fig. 2 Changes in the landscape structure of the study area: arable land (brown), meadows (light green), non-forest woody vegetation (green), built-up areas (dark green), water management company premises (grey), sports facilities (hatched), boundary of the study area (red line), cycling route (orange line), three wells (blue droplets), and the Nitra River channel (light blue).

The study area, covering 1.92 ha, is adjacent to administrative and technical facilities of the water utility company. In 2025, most of the vegetation cover was removed, and the site was enclosed with a single entrance. Several elements of technical infrastructure that no longer serve their original function have been preserved, including pipelines, valves, a hydrant structure, and disused electrical lines. The original woody vegetation consists of *Fraxinus excelsior*, *Populus* sp., *Salix* × *fragilis*, *Juglans regia*, *Cerasus avium*, *Rhamnus catharticus*, and *Robinia pseudoacacia*.
The conceptual design was developed as part of a studio-based project by students of the Institute of Landscape Architecture at the Slovak University of Agriculture in Nitra. Students worked in groups to develop various design concepts, exploring the transformation of the technical site into an open recreational and educational landscape integrating cultural, ecological, and sports functions.
The methodology is based on pre-design research, which, through the analysis of spatial relationships, historical context, and functional conditions, aims to identify site constraints and potentials. Subsequently, a research-by-design approach was applied to address the research question: *"How can closed technical infrastructure be transformed into a public space without losing its historical identity?"*

Results
The design is based on the transformation of a technical water utility site into an open recreational and educational landscape. Water functions as a key structuring and interpretative element, organizing the spatial composition while conveying the site's content and meaning. The integration of artistic, ecological, and recreational components creates a multifunctional environment supporting diverse uses.

The landscape architectural concept is structured around three interconnected components: an outdoor museum exhibition, a water body with a wetland habitat, and a sports and recreational zone designed for active use (Figure 3).

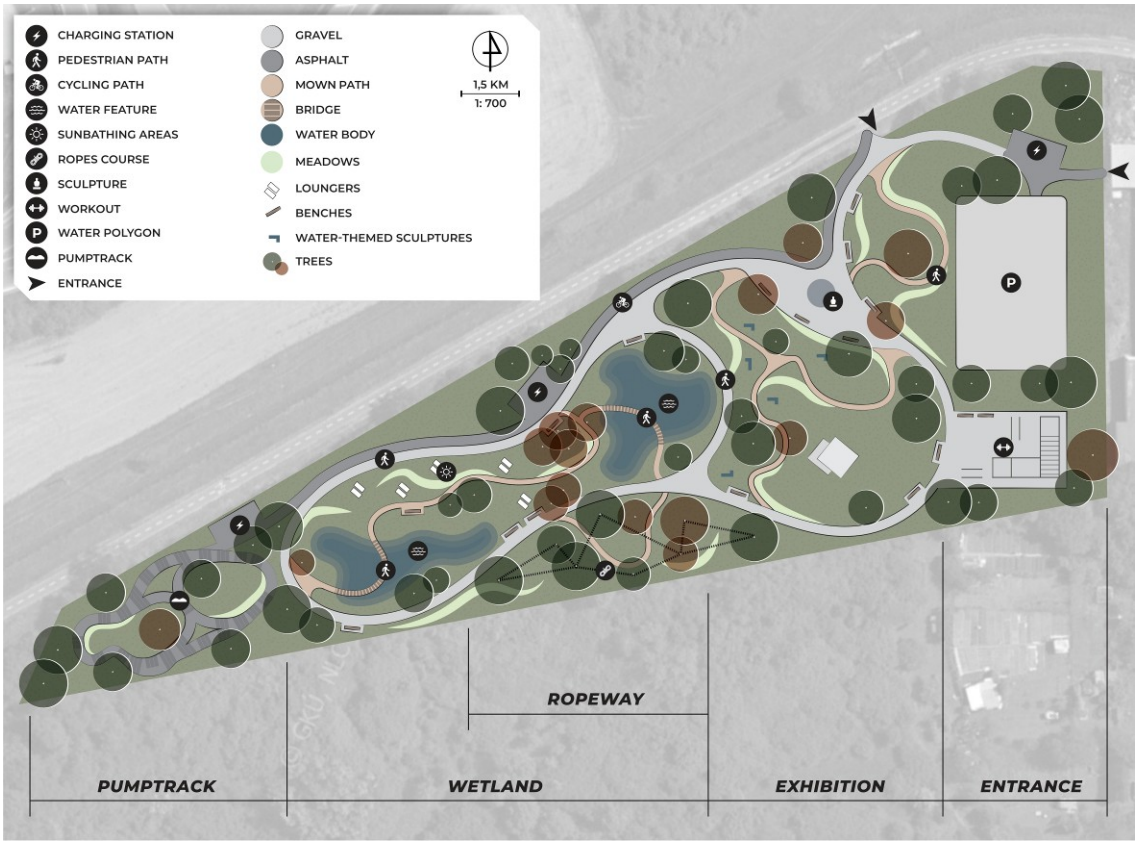

Fig. 3: Functional activity zones in the design area. Entrance zone – water museum exposition (Exhibition), large running loop and outdoor workout area (grey). Wetland – presentation of aquatic and wetland vegetation, Ropeway – a play element for children. Cycling routes and infrastructure (dark grey). Pumptrack – a closed-loop terrain circuit (Authors: Králik, Molnárová, Flórová; Supervisors: Kuczman & Paganová, 2025)

The water museum exhibition is conceived as the main प्रवेश area to the site and represents its technical and industrial identity. Water infrastructure components—pipes, valves, fittings, and pumps are presented as technical artefacts, some of which are artistically reinterpreted. The exhibition enables visitors to perceive the functionality, design, and development of water infrastructure systems. In its immediate vicinity, a training polygon is designed to support the practical skill development of water utility employees.

In the central part of the site, the wetland zone is established (Figure 4), where water acts as a key landscape-forming element shaping local ecosystems and habitats. The water body and adjacent wetland communities perform ecological and microclimatic functions while enabling direct environmental learning.

Elevated walkways, footbridges, and seating, complemented by interpretative panels, are arranged along the water features. The central zone (Figure 3) also includes a rope playground (Ropeway) supporting the development of motor skills and balance in children. Together with a small running loop (500 m), it promotes active use of the area, connects natural settings with physical activity, and balances recreational and educational functions.

The “Pumptrack” represents an intensively used sports and recreational zone for cycling. It is located in the peripheral part of the site and is accessible via a dedicated cycling route. Vegetation elements, including lawns and meadow areas, soften the visual character of the sports infrastructure, while planted trees provide shade and improve microclimatic conditions.

The entire site is equipped with cycling infrastructure ensuring continuous and functional use. In addition to paved cycling routes and unpaved running paths, open areas are designed as meadow vegetation. Larger areas consist of commercially established flowering meadow mixes managed

through regular mowing. These areas support pollinators and small fauna and contribute to increased ecological diversity.
The design creates a multifunctional landscape that supports recreational, educational, and ecological functions, integrates technical heritage, and enhances environmental awareness among visitors.

Fig. 4: Visualization of the wetland habitat zone for recreation, nature observation, and environmental education, featuring elevated timber walkways, seating, and meadow areas with sun loungers. (Authors: Králik, Molnárová, Flórová; Supervisors: Kuczman & Paganová, 2025)

Discussion and Conclusion

The successful transformation of industrial sites is dependent on the integration of technical infrastructure with natural systems, resulting in multifunctional recreational landscapes with a strong sense of plac (Čibik et al., 2019, 2022). This shift expands the discourse from purely architectural adaptation toward landscape-based and systems-oriented thinking (Bellérová & Hus, 2025; Žolobaničová et al., 2025). Transformations commonly combine cultural interpretation, recreational infrastructure, and green spaces, thereby enhancing both spatial usability and social interaction (Lu & Nasir, 2025).
Within this context, interpretation and creative placemaking are key strategies for maintaining the identity of industrial heritage. The reuse of authentic water infrastructure components, together with artistic and interpretative interventions, enabled the communication of historical narratives while supporting contemporary public use.
The findings of this study demonstrate that the transformation of technical water utility infrastructure into a public space can be achieved without the loss of its historical identity. This is enabled through the integration of three complementary approaches: the preservation and reinterpretation of technical elements, the incorporation of ecological structures, and the introduction of recreational functions. Together, these strategies allow the site to retain its technical character while being redefined as a multifunctional landscape for contemporary urban use.

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Souhrn
Tato studie se zabývá přeměnou areálu vodárenského podniku v Nitře na Slovensku na otevřený rekreační a vzdělávací prostor při zachování jeho historické identity. Výzkum vychází ze současných přístupů k regeneraci průmyslových areálů, včetně adaptivního opětovného využití, multifunkčního krajinářského návrhu a ekologické obnovy. Byla použita metodika „research-by-design“, kombinující analýzu lokality s koncepčním návrhem krajiny. Navrhované řešení je strukturováno kolem tří propojených komponent: venkovní expozice představující dědictví vodního hospodářství, ekologická zóna založená na mokřadech a sportovní a rekreační oblast. Voda slouží jako ústřední prvek utvářející krajinu a sloužící k interpretaci, který propojuje technické, ekologické a sociální funkce. Návrh integruje zachované prvky infrastruktury, biotopy podporující biologickou rozmanitost a rekreační zařízení, čímž vytváří multifunkční veřejný prostor. Výsledky ukazují, že transformace technické infrastruktury na přístupné veřejné krajiny lze dosáhnout integrací zachování dědictví, ekologického designu a rekreačních programů. Tento přístup umožňuje zachovat technický charakter lokality a zároveň reagovat na současné městské potřeby a podporovat environmentální povědomí.

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PERCEIVED CONSEQUENCES OF CHILDREN'S SENSE OF PLACE: A FOUR-PATHWAY DEVELOPMENTAL MODEL

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Abstract
Sense of place is widely associated with pro-environmental attitudes and behaviour. However, considerably less attention has been devoted to how children themselves perceive the consequences of their relationship to place. This study proposes a four-pathway developmental model grounded in qualitative data from 339 fifth-grade pupils in Czechia. Pupils provided written responses to an open-ended question exploring whether and how their attachment to the local region influences them. Using inductive thematic analysis, we identified four interrelated pathways through which children perceive the impact of place: (1) an emotional-regulative pathway, in which place shapes emotional well-being, safety and everyday comfort; (2) a moral-normative pathway, where place serves as a moral lens for evaluating social and environmental behaviour; (3) a behavioural-agency pathway, linking place to participation, everyday practices and environmental responsibility; and (4) an identity-formative pathway through which children connect place to belonging, future aspirations and possible selves. The findings indicate that children conceptualise sense of place not merely as emotional attachment, but as a multidimensional developmental structure that actively shapes self-concept, values and action orientations. The model advances theoretical discussions in geographical and environmental education and provides a framework for strengthening place-based and sustainability-oriented learning in primary education.

Key words: sense of place; primary education; environmental education; landscape protection; sustainability

Introduction

Sense of place (SOP) represents an important concept studied across multiple disciplines and describes the relationship between people and places. In geography and environmental education, this concept is understood as a multidimensional relationship to place consisting of affective, cognitive, and behavioural domains (Rubáš, Matějček, Řezníčková, 2024). Research in this field frequently works with related sub-concepts, such as place identity, place dependence, and place meaning, which capture different aspects of SOP (Brandenburg, Carroll, 1995). Previous empirical studies suggest that strengthening relationships to place may support environmental awareness, value orientations, and pro-environmental behaviour among pupils and students (Rubáš et al., 2026; Činčera, Kroufek, Bogner, 2022). At the same time, the literature indicates that SOP research has so far focused more strongly on adult populations, while children's perspectives and their own interpretations of place relationships remain less explored (Farber, Puttick, 2026). Understanding how children themselves perceive the significance of their local environment may therefore contribute to a deeper understanding of the role of place in their personal, value-related, and environmental development.

Methods

The study was designed as qualitative research based on an inductive interpretative approach. The aim was to understand how children themselves reflect on the consequences of their relationship to place without imposing predefined theoretical categories.
The research sample consisted of 339 fifth-grade pupils (approximately 10–11 years old) from 18 primary schools in Czechia. The sample included schools from both urban (9 schools) and rural (9 schools) settings in order to capture the diversity of settlement and environmental contexts.

Participation was voluntary, and the research was conducted in accordance with ethical principles for working with minor participants.
Data were collected through written responses to an open-ended question administered during classroom instruction. Pupils were invited to describe whether and how their relationship to the local region influences them. The written format enabled individual reflection and allowed pupils to formulate their responses in their own words without the immediate influence of peers.
The data were analysed using inductive thematic analysis (Braun, Clarke, 2006). The analysis proceeded through iterative cycles involving open coding, the gradual development of categories, and their continuous comparison across responses. Codes were generated directly from the data and subsequently clustered into broader thematic units. Based on recurring patterns of meaning, four interrelated dimensions were identified and conceptualised as developmental pathways. Although analytically distinguished for the sake of clarity, these pathways frequently overlapped in the pupils' responses. The proposed model therefore represents a conceptual synthesis of recurring structures of meaning rather than a set of mutually exclusive categories.

Results: A Four-Pathway Developmental Model of Children's SOP
Based on the inductive thematic analysis, we proposed a developmental model grounded in the children's own accounts (Figure 1). The analysis suggests that children perceive the consequences of their relationship to place through four interrelated pathways: emotional-regulative, moral-normative, behavioural-agency, and identity-formative. These pathways do not operate in isolation but frequently overlap and mutually reinforce one another.

Fig. 1: A four-pathway developmental model of the consequences of children's SOP.
Source: Authors' elaboration (visual model prepared by the authors with AI-assisted graphic support).

Emotional-regulative pathway
The emotional-regulative dimension captures how children describe the influence of place on their emotions, sense of well-being, and feelings of safety. Many respondents associated their local environment – particularly the proximity of nature, silence, clean air, and familiar surroundings – with feelings of calmness, joy, and security (*"I live near meadows and forests. The air is clean and it is quiet there... It feels cosy and pleasant to me. I like walking around because it is peaceful and calm."*). By contrast, noise, pollution, unsafe streets, or negative school experiences were linked to anger, fear, or sadness. In this pathway, place functions as a regulator of emotions: it stabilises mood, provides a sense of safety, and enables the restoration of psychological balance (*"I feel safe here"; "I am happier here and would like to live here all my life."*). A number of responses also revealed anticipated

emotional reactions – for example, the idea that the destruction of a familiar place would lead to a significant deterioration in feelings (*"If someone tried to destroy the alley, my relationship to this place would change from neutral to negative."*). The relationship to place therefore shapes not only children's present emotional experience but also their expectations of future emotions. In this sense, the emotional dimension represents a foundational layer upon which value orientations and behavioural responses may further develop.

Moral-normative pathway

This dimension captures how children interpret their relationship to place through value judgements and ethical evaluations. A substantial proportion of responses expressed strong disapproval of environmental pollution, tree cutting, factory construction, or harm to animals. These attitudes were often accompanied by explicit moral reasoning, for example through references to damage caused to nature, animals, or future generations (*"People throw rubbish away and it harms animals and nature."*). In this pathway, place appears to intensify moral sensitivity. Environmental damage is not perceived as an abstract problem but as a violation of children's own places (*"If someone destroyed my nature, that would be wrong."*). In some responses, the normative dimension also extended into the social sphere, for example through criticism of aggressive or antisocial behaviour (*"I do not like drunk people hanging around here, and I do not like people who are mean to others."*). At the same time, some responses reflected moral ambivalence or resignation (*"I cannot change all the people on the planet."*), suggesting that the activation of the moral-normative dimension is not equally strong across all children.

Behavioural-agency pathway

This pathway describes how children connect their relationship to place with specific activities, participation, and a sense of responsibility. Many children reported engaging in nature clean-up activities, taking part in environmental events, drawing others' attention to inappropriate behaviour, or intervening in cases of damage to the local environment (*"I like being able to take part in different activities, for example the Clean Up Czechia campaign, tree planting, and so on."*).

Beyond explicitly environmental activities, this pathway is also reflected in the structuring of everyday practices. Sports, outdoor activities, membership in clubs or hobby groups, and time spent outside were often directly linked to the character of the local environment (*"The forest also influences me because my friends and I have a bunker there, we play hide-and-seek in the woods, and the water has influenced me too because I now go rafting."*).

In some responses, children explicitly expressed their willingness to intervene if someone was damaging their environment (*"If someone was destroying monuments or meadows, I would probably stop them."*). This suggests that the relationship to place may foster a sense of personal responsibility and readiness to act. At the same time, some statements also expressed helplessness, indicating that action is not universal for all children.

Identity-formative pathway

The identity-formative pathway emerged as a particularly salient dimension of the model. Children repeatedly reflected on how the place where they live influences who they are – or who they would be if they lived elsewhere. Their responses included reflections on future occupations, lifestyle, sporting careers, educational opportunities, and social relationships (*"I want to live here because there is a hospital here, and because I want to become a doctor, I want to work there."*). Counterfactual scenarios were especially frequent (*"If I lived somewhere else, I would be different"*), suggesting that even at this age children already perceive place as a factor shaping their future life trajectories (*"If I lived in the countryside, I would probably be different."*). Place therefore emerges not merely as a physical environment, but as a formative framework that structures social relationships, opportunities, and aspirations (*"I have friends here without whom life would not be possible."*). In this sense, place can be understood as an environment that provides meanings, relationships, and conditions contributing to the formation of the self. Children do not describe place merely as a backdrop to their experiences, but as a significant factor shaping who they are becoming.

Interrelations Between Pathways

Although the individual pathways are analytically distinguished, they frequently overlap in the children's accounts. Emotional attachment to nature (the emotional-regulative pathway) is often linked to moral disapproval of its destruction (the moral-normative pathway) and to a willingness to intervene or participate in clean-up activities (the behavioural-agency pathway). Identity-related aspirations are similarly intertwined with both value orientations and specific practices. The proposed model therefore

does not describe isolated consequences, but rather a multilayered developmental process in which the relationship to place operates through mutually interconnected mechanisms. The model thus suggests that place relationships do not function merely as isolated emotional bonds, but as a developmental nexus in which children's emotions, values, actions, and identities converge.

Discussion

The findings of this study resonate with recent curriculum discussions emphasising the role of community and place in learning. The concept of Community Curriculum Making highlights the educational value of "going places, meeting people and doing and making things", thereby connecting students' learning with their local environment and community (Leat, Thomas, Whelan, 2026). Such approaches suggest that encounters with local places and community actors can support students' well-being, their actions, civic awareness and identity development. From this perspective, the four pathways identified in this study may represent complementary mechanisms through which place-related experiences become educationally meaningful for children.

These findings are also consistent with emerging research exploring children's environmental relationships. For example, Farber, Puttick (2026) show that environmental emotions and experiential learning play a mediating role between children's local ecological knowledge, place attachment and pro-environmental behaviour. Similarly, the present findings indicate that children's relationships with place are not limited to cognitive knowledge or emotional attachment alone, but involve a dynamic interplay of emotions, moral evaluations, behavioural engagement and identity formation.

The proposed model extends existing SOP frameworks by shifting the analytical focus from dimensional description toward child-perceived developmental consequences of place relationships. The four pathways identified in this study can also be interpreted in relation to existing conceptual frameworks of place relationship research. The identified pathways broadly correspond to the affective, value-oriented, behavioural, and cognitive dimensions described in the literature, while also partially resonating with key SOP sub-concepts such as place meaning, place dependence, and place identity (Brandenburg, Carroll, 1995). These parallels suggest that the proposed model may offer an integrative perspective linking the emotional, moral, behavioural, and identity dimensions of children's relationships to place.

Conclusion

This study explored how children perceive the consequences of their relationship to place through qualitative analysis of pupils' written responses. The findings suggest that children interpret their SOP through four interconnected pathways: emotional-regulative, moral-normative, behavioural-agency and identity-formative. Together, these pathways illustrate how children connect their local environment with emotions, values, everyday practices and future aspirations.

The four-pathway model proposed in this study therefore extends existing perspectives by conceptualising SOP as a developmental structure through which children interpret and experience their local environment. Rather than functioning merely as an affective bond with place, SOP can be understood as a developmental nexus linking emotional well-being, moral reflection, everyday practices and emerging self-concept. In this way, children's experiences of place may contribute not only to environmental awareness but also to broader processes of personal and social development.

These findings highlight the potential of educational approaches that connect learning with local environments and everyday experiences. Place-based and community-oriented learning may therefore play an important role in supporting children's emotional well-being, environmental responsibility and identity development.

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Souhrn
Příspěvek se zaměřuje na to, jak děti vnímají důsledky svého vztahu k místu. Přestože je koncept sense of place v odborné literatuře často spojován s environmentálními postoji a chováním, menší pozornost byla dosud věnována tomu, jak samotné děti interpretují význam svého místního prostředí. Studie představuje vývojový model založený na kvalitativní analýze písemných výpovědí 339 žáků 5. ročníku základních škol v Libereckém kraji. Data byla získána prostřednictvím otevřené otázky a analyzována pomocí induktivní tematické analýzy. Výsledky ukazují, že děti vnímají důsledky svého vztahu k místu prostřednictvím čtyř vzájemně propojených dimenzí: emocionálně-regulační, morálně-normativní, behaviorálně-agentní a identitotvorné. Tyto dimenze se projevují v pocitech bezpečí a pohody, hodnotových soudech, konkrétních aktivitách i vnímání místa jako faktoru ovlivňujícího budoucí aspirace, sociální vztahy a sebepojetí. Navržený model naznačuje, že vztah k místu nepředstavuje pouze emocionální vazbu, ale komplexní vývojovou strukturu propojující emoce, hodnoty, jednání a identitu. Výsledky zároveň poukazují na význam vzdělávacích přístupů propojujících učení s místním prostředím a každodenní zkušeností žáků.

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PERI-URBAN RECREATION AND BIODIVERSITY SERVICES BALANCING IN BRNO: STAKEHOLDER PRIORITIES AND MANAGEMENT FOR MASARYK FOREST KŘTINY

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Abstract

Brno City and neighboring forests face conflicting pressures balancing recreation and other ecological services, such as water provision, biodiversity, climate regulation, and timber production. Our study explores stakeholders' priorities and preferences to assess how to balance recreation and lasting ecological resilience. The study surveyed (n = 234), evaluating perceived forest ecosystem services ranking and management in Brno and adjacent neighborhoods, mainly Masaryk Forest Křtiny. The participants were mostly young people aged 18 to 24 years (approximately 39%), with a balance by gender/sex. Most participants (about 91%) recognized recreation services such as walking and cycling as their major forest visiting activities on a weekly or monthly basis. Biodiversity and climate regulation services were the top choices for participants, i.e., approximately 83% and 78%, respectively, and recreation values at about 39%. Tourism and recreation were robustly weighted at about 39% valued forest recreation support as being very important, 41% (important). Moreover, for future forest management priorities, recreation services ranked roughly 43%. Forest Ecosystems Trade-offs predominantly focused on timber versus biodiversity; however, participants selected and acknowledged the necessity to sustain recreational quality and standards together with regulatory/support services. More so, for forest management considerations, concerns were raised about the possible effects of climate change on recreational prospects. Ceteris paribus, forest management that conserves recreational services accessibility and values whereas improving biodiversity and resilience to climate impacts were prioritized by stakeholders. The study results support a directed approach to integrating recreation obligations with preservation and adaptive management in peri-urban forestry.

Key words: Climate regulation, Ecosystem services, Forest management, Public preferences, Recreation services, Trade-offs

Introduction

Society's welfare and ecological resilience in and around cities hugely depend on peri urban forests for essential supportive ecosystem services and production (Bolund and Hunhammar 1999, Kabisch et al. 2016, Bamwesigye et al. 2021, Doli et al. 2021, Yu et al. 2024). These forest services include climate regulation, supporting (biodiversity), water and soil protection, nutrient cycling, provisioning (timber), and cultural services such as recreational and outside facilities (Bolund and Hunhammar 1999, Kabisch et al. 2016, Deng et al. 2016, Doli et al. 2021, Bamwesigye et al. 2023, Yu et al. 2024).

Peri urban forests are currently facing increasing societal pressure and burden due to rising numbers of urban inhabitants and an increasing obligation/demand for outdoor leisure and relaxation. There is pressure and competing interests between environmental and habitat conservation, production purposes, public access, and infrastructure requirements (Chan et al. 2012, Gómez Baggethun and Barton 2013).

Brno faces opposing obligations and huge demands in its urban and peri urban forests, such as high and consistent forest recreational usage that impends and degrades track/trail quality, wildlife habitat, and soil and water protection services. Moreover, insufficient climate adaptation strategies and the demand for conforming timber harvesting could worsen the negative impacts and associated externalities, including floods and droughts (Haase et al. 2014, O'Brien et al. 2022). The possibility of user conflicts is said to risk the situation further and yet can be solved as necessary by stakeholders and management (Kabisch et al. 2016, Haase et al. 2014).

Furthermore, the mutual ecosystem services, service quantity and quality, and recreational services face systematic risks from climate change effects on precipitation and temperature patterns, extreme events (e.g., flooding), and pests and diseases (Haase et al. 2014, O'Brien et al. 2022). Therefore, city management and stakeholders ought to balance forest ecosystem services, public priorities, and

perceived trade-offs to meet current recreational needs while supporting sustainability goals for biodiversity protection, regulatory functions, and climate resilience.
This study examined and documented stakeholders' priorities for ecosystem services in peri urban forests neighboring Brno City, highlighting forest recreation services to inform related forest planning and management.
We particularly evaluated and ranked stakeholders' patterns and priorities of forest use and visitation, valuation of ecosystem services, and stated trade offs such as between timber production, biodiversity, and recreation. Moreover, current management and concerns about climate impacts were analyzed. The research strives to offer evidence based on stakeholders' preferences and opinions to facilitate management actions that balance excellent recreational services access together with biodiversity protection, adaptability, and nature-thoughtful forestry management practices.

Material and methods
The study conducted a cross-sectional survey to elicit public preferences/opinions and priorities regarding forest ecosystem services in the Brno City neighborhood. An online questionnaire was conducted both in Czech and English. It consisted of multiple-choice, single-answer, multiple-answer, importance ratings, preference and ranking, and socioeconomic characteristics questions.
Sampling and data collection
The study collected data through an online link and QR code between the period 18 March 2025 and 06 March 2026. The overall survey visits were 1,348, while the accomplished responses were 236 and after cleaning 234 usable responses were used for investigation. The target population consisted of forest visitors and stakeholders around the Masaryk Forest Křtiny and nearby training forests.
The study results envisioned for research and policy recommendations were obtained and presented in an incognito manner. The study informed respondents about the purpose and privacy on the survey from the beginning. Moreover, we did not obtain personally identifiable details from the study.
Analytical approach
The study carried out descriptive statistical analysis to obtain frequencies and fractions for categorical variables. Moreover, significant tendencies in ranked factors, such as importance scores, were analyzed to identify preferences, ordered choices, and scaling to create comparative classifications.
We conducted an exploratory analysis to examine connections between main variables, such as forest primary use and recreation importance ratings, to classify patterns across participant subcategories. The study investigated the occurrence and preference, such as timber vs. biodiversity selected (70.5%).
Analyzed results are presented and reported with tallies, sums, and percentages for all categorical results and ranked measurements.

Results and Discussion
Young people were the majority of the respondents, with 38.5% aged 18–24, 25-34 (9.4%), 35-44 (19.7%), and above 45, accounting for 34.4%. The study results demonstrated a gender-balanced general population, with 120 males (51.3%), 107 females (45.7%), and 7 others (3%).
The respondents' educational levels were as follows: high school graduation, 75 (32.1%); Master's degree, 70 (29.9%); Bachelor's degree, 54 (23.1%); and other levels, accounting for about 15%. Educational levels were also categorized as technical (31.6%), biological (41.5%), social sciences (19.2%), and others (7.7%).
The employment results were: 40.6% students employed, 50.9% unemployed, and 7.7% retired.
Regarding primary forest use, respondents were strongly associated with recreation services, with 213 (91.0%) acknowledging activities such as walking, cycling, and sunbathing. Dog walking accounted for 28.6%, spirituality 62 (26.5%), sport 25.2%, and mushroom picking and education also scored highly at 24.8% and 20.5%, respectively (Fig 1).
Respondents stated their forest visiting frequency and usage, the concurrence showed a high connection with forest recreation services, e.g., daily (13.2%), weekly (30.8%), monthly (27.4%), and yearly (28.6%). This demonstrates that approximately 71% of study respondents associate with nature or forest monthly and 44% daily or weekly, indicating continuous recreational demand and consistent forest use in the Brno City neighborhood (Fig 2).
Regarding the four most important forest ecosystem services, 91 (about 39%) participants ranked recreation and tourism fourth. Even though biodiversity (195, 83.3%), climate regulation (183, 78.2%), and soil protection (98, 41.9%) were selected as the most frequently followed by recreation and cultural services. This demonstrates that stakeholders value forest recreation services among the top forest ecosystem services(Fig 3).

Answer Choices
Rekreace (procházky, jízda na kole, opalování atd.) / Recreation (walks, biking, sunbathing etc)
Duchovní / Spiritual
Sběr hub / Mushroom picker
Sport / Sport
Výzkum / Researcher
Výuka / Education
Samovýroba dřeva / Wood picker
Odborná práce v lese (hajný, dělník atd.) / Forestry worker
Venčení psa / Dog owner/walking

Fig. 11: Primary forest use associated with recreation services

Answer Choices	Responses
Denně / Daily	31
Týdně / Weekly	72
Měsíčně / Monthly	64

Fig. 12: Forest visiting frequency

Answer Choices	Resp
Regulace klimatu / Climate regulation	1
Rekreace a cestovní ruch / Recreation and tourism	9
Biologická rozmanitost / Biodiversity	1
Ukládání uhlíku / Carbon storage	6
Produkce dřeva / Wood production	8
Kvalita vody / Water quality	5
Zmírnění následků povodní / Flood mitigation	3
Zmírnění následků sucha / Drought mitigation	9
Ochrana půdy / Soil protection	8

Fig. 13: four most important forest ecosystem services

Concerning the categorical ranking of the forest service's importance/preference-order, recreation services had an average importance score of 4.2 on the 0–10 ordering assignment. Forest recreation ranked lowest to climate regulation (7.2), drought mitigation (6.8), soil protection (6.8), biodiversity (6.6), water quality (5.6), and flood mitigation 4.2. Thus, our study revealed that forest recreation services are valued as distinguished services among the top-priority forest services for stakeholders.
The examination of direct importance ratings for forest recreation using a single choice importance rating about the forest's role in supporting recreation and tourism results showed that participants 79 (34.3%) ranked very important, 94 (40.9%) important, 48 (20.9%), and 9 (3.9%) not important. Our study findings further illustrated that collectively, 75.2% of participants rated the forest recreation as important or very important, demonstrating a robust community/stakeholder valuation of forest recreational services around Brno City.

Forest Recreation and Future Management Priorities

Regarding future sustainable forest management, the study asked which services should be prioritized. Consequently, recreation services were selected by 101 participants (43.2%). Nevertheless, for future forest management, supporting biodiversity scored highest, 193 (82.5%), and other services, such as flood and drought mitigation, 141 (60.3%), and soil protection and nutrient retention (133; 56.8%) were more frequently selected, respectively. Forest recreation services demonstrated a strong management priority for stakeholders among other important forest ecosystem services and functions for Brno city and neighborhood forest management (Fig 4).

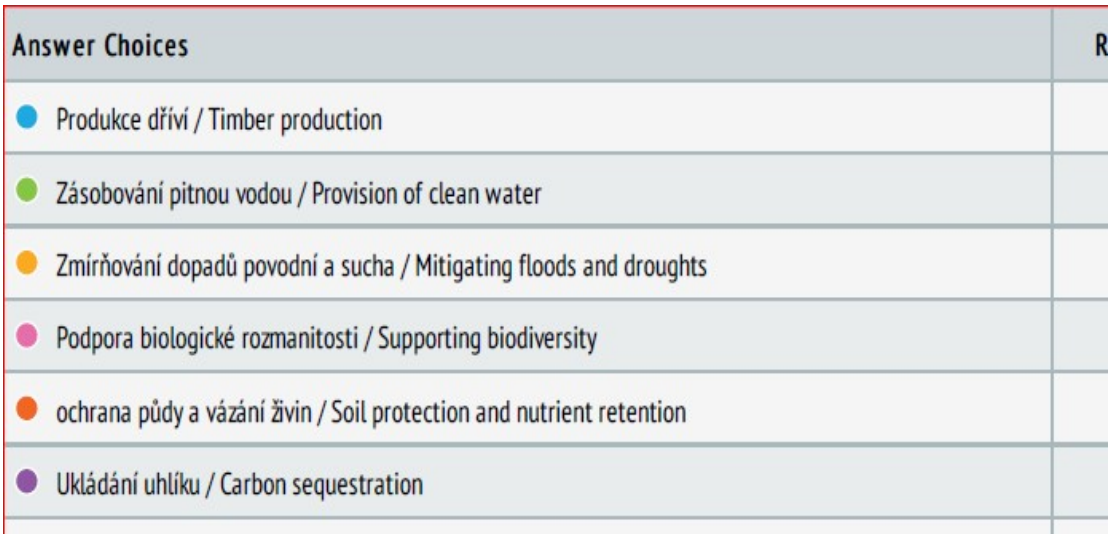

Fig. 14: Management priority for stakeholders among important forest ecosystem services

Forest conservation-focused methods regarding forest management preferences indicated that 112 (47.9%) participants preferred the preservation of old-growth forests, while 104 (44.4%) chose continuous cover forestry as the two forest management enhancements in forests around Brno city. Moreover, the stated preferences are harmonious with the support and sustainability of forest recreation quality services, such as trail experience, shade, and structural complexity. More so, the results showed stakeholders' preference and support for actions and management that sustain naturalness and continuous forest cover rather than large clear-cuts.
Regarding implications for forest recreation services based on participants' satisfaction with the current forest management in Brno and surrounding areas, such as Training Forest Enterprise Masaryk Forest Křtiny, 28 (12.0%) were very satisfied,92 (39.3%) Satisfied, 97 (41.5%), somewhat satisfied, and 17 (7.3%) not satisfied. Mutually, approximately 93% of the participants expressed some level of satisfaction with current forest management. The results demonstrate that the current management is acceptable to most forest recreational consumers and stakeholders, nevertheless approximately half of the respondents were only somewhat satisfied. The results demonstrate demand for targeted improvements, including access, trail maintenance, and amenities.

Trade-offs and conflicts affecting recreation

Timber production over Recreation & Tourism was chosen by 91 participants (approximately 39%) as a significant trade-off. Timber production against biodiversity (165; 70.5%), timber production against climate regulation (139; 59.4%), and timber production against drought mitigation (132; 56.4%) were the most commonly identified trade-offs that indirectly affect the quality of forest recreational services.

Timber production ranks low in importance (3.3 out of 10) compared to Recreation and tourism. While numerous participants recognized the conflict between timber and forest recreation, stakeholders ranked this conflict lower than soil protection services, water, and other regulatory forest services. Essentially, forest ecosystem resilience and biodiversity were more concerned with trade-offs than with the direct timber-versus-recreation conflict.

Climate change concerns specific to recreation

The impacts of climate change on forest ecosystem services were analyzed, and the results of the rating indicated that changes in temperature and precipitation patterns (169; 72.2%), increased pests and diseases (152; 65.0%), and extreme events (141; 60.3%) were the most significant.

Regarding how climate change might impact ecosystem services, the effect on recreational services scored an average importance of 5.9 out of 10. Recreation ranked in the mean range behind temperature and precipitation changes (9.8) and shifting species distributions (8.4), but on top of many other measurements.

Ranking among the top four climate change impacts on forest ecosystems, 29 participants (12.4%) chose impacts on recreational activities. The mean classification showed that stakeholders are reasonably worried that climate stressors could destroy forest recreation amenities, such as trail degradation by storms and increased pest and disease threats.

Forests in Brno City neighborhoods are viewed by stakeholders as spaces for recreation activities. Moreover, participants stated frequent visits and valued recreational services highly, besides robust value attached to biodiversity and forest regulatory services. Study results suggest a management approach that focuses on the quality of recreational services while also deepening protection of biodiversity, soil, and water, and enhancing climate resilience services. The long term sustainable use of peri urban forests is expected to reflect user and stakeholder management priorities and to best reflect climate effects.

Practical implications for recreation-focused management

Prioritize low-impact recreation design combined with biodiversity conservation: given users' dual interest in recreation and biodiversity, management that promotes continuous cover, retains structural complexity, and locates trails to minimize ecological disturbance will likely be socially acceptable.

Maintain access and quality while reducing conflict with production: mitigate timber–recreation conflicts through spatial/temporal zoning (e.g., schedule harvesting outside peak recreational seasons, buffer trails), clear signage, and community consultation.

Invest in climate-resilient recreation infrastructure: strengthen trails, drainage, and hazard monitoring to reduce impacts from extreme weather and shifting precipitation, addressing the moderate concern users have about climate effects on recreation.

Target engagement by user groups: tailor communication and participatory planning to the dominant visitor profiles (young adults, students) and secondary user types (dog walkers, cyclists), and align amenities and rules with users' preferences.

Conclusion

The study aimed at examining public/stakeholder priorities for ecosystem services in peri urban forests of Brno. This study focused on forest recreation services, acknowledged trade-offs such as timber production, and drew on concerns about climate change effects to inform management and policy direction. An online survey was conducted, and n = 234 responses were collected from stakeholders and visitors connected with Masaryk Forest Křtiny. The survey tool used multiple-choice, significance ratings, and classification-priority ecosystem service questions. We used descriptive analysis to obtain frequencies and proportions, as well as ranking scores for ordered preferences. Forest recreation services were ranked as the primary use, with 91% of respondents. Moreover, 44% of respondents visit the forest weekly or daily, and 71% at least monthly, indicating a regular trend in preference for forest recreational services. Biodiversity services ranked highest at 83.3% and, followed by climate regulation services at 78.2%. However, forest recreation was hugely valued at 75.2% as important and ranked 43.2% among future management priorities amongst public valuation of multiple forest services. Stakeholders' opinions on timber vs. biodiversity trade off were the most frequently identified conflict (70.5%), while timber vs. recreation was acknowledged by nearly 39%, although rated lower than trade offs distressing adaptable services. The survey results regarding management outlooks indicated that the public prefers conservation-oriented practices and approaches: 82.5% prioritized biodiversity, 47.9% old growth conservation, 44.4% continuous cover forestry, and were mostly satisfied or somewhat satisfied with current management approaches, indicating openness to nature friendly variations that protect recreation quality. The participants prioritized changes in temperature/precipitation, pest outbreaks, and extreme events as top climate threats; impacts on

forest recreational services were a mid ranked concern, suggesting a need for adaptation measures to maintain recreation amenities.

Policy Outlook

The study recommends implementing multifunctional, participatory planning that unequivocally distinguishes and appreciates forest recreation services as an essential service while also benefiting biodiversity and regulatory resilience of Masaryk Forest Křtiny. Forest management that balances sustained access to better-quality recreational services with conservation and climate resilience actions ought to support public preferences and ensure sustainability, extensive endowment of multiple forest ecosystem services in the Brno peri urban setting.

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Souhrn

Cílem studie bylo prozkoumat priority veřejnosti a zainteresovaných stran v oblasti ekosystémových služeb v okrajových lesích Brna. Studie se zaměřila na rekreační služby lesů, zohlednila kompromisy, jako je produkce dřeva, a vycházela z obav ohledně dopadů změny klimatu, aby poskytla podklady pro směřování lesního hospodaření a politiky. Byl proveden online průzkum a bylo shromážděno n = 234 odpovědí od zainteresovaných stran a návštěvníků spojených s Masarykovým lesem Křtiny. Průzkumný nástroj využíval otázky s výběrem z více možností, hodnocení významu a otázky týkající se klasifikace a priority ekosystémových služeb. K získání četností a podílů, jakož i skóre pro pořadí preferencí jsme použili deskriptivní analýzu. Lesní rekreační služby byly 91 % respondentů hodnoceny jako primární využití. Navíc 44 % respondentů navštěvuje les týdně nebo denně a 71 % alespoň jednou měsíčně, což naznačuje pravidelný trend v preferenci lesních rekreačních služeb. Služby v oblasti biologické rozmanitosti se umístily na prvním místě s 83,3 %, následované službami v oblasti regulace klimatu s 78,2 %. Lesní rekreace však byla ve veřejném hodnocení různých lesních služeb vysoce ceněna jako důležitá (75,2 %) a v žebříčku budoucích priorit hospodaření se umístila na 43,2 %. Názory zainteresovaných stran na kompromis mezi dřevem a biologickou rozmanitostí byly nejčastěji identifikovaným konfliktem (70,5 %), zatímco kompromis mezi dřevem a rekreací uznávalo téměř 39 %, i když byl hodnocen níže než kompromisy ohrožující adaptabilní služby. Výsledky průzkumu týkající se výhledů na hospodaření naznačily, že veřejnost upřednostňuje postupy a

přístupy orientované na ochranu přírody: 82,5 % upřednostňovalo biologickou rozmanitost, 47,9 % ochranu pralesů, 44,4 % lesnictví s nepřetržitým porostem a bylo většinou spokojeno nebo spíše spokojeno se současnými přístupy k hospodaření, což naznačuje otevřenost vůči přírodě přátelským variantám, které chrání kvalitu rekreace. Účastníci upřednostňovali změny teploty/srážek, výskyt škůdců a extrémní jevy jako hlavní klimatické hrozby; dopady na rekreační služby lesů byly středně závažným problémem, což naznačuje potřebu adaptačních opatření k zachování rekreačních zařízení. Studie doporučuje zavést multifunkční participativní plánování, které jednoznačně rozlišuje a oceňuje rekreační služby lesů jako nezbytnou službu a zároveň přispívá k biologické rozmanitosti a regulační odolnosti Masarykova lesa Křtiny. Lesní hospodaření, které vyvažuje trvalý přístup k kvalitnějším rekreačním službám s opatřeními na ochranu a klimatickou odolnost, by mělo podporovat preference veřejnosti a zajistit udržitelnost a rozsáhlé poskytování různých lesních ekosystémových služeb v brněnském příměstském prostředí.

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PHENOLOGICAL MONITORING OF ALLERGENIC GRASSES IN RECREATIONAL ZONES: RISKS OF AN EARLY POLLEN SEASON IN THE CONTEXT OF REGIONAL FLOWERING VARIABILITY

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Abstract
Recreational zones in climatically distinct regions require a specific approach to maintenance management with regard to visitor health. This study analyzes flowering dynamics and the associated pollen production of two key allergenic species: meadow foxtail (*Alopecurus pratensis*) and orchard grass (*Dactylis glomerata*). The monitoring is based on data from three phenological stations: Lednice (South Moravia), Běleč nad Orlicí (East Bohemia), and Mladecko (Silesia). The aim of the research is to quantify temporal differences in the onset and duration of flowering and to determine the periods of highest risk for the pollen season. For meadow foxtail, the results confirm significant variability in the onset of pollen production; however, an increasingly earlier onset of flowering is observed across all sites. A notable difference lies in the flowering duration: in warmer regions, meadow foxtail flowers for an average of 22 days, whereas in cooler areas, this period extends up to 46 days. Orchard grass also exhibits significant variability and an earlier onset of flowering, but maintains an average flowering duration of approximately 23 days across all locations. This study highlights preventive measures and serves as a basis for improving the quality of life and the safe movement of allergy sufferers within recreational zones.

Key words: Flowering phenophase, allergies, *poaceae* family, recreation

Introduction
Phenology, the study of periodically recurring biological events in relation to environmental conditions, currently represents one of the most sensitive bioindicators of ongoing global climate change. In Central European conditions, this trend is manifested by a shift in the onset of phenophases and an extension of the growing season. Grasses of the Poaceae family belong to the taxonomic group with the highest socio-economic and medical impact on human society, as they are the dominant source of airborne allergens during the summer period (Hájková, 2012; Ziska et al., 2000). The long-term rise in average temperatures, combined with increasing concentrations of atmospheric carbon dioxide, not only results in the accelerated development of grasses and earlier pollen release but also demonstrably increases total pollen production. The phenomenon of an early pollen season onset is not spatially homogeneous, as it is characterized by regional variability and the specific microclimate of urbanized areas (Andersson & Lidholm, 2003; Ziska et al., 2000).

In the context of recreational zones, such as urban parks, playgrounds, landscape heritage sites, and sports facilities, the monitoring of allergenic grasses is of great significance. These areas concentrate a high number of individuals suffering from pollinosis, even during periods of peak pollen production. The issue is further compounded by the existence of cross-reactivity between grasses and woody species such as ash, pine, juniper, and cypress (Weber, 2007; García-Mozo, 2017). Despite these risks, detailed monitoring of grasses at the scale of recreational areas is often neglected; yet, understanding the local flowering dynamics can serve as a key tool for effective adaptive green space management or for designing measures aimed at minimizing health risks. This study analyzes the flowering dynamics of meadow foxtail (Alopecurus pratensis) and orchard grass (Dactylis glomerata) at the Lednice, Běleč nad Orlicí, and Mladecko sites. The aim of the research is to quantify temporal differences in the onset and duration of flowering and to determine the periods of highest risk for pollen production across these diverse territories.

Materials and methods
Selected phenological phases are observed and the data subsequently processed in accordance with the methodology developed by the Czech Hydrometeorological Institute (CHMI), (Návod pro činnost fenologických stanic. Metodický předpis č. 1 - Lesní rostliny; Praha, 2009). For this study, the phenological stations of Lednice, Mladecko, and Běleč nad Orlicí were selected. The data have been evaluated starting from 1991 (Lednice, Běleč nad Orlicí) and 1999 (Mladecko).

Results
The duration of the flowering period for each given site and species is evaluated over the maximum

possible or current monitoring period. Individual phenophases are designated by abbreviations according to the aforementioned CHMI methodology for forest woody species: PK10 (onset of flowering 10%), PK50 (onset of flowering 50%), PK100 (onset of flowering 100%), and KK (end of flowering).
In the Lednice na Moravě locality, monitoring was conducted from 1991 to 2022. As shown in Figure 1, a pronounced variability in the onset of flowering for meadow foxtail has been observed over the last ten years. The difference between the earliest year (2014) and the latest onset (2012) is nearly 31 days. On average, meadow foxtail began flowering around the 121st day of the year (around the beginning of May), with a flowering duration of approximately 21 days, ending in late May. The shortest flowering period was recorded in the final year of observation, lasting 10 days, while the longest was in 2011, spanning 39 days.

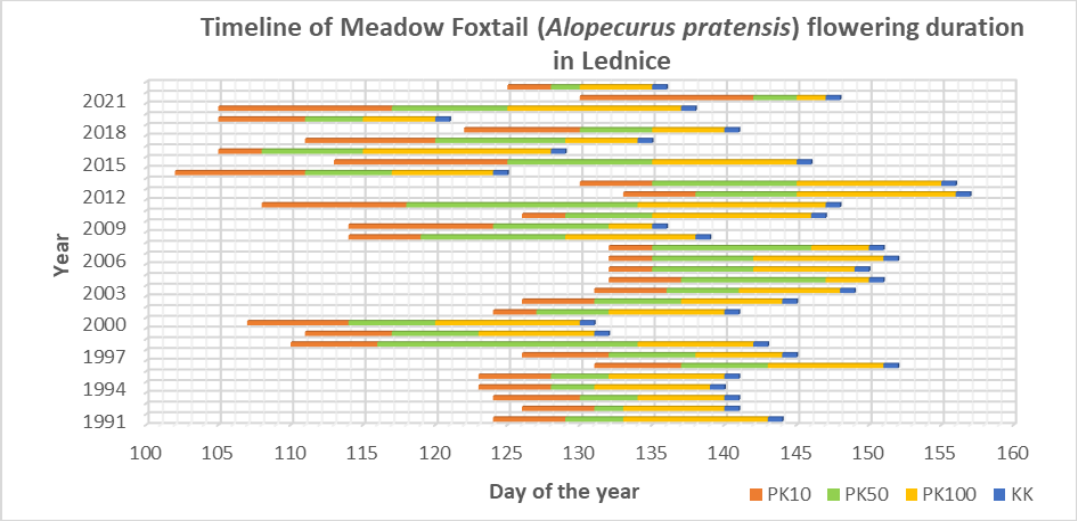

Figure 1: Timeline of meadow foxtail flowering duration in Lednice

Phenological monitoring of orchard grass in Lednice (Figure 2) shows an even greater variance in the onset of flowering, ranging from approximately the 108th day in 2016 to the 155th day in 1991. The results also indicate instability in both the onset and duration of flowering over the last decade; however, it can be clearly stated that the onset occurs significantly earlier compared to the 1990s. In this locality, orchard grass began flowering on average around the 135th day of the year (the second half of May), with an average flowering duration of 23 days. The difference between the shortest flowering period (2021) and the longest (2011) is a remarkable 64 days.

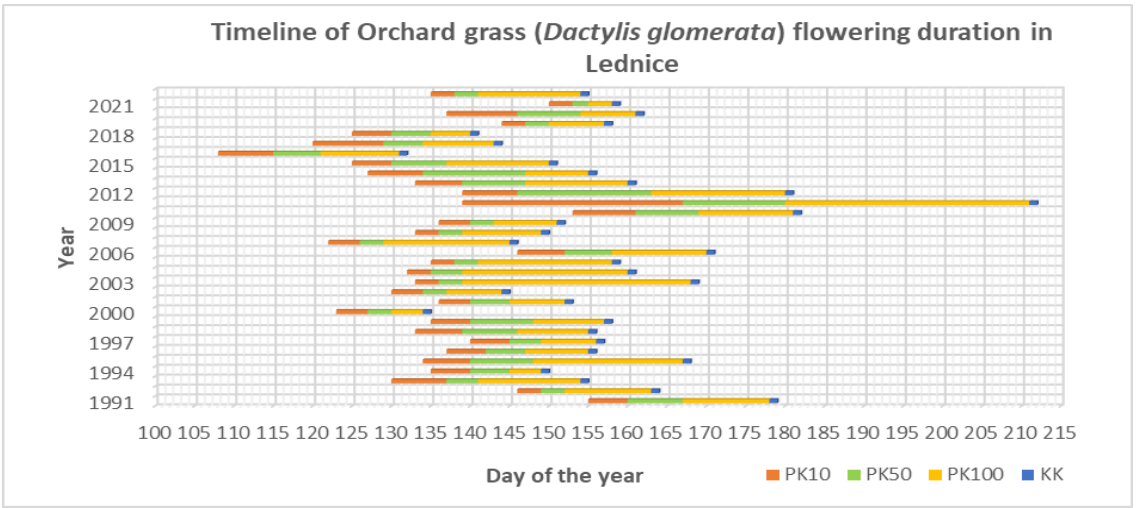

Figure 2: Timeline of orchard grassl flowering duration in Lednice

Another area of interest is Běleč nad Orlicí, located in the Hradec Králové Region. At this phenological station, measurements have been ongoing since 1991. For meadow foxtail, interannual fluctuations in the onset of flowering are evident (Figure 3), with a difference of up to 30 days between the earliest and latest onset. Data from the last two years show a very early onset, confirming the risk of an early overlap between grass pollen loads and fading woody plant allergens. This significantly increases the exposure risk in the region's recreational areas. On average, meadow foxtail begins flowering on the 133rd day of the year (the first half of May), with a flowering duration of approximately 22 days, ending in early June. The difference between the shortest flowering period (1993) and the longest (2013) is 23 days. Analysis of the phenological data for orchard grass in Běleč nad Orlicí (Figure 4) reveals a trend toward an earlier onset of flowering, with the last two years exhibiting some of the earliest values in the entire time series. The pronounced interannual variability, particularly evident when compared to extremely late years such as 1991 or 1992, confirms the high sensitivity of this species to local climatic factors. In this locality, orchard grass began flowering on average around the 143st day of the year (the second half of May) and flowered for an average of 22 days.

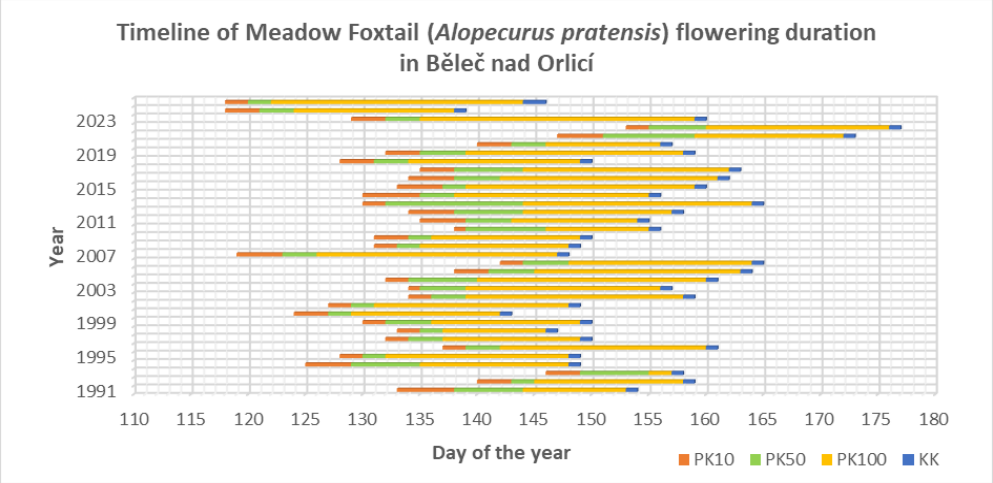

Figure 3: Timeline of meadow foxtail flowering duration in Běleč nad Orlicí

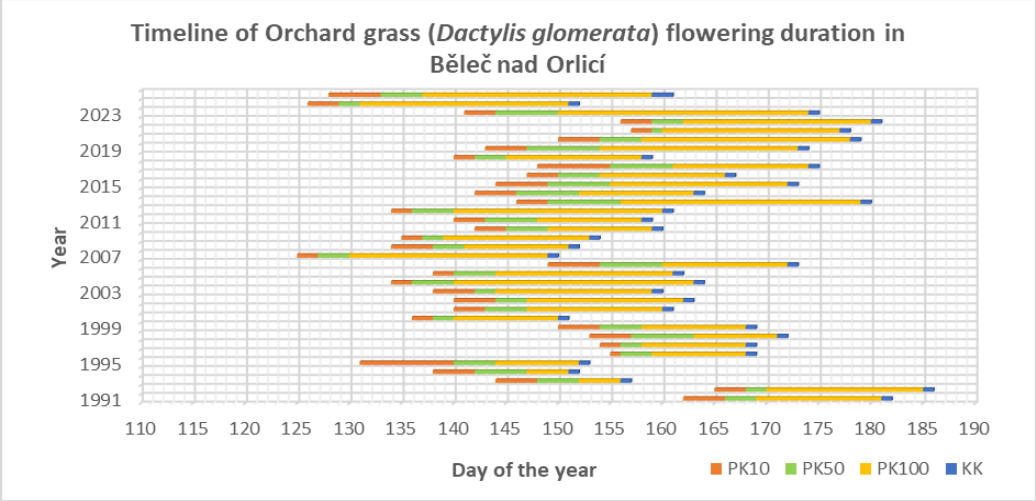

Figure 4: Timeline of orchard grassl flowering duration in Běleč nad Orlicí

The final set of analyzed data comes from the Mladecko phenological station, located in the Opava District within the Moravian-Silesian Region. Monitoring began in 1999 and continues to the present. In the last two years (2024–2025), meadow foxtail (Figure 5) has exhibited an earlier onset of flowering, starting around the 110th day of the year, which represents a significant shift compared to the average of previous decades. A distinctive feature of this locality is a considerable extension of the full flowering phase. Similar to the two previous sites, meadow foxtail generally begins to flower in early May; however, there is a substantial difference in the duration of flowering, which averages 46 days. The difference between the longest flowering period (2024) and the shortest (2000) is 35 days.

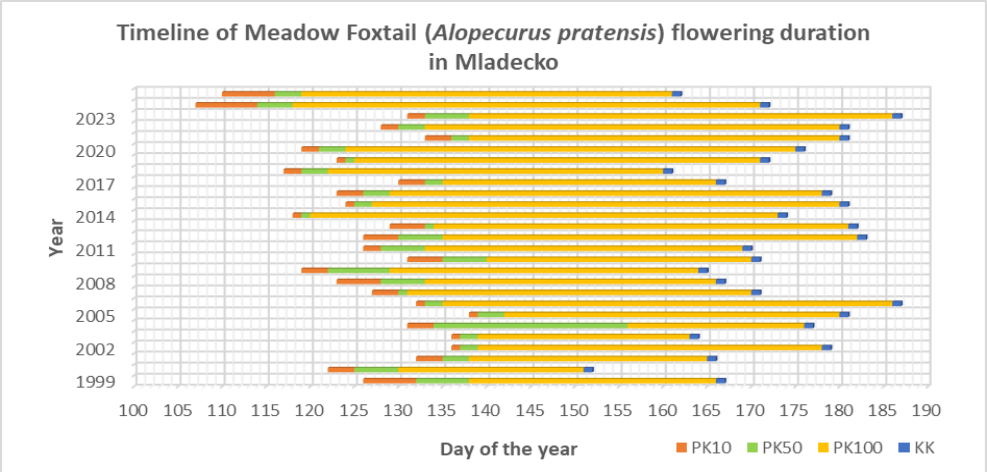

Figure 5: Timeline of meadow foxtail flowering duration in Mladecko

The phenophases of orchard grass in Mladecko (Figure 6) also show a shift toward earlier flowering in the last two years compared to previous decades; however, unlike meadow foxtail, interannual variability is present. On average, it begins to flower around the 148th day of the year, which is later than in Lednice or Běleč nad Orlicí, but the flowering duration is comparable, lasting approximately 24 days. The difference between the longest flowering period (2013) and the shortest (2000) is 28 days.

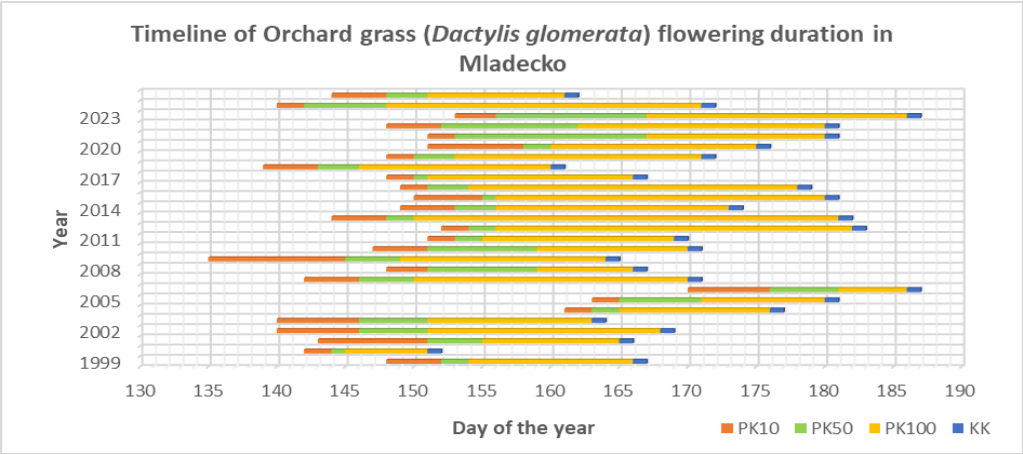

Figure 6: Timeline of orchard grassl flowering duration in Mladecko

Discussion

A comparison of the results of this study with the work of Kožnarová et al. (2011) confirms the long-term trend of extending flowering durations in key allergenic grasses, such as orchard grass and meadow foxtail. While Kožnarová identified the years 2000, 2007, and 2009 (within the 1991–2010 evaluation period) as periods with significantly accelerated phenophase onset, our data from the last fifteen years particularly the extreme years of 2024 and 2025 show that the acceleration process is further intensifying and that previous deviations are becoming the new standard. This shift of the "early pollen season" deeper into April increases the risk of overlap with woody plant allergens, confirming the growing vulnerability of the monitored sites to the impacts of climate change.

Conclusion

Phenological analysis confirmed that the earlier onset of grass flowering is becoming a new trend, with data since 2020 showing a shift in the pollen season of more than three weeks compared to historical averages. To maintain the accessibility and safety of recreational zones, it is critical to move away from fixed calendar-based maintenance schedules and implement dynamic mowing management driven by current temperature trends. Only the timely elimination of flowering culms can effectively reduce the allergenic load for visitors or, at the very least, mitigate the cross-reactivity between grasses and woody species.

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Souhrn
Studie se zabývá analýzou fenologických řad alergenních travin psárky luční a srhy říznačky v lokalitách Lednice, Běleč nad Orlicí a Mladecko. Analýza potvrdila jasný trend urychlení nástupu kvetení a prodlužování délky kvetení. Zatímco v 90. letech byl nástup kvetení (PK10) koncentrován do měsíce května, v posledním pětiletí (2021-2025) dochází k časnějším nástupům již do poloviny dubna. Prodlužování fáze plného kvetení (PK100) indikuje vysokou odlišnost reakce trav na oteplování než se tomu dělo před třiceti lety. Studii lze zařadit do tří kategorií, a to vědecké, zdravotní a praktické, protože oteplování není jen teoretický pojem, ale měřitelný fakt. Pylová sezóna se neustále posouvá dopředu a smyslem práce je poukázat díky zpracovaným datům na možná rizika a přizpůsobit management údržby seče v rekreačních zónách.

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PLANNING OF THE RECREATIONAL ACTIVITIES WITHIN REGIONAL DEVELOPMENT IN FORESTRY: LINKING TO POLICIES AND PLANNING

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Abstract

This contribution deals with the theoretical relationship of how forestry should influence society's requirements for recreation in forests and, on the other hand, how society's requirements for recreation in forests influence forestry. Here, the emphasis is placed on existing planning systems, policies and strategies. Using the examples of selected towns and municipalities from the Hodonín region in the Czech Republic, the study monitors the encounters of national and international policies and strategies with immediate impacts on forestry, and vice versa from the point of view of recreational use. The importance of the state of forests, their location, natural conditions, infrastructure, etc. plays a key role. This study found that although policies and strategies significantly mention forestry and the requirements of recreational use at a sustainable level, from a practical point of view we would expect this to be included in forest management plans. These are understood as a specific practical tool for the forest owner, but they should also include the stated demands of society, which are based on policies, strategies and are reflected through legislation in specific management measures. Unfortunately, the results of the findings point to shortcomings in these expectations.

Key words: forest management planning, strategy, policy, theoretical approaches, implementation

Introduction

Forestry encompasses a few related disciplines, including forest policy, which can be defined as an analytical policy process that involves formulating goals for human activities in forest management and use, and implementing them through feedback (Helms 1998).

In the context of this contribution, we understand regional development as a set of activities on which local actors agree to contribute to the development of a region across the environmental, economic and social dimensions. We focus on the strategic-planning dimension of regional development, because strategic documents at the supranational, national, regional, local and municipal levels shape the priorities and directions of territorial development, including the position and expected contribution of forestry. Understanding how these documents formulate objectives related to forestry is therefore essential for assessing the role that forestry is to play in regional development. The basic tool for planning forest management is the forest management plan. It can be defined as a predetermined procedure and direction to achieve a set of results, usually specified in terms of objectives, tasks and political intentions. (Krott, 2005).

The law of the Czech Republic defines a forest management plan as a tool of the forest owner. Based on a detailed assessment of the state of the forest, the plan determines a sustainable level of timber harvesting in the long term, which, by using the forest's production capabilities, ensures a permanent yield and does not threaten its essence or the fulfilment of other functions (including recreational ones). The Forestry Code (No. 289/1995 Coll., as amended) states that these plans are a tool of the forest owner, who is entitled to significantly influence the principles of future management and thus its yield within certain limits.

The objectives of forest planning can be diverse, from setting strategic visions to assessing the current state of the forest, identifying the results and outputs of forest management and setting political goals (van Hensbergen et al., 2023). According to him, the hierarchy of forest planning is generally based on the objectives of the national forest policy, which are reflected in the regional strategic forest plan. Here, the objectives are implemented mainly through the forest owner.

The aim of this study was to determine, using the example of selected municipalities in the Hodonín region within the Czech Republic, how forestry (the overall state of forests and its management methods) affects society's requirements for recreation in forests and, on the other hand, how society's requirements for recreation in forests affect forestry (in terms of management results – economic aspects, forest condition – ecological aspects, and overall access to forests – social aspects). Here, the emphasis is placed on existing planning systems, policies and strategies. The study monitors the

intersection of national and international policies and strategies with immediate impacts on forestry, and vice versa from the perspective of recreational use.

Material and methods

Study area

The analysis of the approach to recreational forest use and the connection of forestry policies was solved on the example of several selected municipalities in the Hodonín region. Hodonín is a district, according to NUTS units in terms of NUTS 4 units according to European Commission (2007). It is located in southeastern Moravia in the Czech Republic, near the border with Slovakia. For the purposes of this study, 5 municipalities were selected that own forest property. These are the municipalities of Mutěnice, Dubňany, Čejč, Hovorany, Šardice - i.e. located in the immediate vicinity of the city of Hodonín. These municipalities are cadastrally connected to each other, but the approach to forest management and support for recreational forest use is different.

From the point of view of natural conditions, the selected area lies on the border of two different geomorphological units: the Lower Moravian Valley, the Central Moravian Carpathians. The relief is largely flat, flat to slightly undulating, with an altitude of 170-230 m above sea level (Culek 2005). Water is drained from the area by nameless streams, which are part of the Kyjovka River basin, then the Dyje and Morava rivers. According to the climatic classification of Quitt (1971), the municipal forests are in the group of warm areas T4. The geological subsoil consists of terraced gravelly sands, on which wind-blown sands rest. The predominant soil type is arenaceous oligotrophic cambium.

The municipality of Mutěnice owns approximately 95 ha of forest, the municipality of Čejč 16 ha, the town of Dubňany 225 ha, Hovorany 80 ha and the municipality of Šardice approximately 60 ha of forest. In the municipality of Mutěnice, the main tree species is Scots pine, which represents 32% of the growing area and 44% of the stock. Furthermore, black locust occupies 35% of the growing area (25% of the stock), oaks 11% of the growing area (10% of the stock), linden tree 7%. Other tree species are represented marginally (up to 5%). These are mostly invasive species such as ash-leaved maple, glandular juniper, etc. In the town of Dubňany, the species composition of tree species is approximately similar, however, the dominant tree species are oaks, followed by Scots pine. Again, there is a high presence of invasive non-native tree species: especially black locust, ash-leaf maple, tree of Haeven etc. The municipalities of Čejč (up to 90%), Hovorany and Šardice have stands consisting mainly of black locust, with tree of Haeven occurring prominently on the edges. However, there are some exceptions.

In terms of landscape character, this is more of an agricultural landscape with a high incidence of field crops, with minimal incidence of meadows or pastures. It is also a characteristic wine-growing area, which is also widely used for visits to taste wine. The forests in this landscape offer opportunities, especially for cycling or walking on hot summer days.

Analysis of the state of approach to recreational forest use with regard to regional development

The identification of the approach of individual selected municipalities to the recreational use of forest property (regarding its potential) and the connection to various policies (the above-mentioned overview of policies is listed, for example, by Holušová et al., 2025) with a link to regional development and forestry was carried out by verifying several aspects. This verification was identified through discussions with representatives of municipalities and cities in the years 2024 to 2026. Specifically, the following findings were made:

1) Whether the given municipality or city has developed its own strategy for the development of forest property care with regard to the recreational use of forests (i.e. beyond the framework of planning documents);
2) Whether the given municipality or city sufficiently includes its requirements for recreational activities in forests in the forest management plan and practically implements this;
3) Whether the given municipality has infrastructure to support recreational activities. For example, roads - sufficiently marked and passable, also safe, whether there is, for example, an educational trail about forest ecosystems, whether the forest is equipped with, for example, game or other sports elements (or at least there is such an intention) and also with the use of subsidies.
4) Whether the municipality or city intends to improve the health of forests and thus increase the recreational potential of forests and their safety.
5) Which aspects of the three selected ones does the given municipality intend to support the most (economic, ecological or social, or all).

Results and discussion

Results of the analysis of the state of access to recreational use of forests with a link to regional development

A general overview of the approach to solving recreational use in forests owned by selected municipalities and towns in the Hodonín region is presented in Table 1.

The results show that only two municipalities have a strategy for developing forest property care with regard to recreational use of forest: Dubňany and Čejč. Two municipalities also have their own infrastructure to support recreational activities using subsidies, but these are municipalities that have larger assets than the others. These two municipalities with larger forest assets are also trying to improve the health of the forests. Almost all municipalities prioritize economic aspects in the care of their assets over others.

Tab. 1: Results of the solution of recreational activities in forests with connection to the forest management plan, owners' intentions, use of policies and subsidies in selected municipalities of Hodonín region, Czech Republic

Name of municipality	Forest area in ha	Manages the forests itself or a foreign private entity manages them	Own strategy for developing forest property care with regard to recreational use of forests	To incorporates its requirements for forest recreational activities into the forest management plan and practically implemented	Providing infrastructure to support recreational activities using subsidies	Targeted improvement of the health of forests and increasing the recreational potential of forests and their safety	Mostly supports these aspects (economic, ecological, social, all of them)
Mutěnice	95	Municipality	No	Partly	Yes	Yes	Economic
Dubňany	225	Municipality	Yes	Partly	Yes	Yes	All of them
Čejč	16	Municipality	Yes	No	No	No	Economic
Hovorany	80	Private entity	No	No	No	No	Economic
Šardice	60	Private entity	No	No	No	No	Economic

It is possible to conclude that if a municipality transfers the right to manage forests to a private company. It is very difficult to talk about how it will influence and support forest management and how it will support recreational activities in forests located in the municipality's cadastre. With the transfer to private management and use, it can be said that the influence of politicians or the influence of a forest management plan or interest is not possible and in principle not even real. On the other hand, the management by municipalities itself does not seem ideal either. As for the state of the forest, we often find stands that are neglected in terms of cultivation.

All properties are burdened by the occurrence of invasive tree species, and their development is evident here. Where there were stands in the past that were logged in previous years, they were not afforested but rather allowed to rejuvenate the invasive black locust.

In the forests of the municipality of Mutěnice, the plans are currently similar. This may be due to the fact that these are again larger properties. Forests in the municipality of Čejč are another specific feature, the municipality has a developed strategy, but the condition of the forests is not good, and economic aspects are prioritized over others. The reason may be the small area of forests and their dispersion. Hovorany and Šardice currently do not address recreational use of forests in any way, the policy does not affect it in any way, and neither does the management of private owners. Which is probably not a sustainable model with the support of all aspects.

Conclusion

In five selected municipalities and towns in the Hodonín region in the Czech Republic, it was investigated how forestry planning is linked to regional development policies and how recreational opportunities in forests are supported and addressed within this connection. It was found that although policies and strategies significantly mention forestry and the requirements for use for recreational purposes at a sustainable level, from a practical point of view we would expect this to be included in forest management plans, but this is not the case. The findings point to aspects of the importance of a larger area of forests managed by municipalities, and it is appropriate not to transfer the right to manage to other (private) entities. Thus, the municipality and its management cannot influence the

state of the forests or their use. Policies are therefore inapplicable within the framework of voluntary will. All that remains is a legislative regulation that does not directly direct specific goals and methods of management to the owner or manager of the forest (managing entity).

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Souhrn

Tento příspěvek se zabývá teoretickým vztahem mezi tím, jak by lesnictví mělo ovlivňovat požadavky společnosti na rekreaci v lesích, a naopak, jak požadavky společnosti na rekreaci v lesích ovlivňují lesnictví. Důraz je zde kladen na stávající systémy plánování, politiky a strategie. Na příkladech vybraných měst a obcí z Hodonínského regionu v České republice studie sleduje prolínání národních a mezinárodních politik a strategií s bezprostředním dopadem na lesnictví a naopak z hlediska rekreačního využití. Klíčovou roli hraje význam stavu lesů, jejich umístění, přírodních podmínek, infrastruktury atd. Tato studie zjistila, že ačkoli politiky a strategie významně zmiňují lesnictví a požadavky rekreačního využití na udržitelné úrovni, z praktického hlediska bychom očekávali, že toto bude zahrnuto do plánů lesního hospodaření. Ty jsou chápány jako konkrétní praktický nástroj pro vlastníka lesa, měly by však zahrnovat i uvedené požadavky společnosti, které vycházejí z politik, strategií a promítají se prostřednictvím legislativy do konkrétních opatření v oblasti hospodaření. Výsledky zjištění bohužel poukazují na nedostatky v těchto očekáváních.

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PREMISES FOR TOURISM DEVELOPMENT IN URBAN AREAS USING PPGIS TECHNIQUES

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Abstract
Public Participation Geographic Information Systems (PPGIS) practices have become a widely debated research topic in recent years, with clear practical implications and outcomes. Numerous studies and research platforms share experiences and best practices related to software resources capable of supporting participatory governance and enhancing sustainable resource management and accessibility. Understanding the different perspectives of stakeholders on tourism resources, and using their input to generate integrative planning for recreational activities, is essential for the successful and sustainable development of urban leisure activities in major capital cities such as Bucharest. Methodological approaches to this topic are diverse and depend on selecting the most appropriate methods for each specific context. Producing knowledge through stakeholder participation in the communication of tourism resources and events can help build communicative planning mechanisms and foster convergent social and institutional policy-making structures. PPGIS techniques can therefore generate more equitable and resilient mechanisms for various objectives, including the planning of leisure and recreational spaces and activities, as regions and cities increasingly compete for top positions in tourists' preferences as visible, creative, and community-oriented international leisure destinations worldwide.

Key words: stakeholders, tourism industry, social involvement, GIS databases

Introduction

Public Participation Geographic Information Systems (PPGIS) practices have become a widely debated research topic in recent years, with clear practical implications and outcomes for a wide range of users and domains.

Tourism is one domain that considers place-based information from people and uses mapping techniques to explore and leverage both quantitative and qualitative knowledge. This approach provides deeper analyses of the relationship between spatial studies and human perceptions and/or experiences on the one hand, and offers valuable input for participatory, sustainable, and integrative planning processes on the other.

Taking this context into account, this paper examines and analyses—while drawing on existing scientific literature—the opportunities and methods related to the use of PPGIS practices for leisure planning purposes and tourism outcomes. It focuses on their general application, which may support the development of community-oriented and community-owned participatory products, as well as the sustainability of the existing, limited pool of tourism valued natural and cultural resources.

Theoretical background and methods

Advantages for using PPGIS methods

Numerous studies and research platforms present methods, experiences, and best practices related to software resources (e.g., Maptionnaire, Debatomap, Esri ArcGIS Survey123) (Ramírez Juárez et al., 2023; Salminen et al., 2025) that are capable of supporting participatory governance and enhancing sustainable resource management and accessibility.

Understanding the different perspectives of stakeholders on tourism resources, and using their input to inform integrative planning for recreational activities, is an essential aspect of the successful and sustainable development of urban leisure activities in major capital cities such as Bucharest. PPGIS methods used to collect data from different stakeholder groups (international and domestic tourists, visitors, local residents, etc.) can be of crucial importance for understanding travel behaviour (Ramezani et al., 2020), as well as for visualization, mapping, and, subsequently, smart spatial planning of tourism development projects and community-oriented, visitor-friendly planning.

The interactive map principles allow to surpass both a dynamic and a continuously evolving landscape as well as a very diverse real-time perception perspective through individual input generated by survey methods (Kantola et al., 2023).
Therefore the methodological approaches to this topic are diverse and depend on selecting the most appropriate methods for each specific context.

Constraints for using PPGIS methods
Data quality is often an important barrier for using PPGIS method in scientific studies and/or for planning purposes in real administrative projects (Fagerholm et al., 2021). Survey design, participant recruitment and data collection may be biased and influenced to a great content by convenient or purposive and volunteer sampling methods (Garcia-Martin et al., 2017; Rall et al., 2017; Fagerholm et al., 2021) as methodological framework addapted for PPGIS are quite innovative and demand also a high potential of involvement from the interviewed stakeholders. The type of place-related data to be collected, such as the individuals map spatial attributes and data gathering without external assistance are also important features that may reppresent constraints for PPGIS methods (Brown, 2017; Fagerholm et al., 2021).

In this context the present study performs a desk research, a common method used for gathering information and insights by analysing and synthesizing data and sources so as to depict main elements on the topic of PPGIS technics usage as support for urban tourism development.

Results
A main topic addressed in the reference studies, as noted above, concerns the types of data collected in PPGIS research. The distinction and overlap between non-spatial and spatial PPGIS data, as well as other forms of spatial data, remain a focal point of the method across various types of PPGIS studies (exploratory, explanatory, or predictive/model-based studies) (Fagerholm et al., 2021).
If considering *data collection* for spatial analyses Brown et al. (2014) support both workshops, as common group focused data collecting methods, but also surveys as usefool tools which could and should rather be complementary and support different perspectives and different scales of spatial analyses. According to the same authors (Brown et al., 2014) complementary methods are useful to obtain and process both deductive mapping methods (predefined landscape/object values) as well as inductive mapping methods (values generated by qualitative data, consequently from values coded from participant text). These perspectives could perfectly be addapted and correspond to tourist perception studies concearning landscape evaluation with respect to visitor experience and satisfaction as demonstrated in other mixed methods analysis studies focusing on valuing qualitative PPGIS data (Garcia et al., 2018). PPGIS perception studies are useful especially in case of urban tourism, as proven through complex evolving methods for outdoor recreation (Skriver Hansen et al., 2021).
Urban tourism and its associated / overlapping leisure segments (e.g. cultural tourism, leisure outdoor urban activities, etc.) is by excellence a domain which could take advantage of the usage of PPGIS techniques in order to improve its products as related to main types of consumers and their characteristics (e.g. age, profession, cultural background etc) by using both spatial and non-spatial data and appealling to participatory input resulted from top-down approaches and sub-sampled survey data. The complementary botom-up approach connected to workshop or focus group data generative processes as well as hotspot approaches based on clustering methods (Brown et al., 2014) are also appropriate to urban environment research and could match tourism development studies with respect to tourist behavior and preferences in light of further improvements of existing conditions and attributes of main tourism resources (attractions).
Spatializing urban perception by refering to tourist satisfaction is by far a topic which can value subjective input translated in participatory GIS metadata and indicators (Delpino-Chamy & Pérez Albert, 2026).

Discussion and Conclusion
Producing knowledge through stakeholder participation in the communication of tourism resources and events can help build communicative planning mechanisms and foster convergent social and institutional policy-making structures especially in fragmented and incresingly problematic urban contexts (Delpino-Chamy & Pérez Albert, 2026). PPGIS is engaging public decision-making by integrating local knowledge and complex information that allow active interaction and dynamic analyses that empower citizens for both tourism attractions usage and valorization (Kantola et al., 2023).

PPGIS techniques can therefore generate more equitable and resilient mechanisms for various objectives, including the planning of leisure and recreational spaces and activities, as regions and cities increasingly compete for top positions in tourists' preferences as visible, creative, and community-oriented international leisure destinations worldwide.

As related to planning goals participation and collaboration processes taking place among different stakeholder groups suppose four types of communicative actions namely (https://participatory.tools/before-you-start/fourfold-model/):

- The one in which the broad public produce diverse information or ideas for planning (I)
- The one in which the knowledge (existing information) is structured and organized with broad public (II)
- The one in which common work and results make an input to the process (III)
- The one in which informational content (Knowledge) is converged in a smaller group – possibly expert group (IV)

Bucharest can be a perfect illustrative example and a real scale laboratory for demonstrating PPGIS techniques and further applicative research studies on the topic in the light of its competing interests at regional and national level for developing tourist attractivenes and addapted tailor-made leisure products which better respond and addapt consummer needs and expectations. Both urban tourism resilience and visibility, as well as planning strategies for leisure and recreational activities in major cities of Romania, could benefit from PPGIS techniques and methods, which can provide dynamic and accurate representations of reality to further support adaptive planning policies.

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Souhrn

Postupy v oblasti geografických informačních systémů pro zapojení veřejnosti (PPGIS) se v posledních letech staly široce diskutovaným tématem výzkumu s jasnými praktickými dopady a

výsledky. Cestovní ruch je jednou z oblastí, která zohledňuje informace o konkrétních místech poskytované lidmi a využívá mapovací techniky k prozkoumání a využití jak kvantitativních, tak kvalitativních poznatků. Tento přístup umožňuje na jedné straně hlubší analýzu vztahu mezi prostorovými studiemi a lidským vnímáním a/nebo zkušenostmi a na straně druhé nabízí cenný podklad pro participativní, udržitelné a integrativní procesy plánování.
Četné studie a výzkumné platformy sdílejí zkušenosti a osvědčené postupy týkající se softwarových zdrojů, které jsou schopny podporovat participativní správu a zlepšovat udržitelné řízení zdrojů a jejich dostupnost. Porozumění různým pohledům zainteresovaných stran na turistické zdroje a využití jejich podnětů k vytvoření integrativního plánování rekreačních aktivit je zásadní pro úspěšný a udržitelný rozvoj městských volnočasových aktivit ve velkých hlavních městech, jako je Bukurešť. Metodické přístupy k tomuto tématu jsou rozmanité a závisí na výběru nejvhodnějších metod pro každý konkrétní kontext. Získávání poznatků prostřednictvím zapojení zainteresovaných stran do komunikace o turistických zdrojích a akcích může pomoci vybudovat komunikační plánovací mechanismy a podpořit konvergentní sociální a institucionální struktury tvorby politik.

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PROPOSAL FOR A GEOTOURISM TRAIL TO ENHANCE THE OFFER OF THE MALÉ KARPATY GEOPARK

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Abstract
This paper proposes a geological educational trail in the Malé Karpaty Mountains, in the village of Kuchyňa (Slovakia). It focuses on identifying, evaluating, and interpreting natural and cultural heritage to support geotourism and environmental education. The trail incorporates key geological, geomorphological, hydrogeological, and historical features, including fluvial landforms, sedimentary structures, and remnants of historical mining. It is designed for diverse audiences, including school groups, families, and recreational visitors, offering both a shorter educational route and a more challenging hike. The emphasis is on experiential learning, interdisciplinary links, and effective communication of scientific knowledge through interpretative materials. The trail can help promote geotourism, raise environmental awareness, and strengthen regional identity within the Malé Karpaty Geopark. The study underscores the importance of combining scientific research with practical approaches to sustainable landscape management and education.

Key words: geopark, geotourism trail, geoeducation, geointerpretation, proposal

Introduction

Geology as a scientific discipline is not limited by administrative boundaries, as it studies processes and structures that transcend territorial divisions. In contrast, a geopark is defined as a specific area with clearly delineated boundaries that holds significant geological, natural, and cultural value. Its primary aim is to support regional development through conservation, environmental education, and sustainable tourism. The concept of a geopark is based on the preservation of geological heritage through active cooperation with the local community (UNESCO, 2026). Such development should be mutually beneficial for both residents and visitors, while respecting the natural environment and its values.

There are currently four established geoparks in Slovakia: the Novohrad–Nógrád Geopark, the Banská Štiavnica Geopark, the Banská Bystrica Geopark, and the Little Carpathians Geopark. The latter is among the youngest and represents an important step in the development of geotourism and environmental education in the western part of the country (SAŽP, 2025).

This paper focuses on the identification, characterisation, evaluation, and interpretation of the natural and cultural heritage of a selected part of the Malé Karpaty Mountains, with the aim of proposing a potential educational trail in the central part of this region, specifically in the village of Kuchyňa, which is characterised by a rich mining history. The proposed route includes selected sites with high natural, geological, and cultural potential that could significantly contribute to tourism development in the region.

Materials and methods

The geology of the Malé Karpaty Mountains exhibits considerable diversity. It includes mountain terrains suitable for hiking, watercourses and reservoirs with recreational potential, as well as wetlands with distinctive ecological and aesthetic characteristics. This diversity creates favourable conditions for the development of geotourism, environmental education, and the protection of natural heritage in cooperation with local communities.

- The following methodological approach was applied in the design of the educational trail:
- Field survey and geoheritage analysis – identification of geologically, ecologically, and culturally significant sites, including the collection of data on rocks, geomorphology, and hydrogeological features.
- Assessment of the area's potential – evaluation of the attractiveness of the locality for different target groups (tourists, schools, families, and other interest groups), including accessibility, safety, and infrastructure, as well as opportunities for interdisciplinary integration (geology, biology, history, environmental science).
- Design of educational content – development of information panels, posters, leaflets, and

interactive elements; adaptation of specialised information into an accessible form for the general public; and alignment with school curricula through suggested field-based activities.

- Route and stop planning – logical organisation of the trail with respect to thematic units, selection of stops based on their significance, visual attractiveness, and accessibility, and consideration of different modes of use (walking, cycling, families with children).
- Sustainability and nature conservation – minimisation of interventions in the natural environment.
- Community and stakeholder engagement – consultation with local residents, schools, municipal authorities, and experts; support for local crafts, entrepreneurship, and cultural heritage; and creation of opportunities for volunteer and community activities.
- Graphic and technical design – preparation of visualisations, maps, and panel designs; development of signage and trail infrastructure; and preparation of technical documentation for implementation.

Results

The route leads through a forested area, passing a forester's lodge and stopping at a former quarry, with the final destination at the Kuchynská priehrada reservoir (or vice versa).

The proposed trail (Figure 1) is designed to enable the application of theoretical knowledge in a real natural environment through an educational and experiential approach. It focuses on developing observational skills, supporting critical thinking, and enhancing environmental awareness. By incorporating local geological, biological, and cultural-historical features, the trail connects theoretical learning with practical landscape exploration and promotes a deeper relationship with nature and its conservation.

Fig. 1: Proposed geotourist trail

The route begins in the village of Kuchyňa near a hydrological gauging station. It continues through a scenic forest landscape along the Malina stream. Throughout the route, visitors can observe various geologically significant features. The trail leads from the gauging station towards the Köberling 2 adit (or to a nearby crossroads, if the short detour is omitted), then continues across Kerečnatá (also referred to as Korečnatá on some maps). It passes former quarry sites and ends at the Kuchynská priehrada reservoir.

The total duration of the full route is approximately 6 to 7 hours, depending on terrain conditions and breaks. A shorter version takes approximately 2 to 3 hours (from the water source to Köberling 2 and back). The educational trail includes a total of eight stops.

The total length of the route is approximately 13 km, corresponding to about 4 hours and 40 minutes of walking at a steady pace with short breaks, excluding interpretation stops. The route can be shortened by using an unmarked path, reducing the duration to approximately 4 hours and 30 minutes and the length to about 12.5 km. The shorter educational route (from the water source to Köberling 2 and back) takes approximately 2 hours.

The trail focuses on geological structure, rocks and minerals, fluvial processes (river sections, meanders, waterfalls, alluvial deposits, bank erosion, and slope undercutting), sedimentation, folding, mining activity and its environmental impact, quarrying, and practical geological observation (e.g. use of a geological hammer).

The route can be adapted for educational purposes, particularly for kindergarten and primary school

groups. In such cases, it is recommended to use the first third of the route, from the water source to Köberling 2 and back, covering approximately 3.1 km (6.2 km return). Alternatively, starting from the reservoir, the distance is approximately 5.1 km (10.2 km return). This section is relatively undemanding and offers a high concentration of observable geological features, allowing for interdisciplinary teaching.
The section passing through Kerečnatá towards the former quarry is more physically demanding, with an elevation gain of approximately 300 metres.
The proposed educational trail consists of eight main stops, arranged logically along the route and reflecting the most significant natural and anthropogenic features of the area. The first stop is the hydrological gauging station in the village of Kuchyňa, which serves as the entrance to the forest environment and the starting point of the trail. The second stop is located at a water source near Modranská Skala, an important hydrogeological site where karst–fissure groundwater accumulates in carbonate rocks. The third stop is situated along the Malina stream, where visitors can observe the dynamics of a mountain watercourse, including meanders, erosion, alluvial deposits, and small waterfalls. This is followed by two stops focused on the Köberling 1 and Köberling 2 mining adits, which represent historical pyrite mining sites and illustrate past mining activities in the area. The sixth stop is located in the Kerečnatá area, representing a more demanding section of the route with visible geological outcrops. The seventh stop is situated in a former quarry below Mešťánková hill, where various rock types and remnants of mining activity, such as spoil heaps and mining pits (pinga), can be observed. The final, eighth stop is the Kuchynská priehrada reservoir, which serves as the endpoint of the trail and provides an opportunity to summarise the acquired knowledge.

Discussion

The educational trail is divided into two parts – an educational section and a more demanding hiking section – thereby accommodating different types of potential geopark visitors (Amaro et al., 2023; Drápela et al., 2021)
The educational section is designed to be accessible to school groups, families with children, and individuals interested in geology who prefer less physically demanding activities. It allows direct observation of geological phenomena such as karst features, sedimentation processes, and tectonic deformation. The trail also enables interdisciplinary connections, linking geology with geography, biology, history, and art education. The educational panels are designed to be clear and engaging, making them accessible to a broad audience without requiring specialised knowledge.
The hiking section offers a more immersive natural experience. Although physically more demanding, it provides close contact with the natural environment. The route passes through forest paths also used by wildlife, allowing visitors to observe species such as roe deer, deer, and birds. It is also suitable for mushroom foraging, particularly in autumn.
A notable feature is the quarry, which initially appears as a stone field. However, with the use of a geological hammer, visitors are able to discover intriguing rock samples, potentially appealing to geotourism enthusiasts.
The entire trail is designed with a strong emphasis on environmental education, encouraging visitors to reflect on the relationship between humans and the landscape, the impact of human activity on nature, and the importance of conservation.
From a tourism perspective, it is important to consider the needs of different visitor groups. For families, kindergartens, and primary schools, simplicity and clarity of interpretation are essential. Educational panels should be visually clear, concise, and interactive, supporting experiential learning.
Another important group consists of mushroom foragers, who frequently visit the area. An interesting approach is to link mushroom occurrence to geological conditions, explaining the relationship between fungi, bedrock, soil types, and microclimate. This can enhance understanding of geological processes.
Cyclists experience the trail differently from pedestrians – more dynamically, with an emphasis on clarity and visual readability. Therefore, information must be presented in a concise and visually accessible manner.
Effective interpretation connects geological phenomena with everyday experience, such as the relationship between bedrock and vegetation, the influence of streams on landscape formation, or differences in fossil and mineral occurrence. Such connections make geological concepts more accessible and engaging for the general public.

Conclusion

The proposed geological educational trail follows the courses of the Javorinka and Malina streams, which have significantly shaped the local landscape. Along the route, visitors can observe geomorphological features such as meanders, cascades, small waterfalls, and fluvial karst, illustrating

the dynamic processes of erosion and deposition.
The area around the village of Kuchyňa is characterised by a diverse geological structure, including sedimentary and metamorphic rocks, providing suitable conditions for environmental education and field observation.
The proposed trail represents an effective tool for linking theoretical knowledge with practical experience and can serve as a valuable resource for field-based education. It also has the potential to support the development of geotourism, strengthen local identity, and increase environmental awareness within the Malé Karpaty Geopark.

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Souhrn

Článek se věnuje návrhu geoturistické naučné stezky na území Geoparku Malé Karpaty na Slovensku, propojením environmentálního vzdělávání, geoturistiky a regionálního rozvoje. Hlavní zaměření je na identifikaci a interpretaci přírodního a kulturního dědictví v okolí obce Kuchyňa, která se vyznačuje výraznou geologickou diverzitou a historickou těžební činností. Metodologicky práce vychází z terénního výzkumu, analýzy geologického dědictví a hodnocení potenciálu území z hlediska turismu a vzdělávání. Návrh respektuje principy udržitelnosti a minimalizace dopadů na přírodní prostředí a zdůrazňuje význam zapojení místní komunity. Navržená trasa sleduje významné krajinné prvky, zejména vodní toky Malina a Javorinka, které formovaly reliéf území. Na trase lze pozorovat geomorfologické jevy, jako jsou meandry, kaskády, menší vodopády a projevy fluviálního krasu. Tyto prvky dokumentují erozní a akumulační procesy a poskytují vhodný základ pro terénní výuku. Součástí stezky je osm tematických zastavení zaměřených na klíčové aspekty geologického a kulturního dědictví. Důraz je kladen na srozumitelnou interpretaci odborných poznatků prostřednictvím informačních panelů a interaktivních prvků. Stezka je navržena pro různé cílové skupiny, včetně školních kolektivů, rodin s dětmi i individuálních návštěvníků. Navržená koncepce ukazuje, že geologické dědictví lze efektivně využít pro vzdělávání i rozvoj cestovního ruchu. Stezka má potenciál posílit geoturistiku v rámci Geoparku Malé Karpaty a zvýšit povědomí o ochraně přírodního prostředí.

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RECOMMENDATIONS FOR EFFECTIVE AND SUSTAINABLE PRESENTATION OF THE SIGNIFICANCE, FUNCTIONS AND HISTORY OF WATER MANAGEMENT ELEMENTS AND SYSTEMS

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Abstract
The aim of the work is to propose suitable ways of presenting industrial water management heritage with regard to its historical and technical value. The research combines literary research, field investigation and comparative analysis of various presentation methods. The results show the benefits of interactive elements, such as QR codes, games or physical models, to increase attractiveness and understanding. At the same time, shortcomings were identified, in particular poor maintenance and inappropriate processing of information materials. The preferred method of presentation, which is supposed to ensure accessibility and attractiveness to a wide range of visitors, is a combination of traditional and modern forms of presentation and an emphasis on quality content and regular maintenance.

Key words: Water element; historical water systems; QR code; information board; nature trail

Introduction
The aim of the presented work, which is part of a broader research on industrial heritage in the field of water management and water management structures, is to obtain data for the design of suitable forms of presentation of objects and their systems, or functional units, if they have been identified as potentially of historical significance or unique in terms of their technical and historical character.

Materials and methods
The methodology of the research work is based on a combination of qualitative methods focused on the analysis of the possibilities of presenting the cultural and industrial heritage of water management objects and their systems (Ryšková, Dzuráková et al., 2022). First, a literature search of expert sources and existing approaches to the interpretation of technical heritage was carried out. Subsequently, a field survey was carried out in selected locations, focused on the documentation and analysis of presentation forms. The research included processing a reflection of one's own experiences in solving the presentation of research project results from the calls for applied research of the Ministry of Culture of the Czech Republic (calls "NAKI II"), processing exhibition panels, catalogs and information materials (Sviták et al., 2022). The obtained data were evaluated by comparative analysis, which will allow comparing the benefits and limitations of individual methods.

Results
Results of the field research
Figure 1 shows an example of diversifying the information table with the aim of keeping the attention of visitors and those interested in information along the entire nature trail. Appropriate addition of tasks for children (bottom left in the picture), or a quiz or game (bottom right in the picture) will increase the attractiveness and maintain the attention and interest of a wider range of visitors to the nature trail. Figure 2 presents an example of a suitable placement of a QR code to obtain additional information about the issues presented on the panel at a height accessible to a wide range of visitors. At the same time, the size and color of the panel element are appropriately selected so that it attracts attention within all parts of the panel.

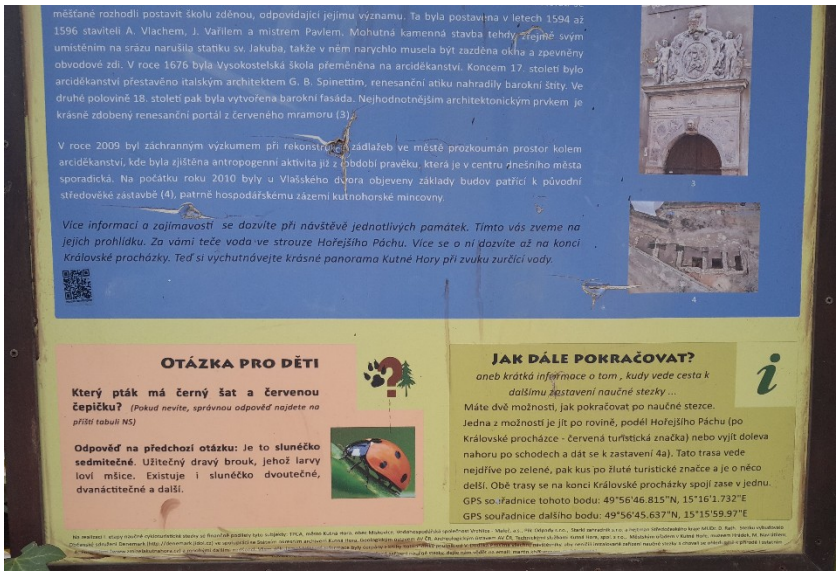

Fig. 1:Appropriate addition of the information board will increase the attractiveness and maintain the attention and interest of a wider range of visitors to the nature trail.

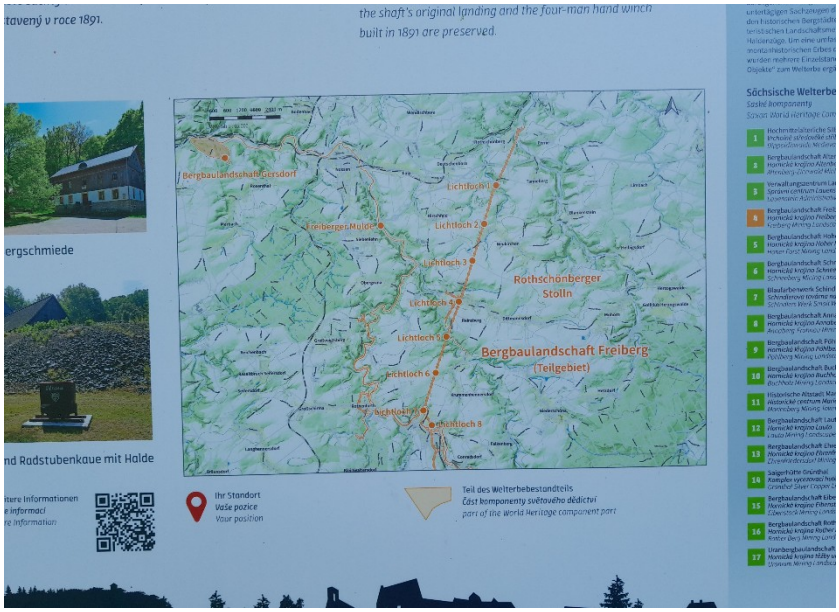

Fig. 2:Appropriate placement of the QR code at a height accessible to a wide range of visitors to access additional information about the presented industrial heritage.

Figure 3 shows examples of physical models, in the case of the model on the left also interactive ones. The model of the water management system of the city of Augsburg (Figure 3 left) in the visitor center, which complements other forms of presentation and allows the visitor to obtain clear information about the entire complex. The physical model of the water system (Figure 3 right) for the agglomeration of the city of Tainan (Taiwan) allows to perceive the spatial and height connection of individual objects of transport, purification and storage of water, water sources and user terminals, helps to locate the objects of the water museum, which visitors pass through, within the system. With a suitable aesthetic representation, it complements the concept of park landscaping of the entire museum.

Fig. 3:Examples of physical models of functional units of water management facilities located indoors and outdoors.

Identified deficiencies and problems

The first selected group of identified problems and shortcomings is related to insufficient maintenance, or even insufficient security of information boards, signs, models and other physical means of presentation. Figure 4 shows an example of damage to an information board, which made it difficult for visitors to perceive and read information. It often causes and attracts further vandalism and leads to a lack of interest in reading and obtaining further information. This is a waste of the initial investment.

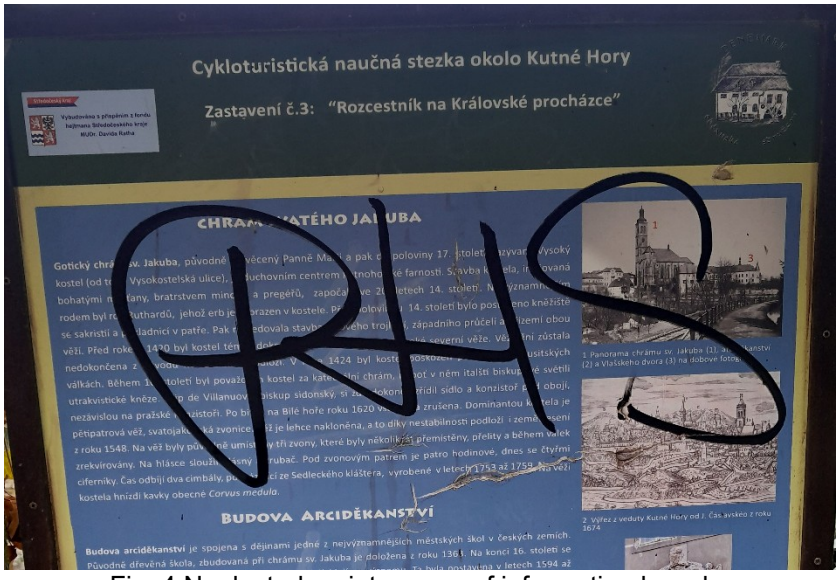

Fig. 4:Neglected maintenance of information boards.

Fig. 5:Example of inappropriate placement of QR codes with links to electronic materials on exhibition and information panels

The second selected group of shortcomings and problems is related to the inappropriately chosen concept of information materials and objects, the distribution of information sources within these materials and objects, which makes reading, scanning and perception difficult or impossible for certain groups of visitors. Which may lead to the practical non-use of the information offered. Figure 5 shows an example of inappropriate localization of QR codes within exhibition panels. The authors' intention was to enable access to websites with detailed and additional information on the presented issue through QR codes.

Discussion

The use of QR codes on nature trails, cultural monuments and nature reserves has generally proven to be a useful addition that allows information to be expanded with audio, video or interactive content without cluttering up physical boards. Practice and expert studies show that QR codes increase visitor engagement, especially when they offer clear added value, such as stories, sounds or game elements, and are part of a well-thought-out concept of the entire trail (Solima, Izzo, 2017). On the other hand, the mere presence of a QR code without explanation and attractive content usually does not lead to its use, because visitors often do not see a reason to scan it. Problems also arise due to technical limitations, such as poor signal, inappropriate location or user distrust. Research also confirms that QR codes work best as a supplement to classic information, not as a replacement for it, and that their effectiveness depends primarily on the quality of the content and the way in which it is presented to visitors (Voříšková, 2024).

Information boards at cultural and industrial heritage sites require regular and systematic maintenance to maintain their legibility, aesthetic value and information function in the long term. The basic principle is to use durable materials that can withstand weathering, UV radiation and temperature fluctuations. It is also important to install the boards correctly so that they are stable, safe and easily accessible for inspection and cleaning. Regular maintenance should include removing dirt, dust, biological deposits and any graffiti, ideally with gentle cleaning agents that do not damage the surface. Care also includes checking the legibility of the text and the condition of the graphics, as fading or mechanical wear may occur over time. It is necessary to continuously monitor damage caused by vandals or weather conditions and carry out repairs or replacement in a timely manner. Regular updating of the content is also recommended if historical knowledge or the interpretative framework changes. Maintenance should be planned at certain intervals, for example seasonally or annually, to prevent gradual degradation. The overall goal is to ensure that the boards remain a dignified and understandable information element of the cultural space.

Physical spatial models and electronically processed models allow those interested in the issue and visitors to convey information about the overall arrangement of industrial functional units, the interconnection of objects within these units, or the arrangement of technical and technological equipment of individual objects. When implementing physical models, it is necessary to adhere to the principles of visitor safety, durability and durability of the models (selection of appropriate materials, consideration of climatic influences), aesthetic effect and appropriate composition within the exhibition space.

Conclusion

Possible methods of presenting industrial heritage are quite diverse and combine traditional and modern approaches to make the information understandable to the widest possible audience. In addition to museum exhibitions, the traditional form is in situ presentation, i.e. making objects accessible directly in their original environment, supplemented by information boards. Educational trails that connect multiple locations and provide visitors with a comprehensive interpretation in the field also play an important role. Modern approaches include digital and interactive presentations, mobile applications, QR codes, audio guides or augmented reality, which allows the visualization of the original state of objects. The use of virtual reconstructions, which make monuments accessible to people who cannot visit them physically, is also increasingly common.

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Souhrn

Cílem práce je navrhnout vhodné způsoby prezentace industriálního vodohospodářského dědictví s ohledem na jeho historickou a technickou hodnotu. Výzkum kombinuje literární rešerši, terénní šetření a komparativní analýzu různých prezentačních metod. Výsledky ukazují přínosy interaktivních prvků, jako jsou QR kódy, hry či fyzické modely, pro zvýšení atraktivity a porozumění. Zároveň byly identifikovány nedostatky, zejména špatná údržba a nevhodné zpracování informačních materiálů. Preferovaný způsob prezentace, který má předpoklad zajistit dostupnost a atraktivitu širokému spektru návštěvníků, je kombinace tradičních a moderních forem prezentace a důraz na kvalitní obsah i pravidelnou údržbu.

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RECONVERTING RESIDUAL SPACES INTO RELAXATION HUBS FOR THE ACADEMIC COMMUNITY

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Abstract
This article explores the paradigm of an "open campus," supporting the idea that the academic environment transcends through architectural boundaries of the faculty, thus making the public space an organic extension of the classroom. The study focuses on the urban regeneration potential of a degraded site located at the intersection of Academia Militară, near the Rectorate of the University of Bucharest, proposing its transformation from an urban barrier into a multifunctional relaxation park open for everyone. By giving the city back to the people, the project aims to eliminate the functional barriers imposed by heavy traffic, transforming a residual space into a hub of social cohesion and ecological balance. Using visual analysis and public opinion research among students and passers-by, the article highlights the need for green intervention in an area dominated by heavy traffic and concrete surroundings. The results demonstrate that the conversion of this residual space would stimulate social cohesion, providing a vital refuge for both residents and people passing through the area or waiting for public transport. In conclusion, the project transforms an urban barrier into a hub of relaxation, essential for the well-being of the academic community and citizens.

Key words: Urban regeneration, open campus, social cohesion, functional conversion, green infrastructure.

Introduction

In the contemporary urban landscape, defined by rapid densification and a predominance of gray infrastructure, the concept of "residual space" is no longer viewed merely as a planning error, but has become a strategic opportunity for urban regeneration. These “urban voids” or terrains vagues, though often degraded and lacking a clear function, possess a latent potential to repair the social and ecological fabric of the metropolis. In this context, the modern university is reevaluating its role, moving beyond the physical confines of lecture halls to embrace the “open campus” paradigm.
The concept of an open campus supports the idea that the learning process and academic interaction do not stop at the university gates. On the contrary, the adjacent public space becomes an organic extension of the classroom—a social laboratory where ideas are freely debated. However, in Bucharest, many of these spaces adjacent to prestigious institutions remain trapped in a state of functional abandonment, acting more as barriers than as points of convergence.
This article examines the derelict lot located at the Military Academy intersection, in the immediate vicinity of the University of Bucharest’s Rectorate. Currently, this site represents an urban paradox: although it is situated at a strategic hub, dominated by imposing institutional architecture and traversed daily by thousands of students and citizens, the space functions as a visual and functional barrier. Noise pollution, heavy traffic, and the lack of green spaces transform this area into a place of hurried transit, depriving the community of a vital space for psychosomatic recovery.

Material and methods

The research began with a literature review focused on the concepts of urban regeneration, vacant lots and green infrastructure. Academic databases (Web of Science, Scopus, Google Scholar) were consulted to identify international best practices regarding the transformation of urban barriers into spaces that foster social cohesion. Particular emphasis was placed on “Open Campus” theories, which analyze how higher education institutions can positively influence the quality of adjacent public space. To understand the dynamics of the site’s evolution and the causes of its current degradation, a cartographic and satellite analysis was conducted. Using platforms such as Google Earth Pro (Historical Imagery feature) and data provided by the Copernicus program, the study tracked the history of land use changes at the Military Academy intersection over the past few decades. The proposal phase for the redevelopment solution was carried out using ArchiCAD design software, employing modules and libraries specific to landscape architecture.

Results

A comparative analysis of the site over the course of 15 years reveals a transition from an area used for technical and storage purposes to a green open space which, although undeveloped, has begun to be visually absorbed into the urban fabric.

The 2010 image shows the site in (*fig.1)* in a highly fragmented state. The land was partially used as a logistics base and materials storage area (likely in connection with adjacent infrastructure work or construction in the area). The ground cover was dominated by impervious surfaces, temporary barracks, and compacted soil, with vegetation being nearly nonexistent or spontaneous and degraded.

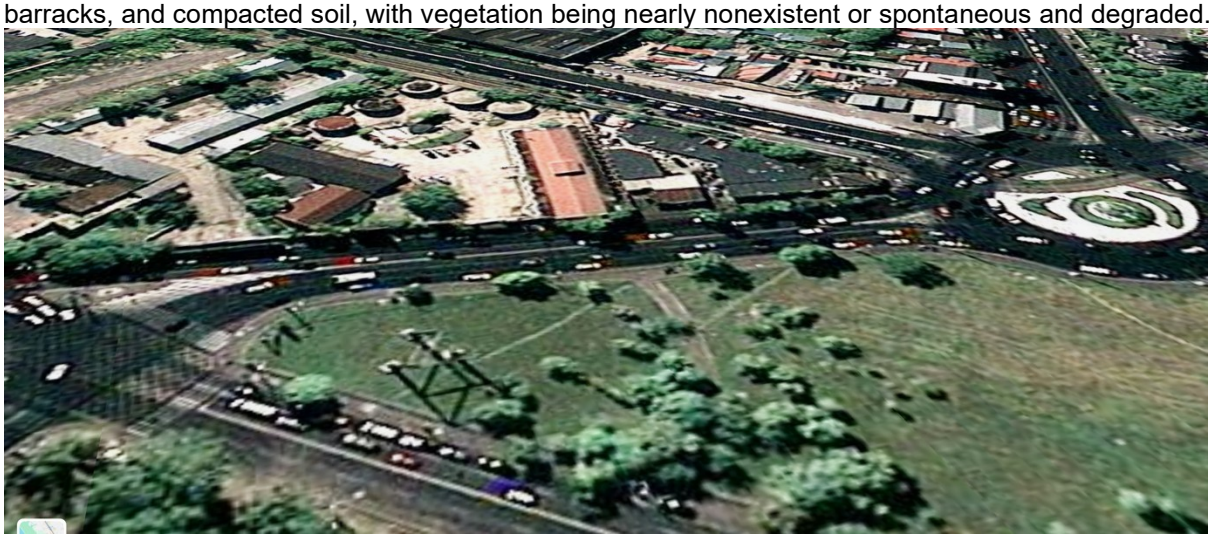

Fig.1: Military Academy Area in 2010

In contrast, the current situation (2025), representated in *(fig.2)* points to a passive “re-greening.” With the completion of major infrastructure projects (the M5 subway line), the land has remained free of buildings but has become a captive residual space. Although vegetation has taken over much of the plots, it is uncontrolled, and the lack of pedestrian accessibility turns the area into an inaccessible “green island” surrounded by heavy traffic.

Fig. 2: Military Academy Area in 2025

The strategy for unifying the two lots represented in *(fig.1 and fig.2)* under the umbrella of a cohesive urban park is based on a series of technical and landscape interventions designed to mitigate the negative impact of the road infrastructure and return the space to the community. The primary focus is on ensuring pedestrian continuity through the implementation of safe seen in *(Fig.3),* oversized crossings or a green bridge that organically connects the North Plot to the South Plot, thereby eliminating the current fragmentation caused by traffic.

Fig. 3: Actual situation of the site in 2026

At the same time, the acoustic comfort of the future hub is guaranteed by creating a natural sound barrier, made of layered vegetation screens (trees and shrubs) that acoustically isolate the interior of the park from the intense noise of the intersection. The functionality of the space is enhanced by the integration of smart urban furniture, equipped with solar charging stations and Wi-Fi access, thus directly addressing students' study and connectivity needs.

Discussion

The proposed development plan *(Fig.4)* is not merely a cosmetic change, but a comprehensive strategy to "heal" the urban divide between the University Rectorate and the Military Academy intersection.

The central element of the project is the oval-shaped urban clearing. In the context of the "open campus" concept, this organic form functions as a "green amphitheater." In contrast to the rigidity of the surrounding institutional buildings, the central oval invites free use: from individual study on the grass to spontaneous social interactions or even outdoor classes. This area becomes the nucleus of social cohesion, offering the "psychosomatic restoration" mentioned in the study's objectives.

Fig. 4: Planning Proposal Parck for Military Academy Area

The rectangular areas marked on the plan, adjacent to the main walkways, suggest the placement of functional zones equipped with smart street furniture. The discussion here extends to the concept of a "living lab": spaces where students can access free Wi-Fi, charging stations, and sustainable lighting. This feature transforms the unused space into a productive workspace, extending the library and classroom into the outdoor environment.

Conclusion

This study has demonstrated that the process of urban regeneration of brownfield sites is an imperative necessity for Bucharest's evolution into a sustainable and resident-friendly city. The analysis of the site located at the intersection of Academia Militară, near the Rector's Office of the University of Bucharest, has highlighted several fundamental aspects, such as the following. A diachronic analysis of satellite imagery from 2010 to 2025 revealed the site's transformation from a logistical support area for infrastructure into a "captive" residual space. Although spontaneous renaturalization has occurred, the lack of coherent planning has transformed this potential green lung into a visual and functional barrier. Research confirms that the academic environment extends beyond the physical boundaries of the university buildings. The proposal to transform this space into a relaxation hub directly addresses the need of students and faculty for a safe transit area, as well as a place for outdoor study and social interaction. In conclusion, transforming this underutilized space into an organic extension of the university campus represents a crucial step toward eliminating functional barriers. The project not only provides a vital refuge in an area dominated by concrete, but also reaffirms the university's role as a driving force for regeneration and ecological balance within the landscape of the contemporarymetropolis.

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Souhrn

Studie navrhuje přeměnu zchátralých pozemků u Vojenské akademie na rekreační centrum ve stylu „otevřeného kampusu“ pro akademickou obec. Prostřednictvím satelitní analýzy (2010–2025) a modelování v programu ArchiCAD projekt sjednocuje roztříštěné pozemky do jediného parku, chráněného před hustým provozem vegetativními bariérami. Výsledkem je odstranění stávajících městských bariér a vytvoření inteligentního zeleného prostoru, který podporuje sociální soudržnost a pohodu v samém srdci Bukurešti.

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RECREATION IN CZECH NATIONAL PARKS: TOURISM INTENSITY VS. VULNERABILITY OF PRIORITY AREAS

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Abstract

This study demonstrates how high-value protected areas are increasingly exposed to anthropogenic pressures, particularly landscape fragmentation and intensive tourism. Using Krkonoše National Park (KRNAP) as a case study, we integrated biological and environmental data describing natural values and invasive plant occurrence with spatial indicators of tourism intensity and recreational use. These datasets were synthesized to develop a typology capturing the relationships between ecological sensitivity and potentially harmful human activities. Our results indicate that the most valuable and vulnerable sites are concentrated in the core zones of the national park and, with the exception of built-up areas and their surroundings, significantly overlap with the most frequently visited locations. The approach presented here will be extended to all national parks in Czechia in the coming years. In the context of steadily increasing visitor numbers, understanding these interactions represents a critical prerequisite for the effective management of protected areas.

Key words: anthropogenic pressure, Krkonoše, landscape fragmentation, protected areas

Introduction

Protected areas (PAs) in the highly modified landscapes of Central Europe face increasing anthropogenic pressures that threaten their relatively natural and sensitive ecosystems. Since the first Czech National Parks (NPs) and Protected Landscape Areas (PLAs) were established in the 1950s, both anthropogenic structures and recreational use have increased considerably (Janík et al., 2024). In recent years, particularly after the COVID-19 pandemic, visitor numbers in the most attractive parts of PAs have grown even further. Consequently, effective PA management therefore requires an integrated assessment of internal pressures, conservation priorities, ecosystem vulnerability and the characteristics of municipalities within the PA.

The objective of this study is to synthesize these perspectives, reveal spatial patterns and identify localities where targeted management measures are needed. This paper focuses on KRNAP, while comparable assessments of the other Czech national parks are planned in the coming years.

Material and methods

The area will be captured in three different perspectives:

Pressures versus conservation priorities

Anthropogenic pressures were quantified by fragmentation analysis using the effective mesh size method (EMS; Jaeger, 2000; Moser et al., 2007). The analysis combined a regular 100 x 100 m grid with fragmentation geometry derived from built-up areas and the road network (ZABAGED – Land Survey Office 2024; KVES – NCA CR 2023). To better capture recreational pressure, the infrastructure layer was complemented by STRAVA data (https://www.strava.com/) linked to the OpenStreetMap path network. Comparison with data from Eco-Counter profiles showed a high

correlation, suggesting that the STRAVA-based model provides a useful proxy for visitor movement intensity. Modeled flow was then converted to a buffer around path sections (1 unit of modeled flow = 1 mm radius). The final fragmentation layer—incorporating both physical structures and recreational intensity—was intersected with a conservation priority layer generated in Zonation (Moilanen et al. 2005). These priorities were derived from habitat suitability models for 65 threatened and vulnerable species alongside other ecologically valuable habitats and landscape features.

Ecosystem vulnerability

Habitats within KRNAP were classified based on their susceptibility to plant invasions using the Detailed Habitat Layer 2022 (Global Change Research Institute CAS, 2025). Affinity was assessed across six groups of mechanisms affecting propagule pressure, establishment and spread: landscape context, connectivity, succession, disturbance, management and socio-cultural conditions. Each mechanism was scored on a 0-9 scale, where higher values indicate conditions facilitating plant invasion. This assessment effectively distinguished between degraded or ruderal habitats with high invasion risk and semi-natural or isolated habitats with lower susceptibility.

Characteristics of municipalities

To complement the environmental assessment, the study also analysed the socio-economic characteristics of municipalities in the KRNAP region. Tourism was treated as a spatial development process affecting demographic dynamics, housing markets, local economies and governance capacities (Butler, 1980; Hall and Williams, 2008; Müller, 2011). The analysis drew on demographic, economic and spatial indicators derived from Czech Statistical Office data, cadastral records, tourism statistics and anonymized GSM-based geolocation data capturing the actual presence of people in municipalities during working days, weekends and seasonal peaks. Combining conventional statistics with geolocation-based indicators helps reduce bias caused by the underrepresentation of small accommodation facilities and informal rentals in official statistics. Standardized indicators were used in a hierarchical cluster analysis based on Euclidean distance to identify groups of municipalities with similar development profiles.

Results

Areas with minimal landscape fragmentation occur mainly in the summit parts of KRNAP and in some southern peripheral sections. While conservation priorities are heavily concentrated at higher altitude, these areas are often intersected by intensively used tourist routes, for example around Labská louka and Liščí hora. Large high-value areas remain near the highest peaks (Sněžka, Luční hora and Studniční hora), without recreational use these core areas would form larger continuous patches (Fig. 1).

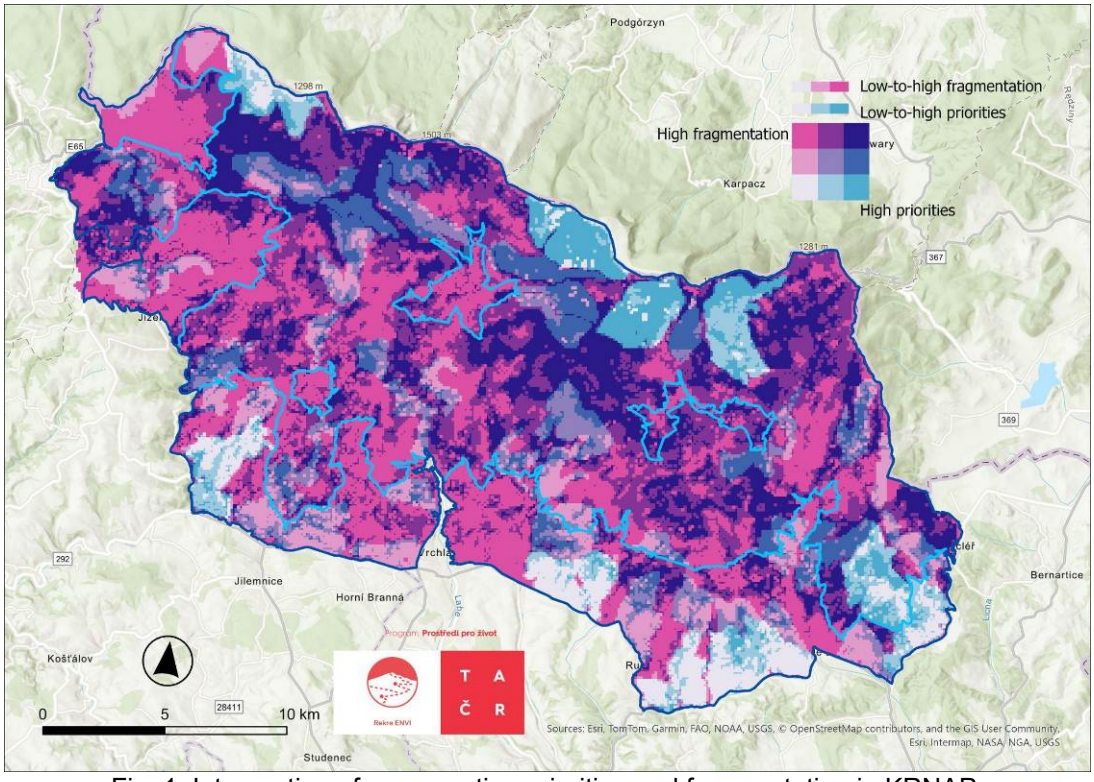

Fig. 1: Intersection of conservation priorities and fragmentation in KRNAP.

Susceptibility to plant invasions ranges from negligible in peat bogs and high-alpine habitats to high in ruderal stands and heavily disturbed urban sites. The spatial pattern closely follows altitude and distance from settlements, with the highest invasion affinity occurring in lower parts of the KRNAP, near built-up areas (Fig. 2).

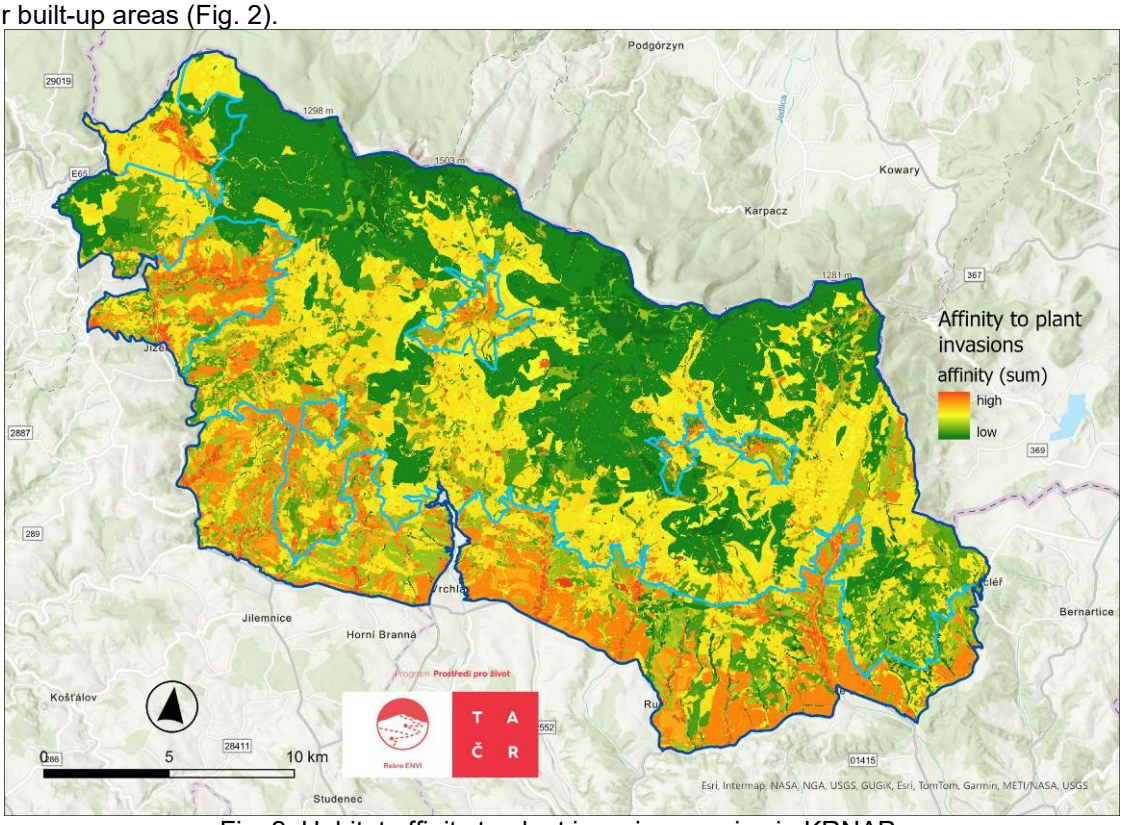

Fig. 2: Habitat affinity to plant invasion species in KRNAP.

Cluster analysis identified five municipality types reflecting different relationships between tourism intensity, housing structure and demographic development. The typology reveals a gradient from diversified foothill centers through traditional mountain resorts to specialized tourism centers. In the most tourism-oriented municipalities, tourism strongly influences housing markets through the growth of second homes and investment apartments (types 1–3). These municipalities also show a gap between registered population and actual presence, indicating seasonal pressure on infrastructure and services. In contrast, less tourism-intensive types maintain more diversified economic structures and greater capacity for future residential or recreational development (types 4–5; Fig. 3).

Discussion

The results reveal a distinct spatial pattern between conservation priorities and the distribution of anthropogenic pressures. While the most valuable parts of KRNAP are concentrated in high-altitude core areas, these same localities are intersected by some of the most intensively used tourist routes. This pattern suggests that recreation pressure is not confined to settlements and access corridors; it also penetrates the ecologically most sensitive parts of the park. In contrast, invasion risk is highest in lower elevations near municipalities and transport-linked habitats. Together, these patterns indicate that different management problems dominate in different parts of the park: visitor regulation is most urgent in high altitudes, while prevention and early control of invasive species are especially important in foothill zones and settlement-related habitats. The municipal typology adds an important planning dimension by showing where tourism-driven development already imposes seasonal stress on housing and infrastructure and where further development pressure may emerge in the future.

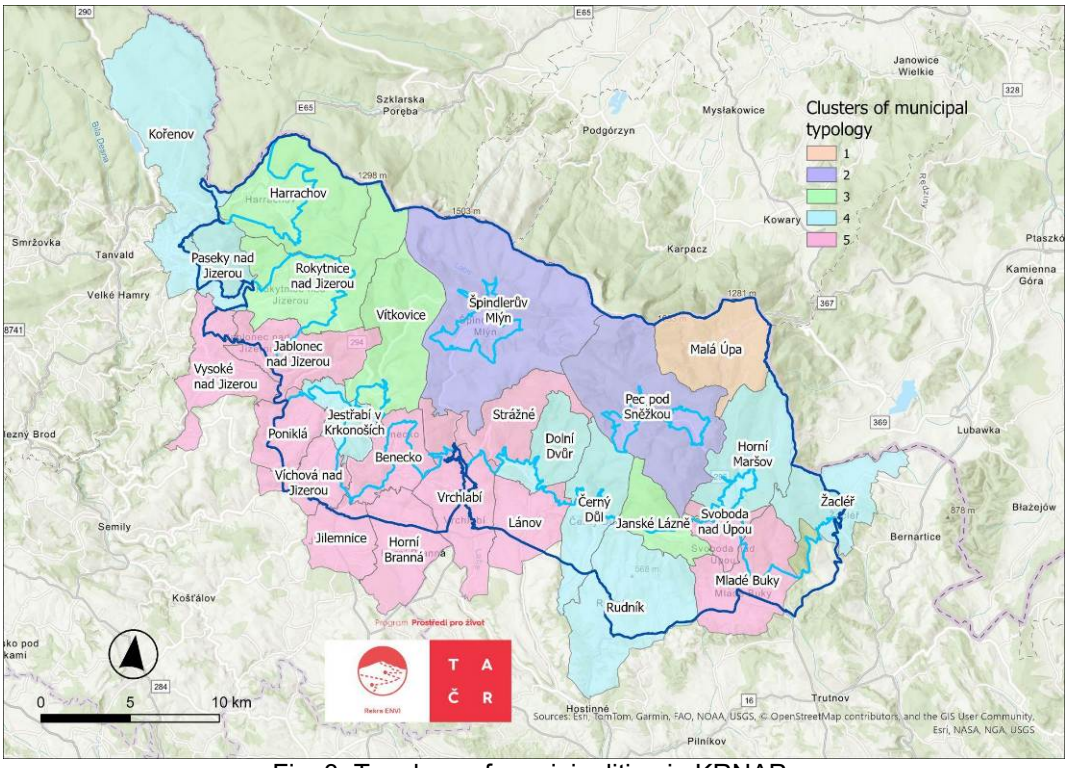

Fig. 3: Typology of municipalities in KRNAP.

Conclusion

This study provides a spatially explicit overview of key values and threats in KRNAP in relation to conservation priorities and increasing recreational pressure. It identifies localities where targeted management is most needed and demonstrates the benefit of linking fragmentation, visitor intensity, prioritization, habitat vulnerability and municipal development trajectories within one analytical framework. Given the continuing growth of visitor pressure, comparable analyses should be carried out for the other Czech national parks to support more proactive and spatially differentiated management.

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Souhrn
Příspěvek představuje integrované hodnocení vztahu mezi přírodními hodnotami a antropogenními tlaky v KRNAPu. Jde o propojení analýzy fragmentace krajiny, intenzity návštěvnosti, prioritizace územní ochrany, zranitelnosti biotopů vůči invazním druhům a socioekonomických charakteristik obcí. Výsledky ukazují, že nejcennější části KRNAP se soustřeďují především do výše položených území, která se však zároveň zčásti překrývají s nejintenzivněji využívanými turistickými trasami. Naopak vyšší náchylnost k šíření nepůvodních druhů se projevuje hlavně v nižších polohách a v blízkosti sídel. Typologie obcí ukazuje gradient od podhůří do jádra národního parku, kde cestovní ruch výrazně ovlivňuje bydlení, infrastrukturu a sezónní zatížení území. Studie tak přináší praktický podklad pro prostorově cílený management národního parku a současně vytváří metodický rámec pro obdobné hodnocení ostatních národních parků v Česku.

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REVITALISATION OF A HISTORIC PARK FOR THERAPEUTIC USE: CASE STUDY OF THE PSYCHIATRIC HOSPITAL IN VEĽKÉ ZÁLUŽIE

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Abstract

This paper addresses the revitalization of a historic site in the context of the current needs of a healthcare facility, focusing on the Psychiatric Hospital in Veľké Záložie, Slovakia. The hospital is located in a historic manor house and its adjacent park, which was originally established as part of the rural aristocratic estate of the Esterházy family. The manor house, completed in its final form in the first quarter of the 19th century in the Empire style, forms part of an extensive estate with a natural landscape park, whose basic composition developed in the second half of the 18th century. Together, they form a protected cultural-historical complex. The park possesses a strong historical atmosphere and significant landscape value shaped by mature vegetation and the original spatial composition. These qualities naturally enhance the therapeutic potential of the environment and provide suitable conditions for patients' recreational and therapeutic activities. However, historical and aesthetic values alone are not sufficient to meet the functional requirements of a modern psychiatric facility. This paper therefore examines the intersection of heritage preservation and the transformation of the site into a functional therapeutic environment. The case study was analyzed as part of the KO-SPACEs research project, which develops a methodological framework for similar contexts. A key component of the proposed approach is participatory and co-design methods involving patients, healthcare staff, and site managers.

Key words: therapeutic landscape, co-design, participation, heritage conservation, mental health environment

Introduction

The conservation and revitalization of historic sites have long been one of the central themes of landscape architecture. Significant professional attention is devoted to methodologies and approaches that enable the systematic preservation and restoration of historic environments.

In parallel, the design and revitalization of therapeutic landscapes and healing greenery have established themselves as a distinct and dynamically developing field. Healthcare facilities are now understood as an active part of therapeutic process, not as a neutral backdrop for the provision of care. Their effect does not arise from the environment itself, but as a result of the interaction of physical, social, and perceptual dimensions (Gesler, 1992; Kaplan and Kaplan, 1989). Kristianova and Basova (2017) also point out that the transformation of historic hospital campuses is aimed at enhancing their therapeutic qualities, with green spaces and medicinal gardens becoming an integral part of these processes.

Nevertheless, the literature still tends to treat these two areas separately, and their overlap remains only partially explored. From a methodological perspective, these are distinct approaches: cultural heritage preservation focuses on maintaining the historical and cultural values of a site, while therapeutic landscape design is based on optimizing the environment to promote health and mental well-being.

Their combination, therefore, requires a specific and integrated approach. This situation creates tension between the preservation of heritage values and adaptation to a healthcare function, and neither approach can be applied in isolation. Overly rigid preservation limits therapeutic use, while overly intensive transformation leads to the loss of a site's historical identity (Paraskevopoulou and Kamperi, 2018).

In the Slovak and broader Central European context, many aristocratic residences were transformed into healthcare facilities in the second half of the 20th century. In many cases, this process contributed to the preservation of their spatial structure and historical value, while simultaneously introducing new functional requirements. These complexes were not originally designed as healthcare or therapeutic environments, but as private, representative aristocratic residences.

The historic parks and landscape compositions of such estates were originally designed as aesthetic, representative, and recreational spaces for a narrow social elite. Their design was based on principles of visual composition, controlled movement, and social use, rather than on medical, hygienic, or therapeutic needs.
From the perspective of contemporary landscape architecture discourse, historic parks occupy a dual position: they are bearers of cultural and historical authenticity, yet without adaptation, they are functionally inadequate for modern therapeutic use (Paraskevopoulou and Kamperi, 2018).
With growing demands on healthcare environments and the physical condition of these sites, further transformation is necessary. On the one hand, heritage conservation principles aim to preserve the identity and authenticity of historical structures. In the past, however, these sites were often adapted primarily for functional reasons without sufficient emphasis on comprehensive landscape and architectural quality. On the other hand, current research emphasizes the importance of a purposefully designed environment based on the principles of biophilic design, which promote stress reduction, spatial orientation, and mental well-being.
Although the concept of healing gardens has historical roots dating back to antiquity and the Middle Ages, since the late 20th century, a body of theories has been systematically developed in the professional literature that provides design guidelines across multiple disciplines. This development builds on the research of Roger Ulrich (1984), which identified the positive effects of natural elements in therapeutic environments, and is further advanced by more recent studies which expand upon and elaborate on these findings (Bratman et al., 2015; Zhu and Shah Sarah, 2024), particularly in the context of vegetation, water features, and sunlight. These findings provide a theoretical foundation for further concepts in the field of therapeutic environment design, particularly for biophilic design.
Biophilic design is based on the assumption of an innate human affinity for nature, and its application in healthcare facilities is associated with measurable benefits for recovery and quality of life. The therapeutic effect of the environment does not arise automatically; it is the result of understanding users' needs and applying appropriate design strategies.

Methodology
The research is based on a qualitative case study of the historic psychiatric hospital complex in Veľké Zálužie. Method of participatory research approach (co-design) was used. It allows for the involvement of users and professional staff in the process of identifying needs and formulating design inputs (Sanders and Stappers, 2008).
Data collection was conducted through structured interviews with staff (management, medical personnel, maintenance), supplemented by a analysis study of student designs. The collected data were subsequently interpreted with an emphasis on identifying spatial, functional, and psychological requirements.

Case study – VEĽKÉ ZÁLUŽIE
Based on multiple sources, including data from the Monuments Board of the Slovak Republic, official historical materials of the municipality of Veľké Zálužie, and regional heritage studies of the Nitra region, it is possible in accordance with the interpretation of Mazanec (2011) date the construction of the manor house in Veľké Zálužie to the second half of the 18th century, when it was built as the noble residence of the Forgách family.
At the turn of the 18th and 19th centuries, it was rebuilt in the Classicist Empire style, which has been preserved to this day. The complex also included a landscape park, whose spatial composition and vegetation structure gradually took shape, particularly during the 19th century.
After World War II, a fundamental functional transformation took place: in 1957, the manor house was converted into a psychiatric facility, thereby transforming the original private aristocratic residence was converted into a medical complex. Despite these changes, the complex has retained its basic compositional structure and a high degree of authenticity, which represents key potential for its current revitalization (Mazanec, 2011).
The psychiatric hospital complex requires an exceptionally sensitive approach to planning and design. Therefore, as part of the KO-SPACEs project, a participatory research process was carried out in the form of a summer school involving 10 students from various academic years.
The aim of this activity was to gather input data for the design in an environment with a complex historical and functional context, while also creating an educational environment in which students worked on a real-world assignment and participated in a co-design process alongside staff and patients.

Several qualitative methods were used to identify users' needs and their relationship to the environment. The key methods were semi-structured interviews and focus groups with employees, the outputs of which were analyzed and incorporated into the studio design process.
The map in Figure 2 represents one such analysis and depicts the survey and illustrates spatial movement patterns, concentrations of activities, and interactions within the grounds of a psychiatric hospital set within a historic park. It distinguishes three user groups—patients, visitors, and staff—and captures both linear trajectories (routes) and diffuse spatial practices (areas of movement), along with zones of increased activity.
The overall spatial configuration exhibits a certain degree of centrality, with the highest density of overlapping trajectories located in the core of the complex. This central zone functions as the main space of co-presence, where patients, visitors, and staff meet. The concentration of movement lines and activities suggests that this is a key interface between therapeutic, social, and operational functions. At the same time, this space forms the core of the site's heritage value. This implies heightened demands for its protection, which, however, conflict with the requirements for the intensive functional and therapeutic use of this central hub.
Patient movement (yellow) is characterized by relatively diffuse trajectories with multiple areas of repeated circulation and lingering. This pattern suggests forms of spatial appropriation that are not strictly utilitarian but reflect routine, habit, and potentially also a search for comfort, stimulation, or escape.

Fig. 1: Outdoor spaces of the hospital area. Source: Author – student Tamara Valičková. Photographic documentation of the Veľké Zálužie site created during a workshop.

Visitor movement (red) is more linear and episodic, connecting entrances with central nodes and selected peripheral areas.
Staff movement (blue) is the most structured and efficient, following clearly defined routes connecting key functional points. Compared to patients, their trajectories exhibit lower spatial dispersion and a tendency to avoid prolonged stays in zones with high concentrations of patients, suggesting an emphasis on operational efficiency and, to some extent, functional separation.
The defined "active zones" correspond to areas of repeated or intensive use and exhibit an uneven spatial distribution. Some of them are located at the intersections of various user trajectories, where they function as meeting and monitoring points. Others are more group-specific, such as zones dominated by patients in quieter parts of the park, suggesting spaces of relative autonomy. The coexistence of shared and differentiated zones points to a spatial balance between interaction and retreat into privacy.
Importantly, the map also captures the implicit dynamics of encounter and avoidance. While the central core supports co-presence, certain movement patterns, particularly among staff, bypass the most heavily used patient zones, suggesting strategies for managing exposure and maintaining functional boundaries. At the same time, patients' movement in repeated loops within certain zones suggests the emergence of "safe" or familiar territories, which may play a role in emotional regulation and the daily management of situations.
Based on these inputs (as well as further analyses), the students developed several design variants, which were evaluated from the perspective of cultural heritage preservation principles and therapeutic requirements. The analysis focused on the degree of preservation of the historical structure and the extent of adaptation to current therapeutic needs.

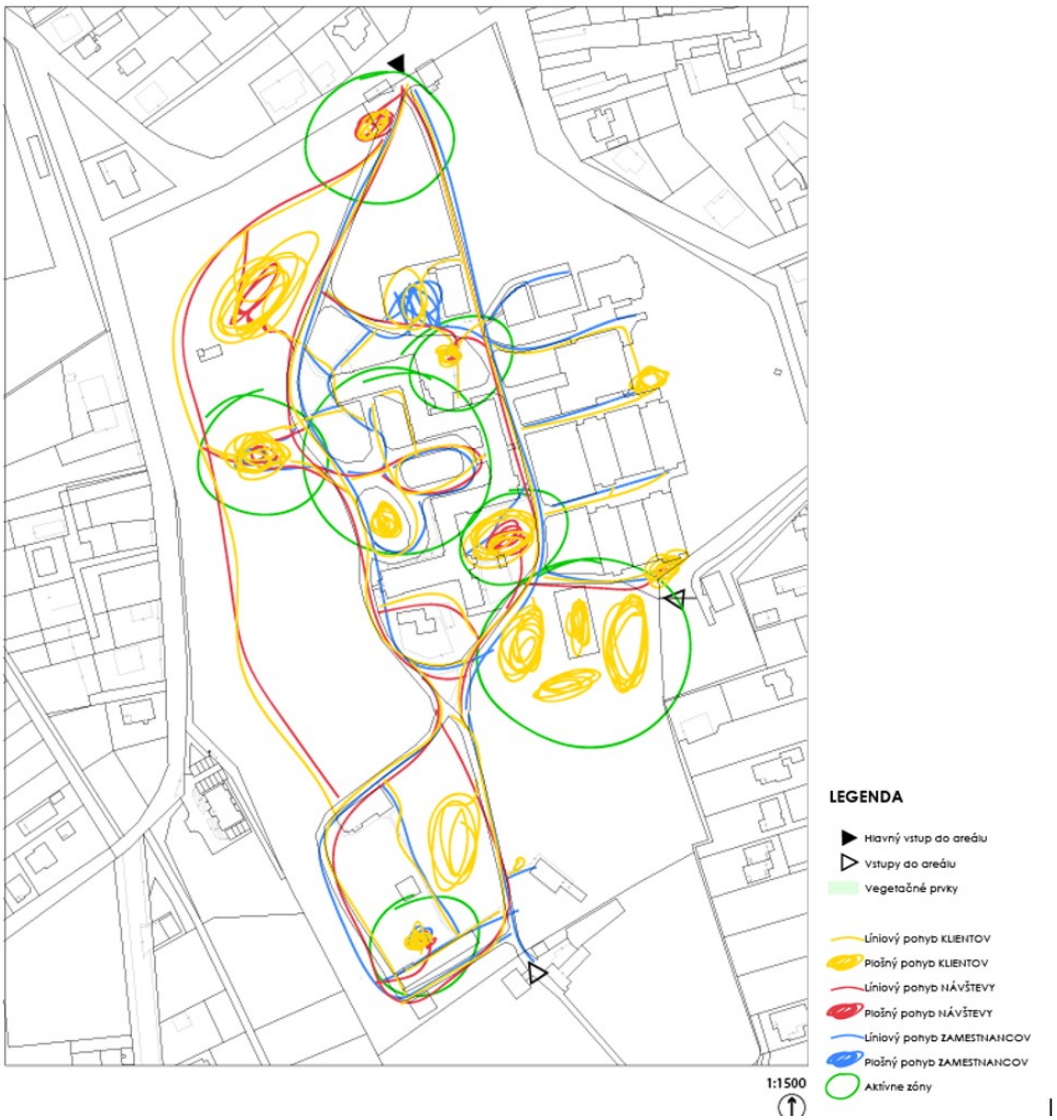

Fig. 2: Example of input data analysis during mapping workshops – Map of movement, routes, and zones of encounter/avoidance. Source: workshop materials, authors – Tamara Valičková, Radovan Tokár, Kristiján Pilarč, Daniela Vojtová.

Results

Key issues emerging from the process included the need for adequate shading (particularly in relation to the effects of patients' medication), the issue of fencing (from both a safety and psychological perspective), and the need for specific therapeutic outdoor furniture. Differing opinions were noted, particularly regarding therapeutic gardens and the use of flowering plants. Another important topic was the protection of historic trees and the establishment of appropriate maintenance regimes.

A significant requirement was the creation of intimate zones for individual activities, such as journaling, as well as spaces for meetings with family and friends during visiting hours.

More "interiority" in outdoor spaces was also needed, as a response to the limited capacity of the interior and the reduced level of privacy in indoor areas. Outdoor spaces are thus increasingly taking on functions traditionally associated with the interior.

These findings represent a set of design inputs that link the principles of cultural heritage preservation with the requirements of contemporary therapeutic environments.

Discussion

The identified need for "interior qualities" in the outdoor environment reflects the limitations of indoor spaces, particularly in terms of capacity and privacy, while simultaneously expanding the traditional understanding of therapeutic space. It highlights the potential of outdoor spaces as an extension of the therapeutic environment, where these areas do not merely serve a recreational function but become an integral part of the daily operations of a healthcare facility.

The relevance of evidence-based design in historic therapeutic landscapes is confirmed, with heritage preservation understood not as a freeze on historic structures but as a managed process of change within a historically valuable environment (Jokilehto, 2006). Requirements for screening, orientation, safety, and privacy are directly related to stress reduction, physiological comfort, and users' sense of control.

A key finding is the need to differentiate spaces according to levels of privacy and social interaction, particularly in the context of patient–family relationships, which underscores the importance of social bonds as part of the healing process.

The ambivalent role of fencing is particularly significant; although necessary from a safety perspective, if it appears inappropriate, it can increase stress and reinforce the institutional character of the environment. This points to the need for a sensitive design of boundaries that combines safety with psychological and aesthetic quality.

The results also confirm that the therapeutic effect of historic parks is not automatic but depends on their adaptation to the specific needs of users. The literature consistently describes that therapeutic landscapes are not inherently healing in their form but acquire their functional and therapeutic effect through a design that connects the spatial structure, user needs, evidence-based principles, and participation. From this perspective, the therapeutic effect of the landscape is understood not as a property of the historical or natural environment, but as the result of the interaction between its spatial configuration, user needs, and applied design strategies based on the aforementioned approaches (Ulrich, 2008; Marcus and Sachs, 2014; Sanders and Stappers, 2008).

Conclusion

This paper highlights the need to expand traditional approaches to the revitalization of historic sites with therapeutic functions to include additional dimensions of the design process. In addition to standard principles of heritage conservation and landscape architecture restoration, participatory approaches (co-design) are particularly key, as they enable the identification of users' specific needs, as well as an emphasis on the qualitative characteristics of the environment that influence psychological well-being.

The research also highlights the importance of working with a degree of "interiority" in the exterior, which expands the traditional understanding of therapeutic space and responds to the limitations of the interior environment of healthcare facilities. Similarly, the aesthetics of the environment emerge as a significant factor, particularly in the context of elements such as fencing, whose visual and spatial design can directly influence patients' stress levels.

The convergence of approaches to historic preservation and the design of therapeutic facilities opens the door to the development of new methodological tools in landscape architecture practice. At the same time, it highlights the existence of places, where these approaches overlap only partially; it is precisely in these gaps that other design tools such as the principles of interiority in the exterior or participatory (co-design) processes can create important points of connection between the two fields. This framework suggests the potential for further development of approaches to landscape transformation, particularly in the context of historic and healthcare sites.

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Souhrn
Článek se zabývá revitalizací historického areálu v kontextu současných potřeb zdravotnického zařízení, přičemž se zaměřuje na Psychiatrickou nemocnici ve Velkém Záluží na Slovensku. Nemocnice se nachází v historickém zámku a přilehlém parku, které byly původně vybudovány jako součást venkovského šlechtického panství rodu Esterházyů. Zámek, jehož konečná podoba byla dokončena v první čtvrtině 19. století v empírovém stylu, tvoří součást rozsáhlého areálu s přírodním krajinářským parkem, jehož základní kompozice se vyvinula v druhé polovině 18. století. Společně tvoří chráněný komplex kulturního dědictví.
Park má silnou historickou atmosféru a významnou krajinnou hodnotu, kterou utváří vzrostlá vegetace a původní prostorová kompozice. Tyto vlastnosti přirozeně podporují terapeutický potenciál prostředí a poskytují vhodné podmínky pro rekreační a terapeutické aktivity pacientů. Historické a estetické hodnoty však samy o sobě nestačí k naplnění funkčních požadavků na moderní psychiatrické zařízení.
Článek proto zkoumá průnik mezi ochranou kulturního dědictví a transformací lokality na funkční terapeutické prostředí. Případová studie byla analyzována v rámci výzkumného projektu KO-SPACEs, který vyvíjí metodický rámec pro podobné kontexty.

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SINGLE-PROMPT CREATION OF WEB MAP APPLICATIONS FOR TOURISM AND NATURE PROTECTION USING OGC SERVICES

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Abstract
Generative AI tools increasingly claim that non-programmers can build interactive web maps. This study tests a single-prompt, no-iteration scenario: one identical "non-programmer" prompt was used to generate a purely client-side web mapping app consuming real OGC endpoints relevant to tourism and nature protection (hiking trails and large protected areas) from Slovak public registries. Three free-tier tools were evaluated (ChatGPT, Lovable, Replit) using (i) time-to-first-output in the tool's native environment and (ii) a 21-item binary functional checklist after self-host deployment. ChatGPT produced the fastest first output (1 min 16 s) and the highest functional score (17/21). Replit achieved comparable core functionality (15/21) but slower first output (7 min 33 s) and added unrequested GIS usability controls (e.g., layer ordering/opacity). Lovable generated a polished prototype but lower geospatial functionality (12/21). Self-hosting Vite-based outputs required additional build/routing adjustments (~10 minutes per app). Deployed versions used for evaluation and used single-prompt are available at: *https://map.iesprit.sk/promptapps/*.

Key words: generative AI; non-programmer; visitor information; client-side deployment

Introduction

Interactive web maps are widely used in tourism and recreation to support visitor information search and trip planning and to communicate spatial opportunities and constraints. Tourism research shows that WebGIS affects how users search for information and complete trip-related tasks (Chang, Caneday, 2011). In nature-based and "slow tourism" contexts, web mapping is frequently used to present routes and contextual layers through open web technologies (Brovelli et al., 2015).

In nature protection, the key challenge is balancing recreation demand with ecological sensitivity. Trail networks concentrate visitor use and can amplify erosion and trampling impacts; GIS-based modelling has therefore been applied to assess environmental sensitivity of recreational trails and support management decisions (Tomczyk, 2011). Visitor monitoring and visitor management are recurrent topics for protected and recreational areas, reflecting increasing visitation pressure and the need for evidence-based interventions (zoning, trail design, information measures) (Pickering et al., 2018). Spatial decision support and participatory approaches are also common: PPGIS can help capture place-based visitor experiences for park planning (Pietilä, Fagerholm, 2019), while web-oriented geospatial decision support systems have been proposed for sustainable tourism and ecotourism planning to translate spatial data into actionable outputs for stakeholders (Mileti et al., 2022).

Despite interoperable geospatial web services, building a tailored web map application remains a technical task. Large language models (LLMs) and generative AI may reduce this barrier; a recent systematic review documents rapidly expanding LLM use in geospatial science, while emphasizing output variability and the continuing need for domain knowledge to avoid critical errors (Wang et al., 2024). This study addresses a practical gap for tourism and nature protection practice: what can a non-programmer obtain from a single prompt when creating a lightweight, client-side web map that consumes real Open Geospatial Consortium (OGC) services and can be deployed on a self-hosted server?

Material and methods

We performed a comparative single-prompt, no-iteration evaluation intended to approximate a "first-try non-programmer" scenario. The same natural-language prompt was submitted once to each tool; no follow-up prompts (clarifications, bug fixes, or retries) were allowed. Three free-tier tools were tested (ChatGPT free, Lovable free, Replit Lite/free), each accessed via a Google (Gmail) login under free usage conditions. Tests were executed in February 2026 on the same workstation and browser.

The prompt (English, intentionally minimal IT terminology) requested a purely client-side web map application using OGC web services for (i) hiking trails and (ii) large protected areas (VCHÚ), with layer toggles, a legend, click-to-identify popups, and a basic layer/service information panel. Two optional functions were included: polygon-based listing of trails and adding an external WMS layer by

URL. The application consumed publicly available WMS/WFS/WMTS endpoints relevant to tourism and nature protection; exact service URLs and layer/type names are reported in Table 1.
For each tool, time-to-first-output (mm:ss) was measured from prompt submission to the first output in the tool's native environment: ChatGPT response completion versus first rendered app preview in Lovable/Replit. All outputs were then exported and deployed to a self-hosted web server to verify portability. ChatGPT output was deployable as a single static HTML file; Lovable/Replit outputs were Vite projects requiring a production build and subfolder base-path/routing adjustments (≈10 minutes of junior developer effort per app), recorded separately from time-to-first-output. Functionality was assessed after deployment using a 21-item binary checklist (YES/NO) covering map load/interaction, both thematic overlays, layer toggling, legend behaviour, WFS identify, the information panel, and optional tools. Service-derived legends were treated as compliant; invented legends were considered non-compliant unless clearly labelled as fallback. Features added without being requested (e.g., layer opacity/order, in-app guidance) were documented separately and not counted toward the core checklist score.

Results
Deployed versions used for evaluation and used single-prompt are available at: *https://map.iesprit.sk/promptapps/*.
Time-to-first-output (mm:ss) differed across tools: ChatGPT produced a complete response in 1 min 16 s, Lovable rendered an in-platform preview in 3 min 14 s, and Replit rendered an in-platform preview in 7 min 33 s. After self-host deployment, the overall functional checklist scores (YES/21) were 17/21 for ChatGPT, 15/21 for Replit, and 12/21 for Lovable. Table 1 summarizes the single-prompt outcomes and the minimal self-host deployment effort across the three evaluated tools.

Tab. 1: Single-prompt results (compact summary after deployment)

Metrics	ChatGPT	Lovable	Replit
Prompts used (n)	1	1	1
Plan / access	free	free	Free
Time-to-first-output (mm:ss)	01:16	03:14	07:33
Use of open-source libraries	yes	yes	yes
Top bar with the title "Smartland"	yes	yes	yes
Working "Contacts" button	yes	yes	no
The map loads and pan/zoom works	yes	yes	yes
The basemap (OSM) displays correctly	yes	no	yes
The WMS layers "Hiking trails" and "Protected areas" are displayed	yes	no	yes
A layer list exists and toggling works for both layers	yes	no	yes
A legend exists for both layers	yes	yes	yes
The legend is retrieved from the web services	yes	yes	yes
A layer's legend is removed from the overall legend when the layer is hidden (and reappears when shown)	yes	yes	yes
Clicking a feature shows a popup with attributes	yes	no	yes
Clicking outside a feature shows a "not found" popup	yes	no	yes
A list of all attributes is displayed	yes	no	yes
A metadata panel exists	yes	yes	yes
Displays at least: layer name + source link	yes	yes	no
Displays Title/Description from capabilities	no	yes	no
Polygon drawing works	yes	no	no
Polygon search returns a list of trails (at least one result somewhere)	no	no	no
Add external WMS tool exists	yes	yes	yes
Add external WMS adds a layer and it appears in the layer list and legend	no	no	no
In Add external WMS, it is possible to display the list of layers from the added service	no	yes	yes

Core “map viewer” requirements were met more consistently by ChatGPT and Replit. Both displayed the thematic overlays for hiking trails and protected areas and provided working layer toggles. Both also implemented click-to-identify behaviour with attribute popups and an explicit “Nothing found” response when clicking outside target features. Lovable produced a visually polished prototype but did not achieve equivalent geospatial functionality after deployment, particularly for WMS/WFS-driven overlay handling and feature identification.
Legend behavior differed in fidelity: service-derived legends were achieved for ChatGPT and Replit, while Lovable relied on a fallback approach rather than consistently retrieving the legend from the service. The layer/service information panel was only partially fulfilled across tools: Lovable surfaced a name/source link and also reported Title/Description from capabilities, whereas ChatGPT and Replit did not consistently expose the requested service metadata.
Optional functions were the least robust. Polygon drawing was present only in the ChatGPT output, but polygon-based trail listing was not completed successfully in any tool. All three included an “add external WMS” interface, yet none fully satisfied the requirement of adding an arbitrary external layer such that it appeared correctly in both the layer list and legend after deployment.
Deployment effort differed substantially. ChatGPT output was directly deployable as a single static HTML file. Lovable and Replit outputs required a Vite build and subfolder base-path/routing adjustments for self-hosting (≈10 minutes of junior developer effort per application). Replit additionally introduced several unprompted GIS usability controls (e.g., layer ordering and opacity settings, and an in-app manual), which were documented separately and not counted toward the core functional score.

Discussion

The single-prompt results suggest that non-programmers can obtain a useful first prototype for tourism and nature-protection web mapping, but mainly for “map viewer” fundamentals: showing authoritative layers, switching them on/off, and inspecting features on click. These functions map well to practical communication needs in recreation and protected-area contexts (e.g., presenting trail infrastructure together with protection layers).
The prototype interface generated by prompt-based platforms (e.g., Replit, Lovable) appears visually complete (Fig. 1), including layer switching and legend rendering from WMS services, yet several advanced GIS functions required iterative refinement. A key implication is that visual completeness is not equivalent to functional correctness. For protected-area communication, feature identification and service-derived legends reduce misinterpretation risk. When these elements are missing or replaced by fallback/invented behavior, an attractive interface can still mislead users, which is a risk in environmental decision contexts.

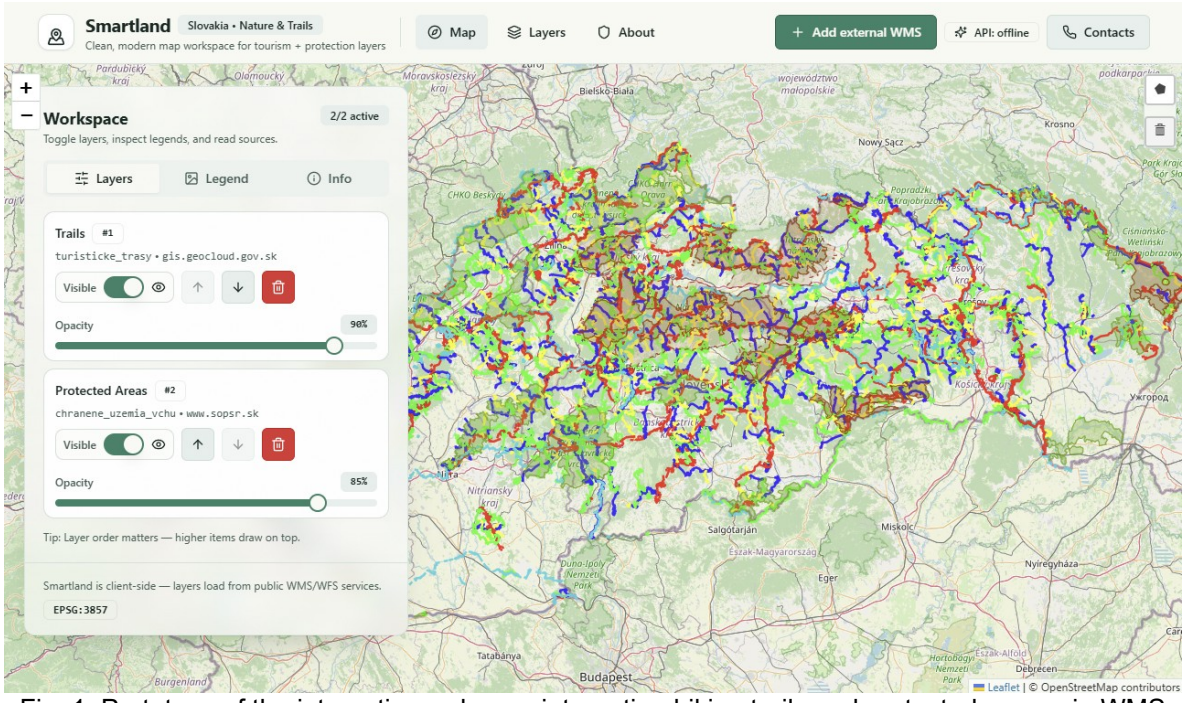

Fig. 1: Prototype of the interactive web map integrating hiking trails and protected areas via WMS services from Replit application

The study also highlights a gap between generating a working preview and publishing a stable self-hosted tool. Even when a platform produces a runnable prototype in its own environment, deployment to a subdirectory on a standard web server can require build and routing/base-path adjustments. In practice, prompt-based tools therefore support rapid prototyping and stakeholder communication, while production publication still benefits from minimal web/GIS deployment knowledge or brief developer support.
Finally, the least robust requirements were those that hide substantial technical complexity behind a simple user story: polygon-based trail listing and adding arbitrary external WMS layers with full integration into the layer list and legend. These functions depend on correct spatial querying, capabilities parsing and CRS consistency. This suggests a realistic boundary for first-try, non-programmer use: single-prompt tools can reliably produce lightweight map viewers, but more "GIS-like" functions typically require iteration or expert input.

Conclusion
This study shows that a single, non-programmer-style prompt can produce a workable client-side web map prototype for tourism and nature protection when the goal is primarily a lightweight map viewer (displaying authoritative layers, basic layer control, and click-to-identify behaviour). However, the experiment also demonstrates clear limits for first-try generation: tasks that require deeper GIS logic and integration—such as polygon-based spatial querying and robust addition of arbitrary external WMS layers with full legend/layer-list integration—were not reliably achieved without iteration.
A second practical conclusion is that "working in the platform preview" does not guarantee easy adoption outside the platform. Exporting and self-hosting may require build and base-path/routing adjustments, meaning that successful operational use still benefits from minimal GIS/web deployment literacy. Overall, prompt-based tools have strong potential to democratize map prototyping in tourism and environmental practice, but production use should include lightweight verification of legends, identify results, and data sources.

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Souhrn
Jedním promptem lze vytvořit použitelný prototyp klientské webové mapové aplikace pro cestovní ruch a ochranu přírody, pokud jsou požadavky omezeny na základní funkce „mapového prohlížeče" (zobrazení a ovládání vrstev a identifikace prvků kliknutím). Pokročilejší GIS funkce (dotazy nad

polygony, robustní integrace externích WMS služeb) a nasazení na vlastním serveru obvykle vyžadují další technické kroky nebo podporu odborníka.

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SMALL VILLAGES AS PART OF THE LANDSCAPE: LANDSCAPE-BASED APPROACHES TO RURAL DEVELOPMENT

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Abstract
Small rural municipalities represent a fundamental component of European cultural landscapes. Despite their importance, landscape planning and design approaches are often primarily focused on urban areas, while rural settlements receive less attention in contemporary landscape architecture research and practice. However, small municipalities are deeply embedded within their surrounding landscapes and play a crucial role in shaping rural spatial structures, ecological processes and local identity. This paper explores the relationship between small rural municipalities and the surrounding landscape, emphasising landscape-based approaches to sustainable rural development. The study focuses on selected examples of small municipalities in Slovakia that demonstrate innovative practices in landscape planning, green infrastructure implementation and nature-based solutions. These examples include projects addressing water management, biodiversity enhancement, public open spaces and the preservation of traditional agricultural landscapes. The research highlights how landscape architecture can contribute to improving the quality of rural environments through integrated design approaches that connect settlements with their surrounding agricultural and natural landscapes. Attention is given to the role of public spaces, ecological corridors, traditional landscape structures and community engagement in shaping resilient and attractive rural environments. The findings demonstrate that even small municipalities with limited resources can implement innovative landscape solutions that strengthen local identity, enhance ecosystem services and support sustainable rural development.

Key words: rural landscapes; small municipalities; landscape architecture; nature-based solutions; green infrastructure

Introduction

Small rural municipalities represent an essential component of European cultural landscapes, shaping spatial structures, ecological processes and local identity. Despite their importance, landscape architecture research and practice have traditionally focused more on urban environments, while rural settlements remain less explored, particularly in the context of contemporary sustainable design approaches (Jančovičová & Štěpánková, 2012; Schüppel & Staudte, 2025). In recent decades, landscape architecture has increasingly addressed the integration of environmental, social and spatial aspects through nature-based solutions and green infrastructure. These approaches have proven effective in improving the quality of public spaces, enhancing biodiversity and supporting sustainable development in both urban and peri-urban contexts (Tóth et al., 2014; Tóth et al., 2018; Čibik et al., 2019). At the same time, research highlights the importance of transforming existing structures and underused spaces, including rural centres and public areas, through context-sensitive and value-based design strategies (Čibik et al., 2020; Bechera et al., 2022). Rural landscapes, however, present specific challenges related to limited financial and institutional capacities, as well as fragmented development processes. Nevertheless, they also offer significant opportunities for the application of innovative landscape-architectural approaches, including the restoration of traditional landscape structures, the revitalisation of public spaces and the integration of cultural and ecological values (Kuczman & Paganová, 2024; Paganová & Kuczman, 2024). Recent studies demonstrate that even small-scale interventions, such as the redesign of rural streets or public spaces, can significantly contribute to improving environmental quality and local identity (Karzhauov et al., 2025; Bellérová & Hus, 2025). An important aspect of contemporary rural development is the role of participatory and bottom-up approaches, which enable local communities to actively shape their environment and contribute to the creation of public spaces and landscape structures (Miklášová et al., 2022). In this context, landscape architecture serves as a mediating discipline that connects expert knowledge with local needs and values. Current research and international initiatives emphasise the need for integrated, landscape-based approaches that consider the landscape as a complex system linking environmental, social and economic dimensions. Projects such as *Landscape in Focus* highlight the importance of providing practical tools and methodological support for small municipalities, enabling

them to implement sustainable solutions despite limited resources (Smetanová et al., 2025; Štemberová et al., 2025). This paper builds on these theoretical and practical frameworks and explores selected examples of small municipalities in Slovakia that demonstrate innovative approaches to landscape planning, public space design and nature-based solutions. The aim is to analyse how landscape-based approaches can contribute to sustainable rural development, strengthen local identity and enhance the quality of rural environments.

Material and methods

The study is based on a qualitative research approach combining case study analysis with landscape-architectural interpretation. It focuses on selected small rural municipalities in Slovakia that demonstrate innovative approaches to landscape planning, public space design and the implementation of nature-based solutions. The primary materials consisted of project documentation, planning materials, photographic records and field observations. Additional sources included methodological frameworks and outputs of the *Landscape in Focus* initiative, which provide tools for landscape-based planning and evaluation in small municipalities. The methodological approach consisted of three main steps: 1. *Selection of case studies* based on their relevance to landscape-based rural development and the application of innovative or replicable solutions; 2. *Analysis of spatial and functional relationships* between settlements and their surrounding landscapes, with emphasis on green infrastructure, water management, public spaces and traditional landscape structures; 3. *Comparative evaluation* of selected examples, focusing on their contribution to landscape quality, ecological stability, local identity and community engagement. This approach enabled the identification of key principles and transferable strategies for the integration of small municipalities into their broader landscape context.

Results

The analysis of selected case studies demonstrates that small rural municipalities can implement effective landscape-based solutions despite limited resources. The examined examples show that targeted interventions—such as the revitalisation of public spaces, restoration of traditional landscape structures and application of nature-based solutions—can significantly improve landscape quality and functionality. The results highlight the importance of integrating settlements with their surrounding landscapes through green infrastructure, ecological corridors and water management measures. At the same time, community involvement and context-sensitive design were identified as key factors contributing to the success and sustainability of these interventions.

Discussion

The results confirm that even small rural municipalities can effectively implement landscape-based solutions, supporting previous findings on the role of landscape architecture in improving rural environments through targeted, context-sensitive interventions (Čibik et al., 2020; Bechera et al., 2022). The identified importance of integrating public spaces, ecological structures and water management measures aligns with broader approaches to sustainable landscape design and multifunctional land use (Tóth et al., 2014; Tóth et al., 2018). Furthermore, the emphasis on community involvement reflects the significance of participatory processes in shaping successful rural projects, as demonstrated in bottom-up initiatives and small-scale public space transformations (Miklášová et al., 2022). The findings also support current research highlighting that innovative design approaches, even at a limited scale, can strengthen local identity and contribute to the long-term resilience of rural landscapes (Kuczman & Paganová, 2024).

Conclusion

The study demonstrates that small rural municipalities can play an active role in sustainable landscape development through targeted, landscape-based interventions. Even with limited resources, the integration of public spaces, ecological structures and community-driven approaches can significantly enhance landscape quality, resilience and local identity.

Fig. 1: Korzo Zálesie, an award-winning wooden promenade in the municipality of Zálesie, designed by P. Derevenec and V. Krumpolec, AŽ PROJEKT (Source: Archive of Naše Zálesíčko Civic Association).

Fig. 2: One of the award-winning park squares in the municipality of Vlčany, designed by A. Tóth and T. Pavelka (Source: Attila Tóth).

Fig. 3: The Eco Centre in Moravské Lieskové was created in the area of a former agricultural cooperative and granary (Source: Archive of Žito v sýpke Civic Association).

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Souhrn
Článek se zabývá rolí malých venkovských obcí jako nedílné součásti krajiny a zkoumá krajinářské přístupy k udržitelnému rozvoji venkova. Na základě vybraných slovenských případových studií poukazuje na to, jak mohou řešení založená na přírodě, zelená infrastruktura a oživení veřejných prostranství zlepšit kvalitu krajiny, ekologickou stabilitu a místní identitu. Zjištění ukazují, že i drobné, komunitně orientované zásahy mohou významně přispět k odolnému a atraktivnímu venkovskému prostředí.

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SUSTAINABILITY OF THE TERRITORIAL ECONOMY AND THE IMPACT OF EUROPEAN PROJECTS IN SMALL TOWNS IN ROMANIA: A CASE STUDY OF BALCEȘTI, VÂLCEA (ROMANIA)

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Abstract.
Small towns in Romania face significant challenges in achieving sustainable territorial economies due to limited local resources, demographic decline, and economic restructuring. This article investigates the sustainability of the territorial economy in Balcești, Vâlcea, with a focus on the role of European Union-funded projects in supporting local development. The research methodology combines historical and statistical data analysis, field observations, and evaluation of the outcomes of EU-funded initiatives on the local economy, infrastructure, and social development. Findings indicate that European projects have contributed to improving public services, enhancing local infrastructure, and stimulating economic activities, while also promoting governance practices aligned with sustainable development principles. Nevertheless, structural challenges such as population decline, limited industrial diversification, and resource constraints persist. The study emphasizes that integrating European funding strategically can act as a catalyst for sustainable development, fostering local resilience, economic diversification, and social cohesion in small Romanian towns. The article concludes that EU-supported initiatives are instrumental in enhancing the sustainability of territorial economies, but their long-term impact requires complementary local strategies and community engagement.

Key words: Community engagement, Urban Regeneration, Public authority, Economic Resilience

Introduction

Small towns in Romania face major challenges in their economic and social development, such as depopulation, limited access to investment, and underdeveloped infrastructure (Ianoș, 2016). In this context, European funds are becoming a crucial tool for stimulating sustainable territorial development.

The town of Bălcești, with a population of approximately 8,000 in Vâlcea County, is representative of small towns seeking to leverage European resources for modernization and economic development. This study analyzes the impact of European projects on the sustainability of the territorial economy in Bălcești, from economic, social, and environmental perspectives, integrating quantitative and qualitative data. Studies in territorial economics show that small towns can become development hubs through investments in infrastructure and economic clustering (Porter, 1998). The EU's cohesion policy recommends "place-based" investments tailored to local conditions, and in Romania, small towns such as Bălcești have often been marginalized without the support of European funds (Benedek, 2014; World Commission). The effectiveness of investments depends on local institutional capacity (Rodríguez-Pose, 2015; Zeleňáková, 2017). Studies on small towns show that the involvement of local actors, infrastructure, and integrated strategies are essential for sustainability (European Commission, 2020).

Material and methods

The study employs a mixed-methods approach, with a case study conducted in Bălcești, Vâlcea (Creswell, 2014; Yin, 2018). The steps followed in conducting the study included:

The first step was data collection and processing. This included the number of businesses, demographic data - particularly the employed population - and other data regarding local budget revenue, infrastructure, and European and environmental projects. The data was provided by the local administration of the city of Bălcești.

A second important step in conducting the study was the interviews. These were semi-structured and involved members of the local community, starting with the mayor, public officials, and beneficiaries (local residents).
The study followed a descriptive and correlational analysis. This allowed for the following types of analyses:
- Econometric Difference-in-Differences (DID) analysis for the impact of European projects (Angrist, 2009);
- GIS analysis for the distribution of investments in Bălcești (Brandsma, 2014);
- Thematic analysis of the interviews to assess the perceptions of local stakeholders.

Results

Trends in local socioeconomic indicators

An analysis of the data for Bălcești shows that the European projects implemented between 2015 and 2025 have had a positive impact on the local economy. In particular:
a. The number of local firms has increased by approximately 18% over the past five years, particularly in the construction, services, and small-scale industrial production sectors, indicating a diversification of economic activities (Benedek, 2014).
b. The employment rate has stabilized at approximately 95% of the registered working-age population, compared to the previous level of approximately 90%, thereby countering the declining trends observed in other small towns in the county.
c. Local budget revenues increased by about 12% following the implementation of major projects, reflecting both the attraction of European funds and the growth of local economic activity.

These results confirm that European funding has stimulated local economic activity and contributed to reducing dependence on national budget transfers.

Impact on Infrastructure and Public Services

The town of Bălcești has undergone significant infrastructure upgrades thanks to European projects, including:

- The rehabilitation and modernization of local roads, with a total length of approximately 15 km of upgraded streets;
- The expansion and modernization of the water and sewerage network, which increased household connection rates from 78% to 95%;
- Modernization of public institutions, including schools, kindergartens, and the city hall, with the implementation of energy-efficiency solutions.

These investments have increased the city's appeal to residents and investors and have helped narrow the gaps with other cities in the county.
Effects on environmental sustainability
European projects have had a visible impact on the city's environmental sustainability:

- The implementation of LED street lighting systems has reduced energy consumption by approximately 25%;
- The installation of solar panels on public buildings has enabled the generation of approximately 150 MWh of green energy annually;
- Projects to develop green spaces and bike lanes have contributed to improving quality of life and reducing urban pollution.

These results show that Bălcești has begun to integrate the principles of sustainable development into its urban infrastructure (Nestoriuc, 2024).

Econometric and spatial analysis

The Difference-in-Differences (DID) econometric model applied to Bălcești indicates:
- Significant increases in economic indicators following project implementation: estimated local GDP +7% for the period 2015–2022;
- A positive impact on employment and on attracting private investment;
- A strong correlation between the volume of European funds and infrastructure modernization.

GIS analysis showed that investments were concentrated in the city center and larger residential neighborhoods, which generated a polarization effect in urban development, but also had a visible impact on the outskirts through the expansion of utility networks.

Residents' perceptions
Semi-structured interviews with the mayor, public officials, and local beneficiaries reveal a generally positive perception of the projects:
- 85% of respondents believe the city looks more modern and attractive for investment;
- 78% appreciate the improvements in infrastructure and public services;
- Residents and local government employees also mention potential shortcomings or weaknesses, such as excessive bureaucracy, difficulties with co-financing, and limited administrative capacity.
These observations highlight the importance not only of the volume of European funds but also of institutional capacity for implementation.

Discussion
The results of the study on the evolution of local socioeconomic indicators in Bălcești point to a significant positive impact of the European projects implemented between 2015 and 2025. The 18% increase in the number of local firms and the diversification of economic activity, particularly in the construction, services, and small-scale industrial sectors, suggest that European funding has stimulated entrepreneurial initiative and contributed to the strengthening of the local economy (Benedek, 2014; ESPON, 2018). This trend is also supported by the stabilization of the employment rate at 95%, which contrasts with the negative trend observed in other small towns in the county, indicating a compensatory effect on unemployment and labor migration (Ianoș, 2016).
The 12% increase in local budget revenues following the implementation of major projects highlights the dual role of European funds: not only as a source of direct financing, but also as a stimulus for local economic activity and the attraction of private investment. These results confirm the findings in the literature regarding the capacity of structural funds to reduce the dependence of small localities on national budget transfers (Rodríguez-Pose, 2015; Teodorescu, 2017). Regarding infrastructure and public services, road modernization, the expansion of water and sewer networks, and the energy efficiency of public buildings have contributed to increasing the city's attractiveness for both residents and investors. GIS results show that investments were initially concentrated in the city center and larger residential neighborhoods, generating polarization effects, but also the expansion of infrastructure toward the periphery, which suggests a positive impact on territorial cohesion and equitable access to services.
The environmental impact is also notable: the implementation of LED street lighting and the installation of photovoltaic panels have reduced energy consumption and carbon emissions, while the development of green spaces and bike lanes has improved the quality of urban life. These results reflect a trend toward integrating sustainable development principles into local urban planning. The Difference-in-Differences econometric analysis confirms these observations, highlighting significant increases in local GDP (+7% between 2015 - 2022) and strong correlations between the volume of European funds and infrastructure modernization. This suggests that external funds, combined with effective local administration, can produce quantifiable and sustainable effects on the local economy. Finally, the perceptions of local stakeholders indicate a generally positive assessment of the projects, but also highlight significant challenges, such as high levels of bureaucracy, difficulties with co-financing, and limited administrative capacity. This underscores that the success of implementation depends not only on volume but also on the quality of management and the institutional resources available. Overall, the results demonstrate that European projects have had a significant effect on economic development, infrastructure, and the environment in Bălcești. At the same time, they confirm the literature, which argues that the impact of structural funds is maximized when accompanied by adequate local administrative capacity and integrated strategic planning.

Conclusion
This study assessed the impact of projects funded by the European Union on the sustainability of the local economy in the city of Bălcești, Vâlcea County, using a mixed-methods approach that combines quantitative, qualitative, and spatial analysis. The results indicate that European investments have generated significant positive effects, albeit with certain limitations specific to small towns. The town of Bălcești is a positive example of a small town in Romania that has benefited from European funds, demonstrating that such investments can support economic, social, and environmental development. However, long-term sustainability depends on effective local management, community involvement, and strategic planning tailored to the local context. The study confirms that European funds are a powerful development tool, but their actual effectiveness depends on the quality of governance and local implementation capacity.

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Souhrn
Město Bălcești v okrese Valcea v Rumunsku představuje pozitivní příklad malého města, které využívá evropské fondy k udržitelnému rozvoji. Evropské fondy podpořily hospodářský rozvoj, infrastrukturu a environmentální udržitelnost v Bălcești. V tomto případě závisí dlouhodobá udržitelnost na administrativní kapacitě a zapojení místní komunity. Je třeba se neustále zaměřovat na posilování místní správy, uplatňování integrovaných strategií, rozšiřování investic do okrajových částí a větší využívání partnerství veřejného a soukromého sektoru.

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SUSTAINABLE NATURAL HABITATS – IMPORTANT CONDITION FOR SUSTAINABLE TOURISM

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Abstract

In marginal mountain areas, tourism is often the only way to diversify the local economy. However, growing tourism pressure threatens the quality of natural habitats, which paradoxically form the very basis of the area's attractiveness for visitors. The aim of this study is to propose a methodological framework for assessing and monitoring tourism pressure and habitat status in marginalised mountain areas, evaluating whether recreational carrying capacity has been exceeded, and recommending measures to support sustainable tourism. The framework integrates three complementary tools: (1) the modified CZ-GLOBIO3 model to assess biodiversity endangerment, (2) a land use change analysis based on CORINE data 2006–2018 to identify development risks, and (3) the Habitat Valuation Method (HVM) to evaluate habitat quality based on eight ecological criteria. The approach is demonstrated in the Novohradské hory Mountains, Czech Republic.

Key words: Biodiversity; overtourism; Corine LC data; GLOBIO model; Habitat Valuation Method

Introduction

Mountain areas are particularly vulnerable to climate change and intensifying human activities, with altering habitats across Europe (IPCC 2022). Many European mountain regions, including those in the Czech Republic, have been additionally affected by marginalisation driven by rural depopulation, (MacDonald et al. 2000).

Tourism represents one of the major anthropogenic pressures on mountain natural ecosystems. Mass tourism, defined by the volume of tourists relative to the territory and local population density (Sharpley 2020), can lead to overtourism, resulting in environmental degradation, soil compaction and disturbance to wildlife (Buckley 2011). Sustainable tourism, which addresses the needs of visitors, the environment and host communities (UNEP and UNWTO 2018), offers a conceptual framework for mitigating these pressures.

Effective governance of tourism in mountain areas requires understanding of the ecological, cultural and social factors determining the maximum recreational capacity of a given area (Monz et al. 2010). The impact of human activities on habitat biodiversity can be assessed using the GLOBIO 3 model (Alkemade et al. 2009)

The aim of this study is to propose a methodological framework for the assessment and monitoring tourism pressure and habitat status in marginalised mountain areas and evaluation an exceeding recreational carrying capacity to recommend measures to support sustainable tourism.

Materials and methods

Study area

The proposed framework is demonstrated on the example of the Novohradské hory Mountains, an only partially protected marginalised mountain area in South Bohemia, Czech Republic, situated on the Czech–Austrian border, and reaching 1,072 m a.s.l. (Kamenec). The study area encompasses six municipalities with approximately 5,500 inhabitants; the landscape is dominated by extensive near-natural forests, species-rich meadows and peatlands. Most of the area falls within the Novohradské hory Nature Park (162 km², est. 2000), partly overlaps with the Novohradské hory Bird Area (Natura 2000), and hosts several nationally significant reserves.

CZ-GLOBIO3 model

The CZ-GLOBIO3 model, adapted from GLOBIO 3 (Alkemade et al. 2009) to Czech conditions by replacing global species occurrence data with habitat quality and naturalness data (Pechanec et al. 2021), assesses four main drivers of biodiversity endangerment: land use change (MSA_LU), infrastructure development (MSA_I), nitrogen critical load exceedance (MSA_N), and habitat fragmentation (MSA_F), with fragmentation elements defined according to Van Rooij (2008). The total

MSA (MSA_Tot) was calculated as a vector sum of individual driver values, weighted by the area of each spatial segment (Pechanec et al. 2021).
The spatial basis for the model is the Detailed Habitat Layer (DHL), which integrates the Habitat Mapping Layer of the Czech Republic at 1:10,000 scale, containing 168 natural habitats (Chytrý et al. 2010) and 45 non-natural habitats (Seják et al. 2018), supplemented by LPIS 2022, ZABAGED 2023, OpenStreetMap 2022, and another 6 data layers from Copernicus Land Monitoring Service, Czech Forestry Institute, and Department of Geoinformatics, UPOL.
Land use change analysis (CORINE Land Cover)
Land use change risk was determined based on changes in land-use categories within 500 × 500 m grid cells, using CORINE Land Cover (CLC) maps from 2006 and 2018. The CLC categories were grouped into three classes according to the degree of built-up intensity: (i) non-built-up, (ii) transitional (discontinuous urban fabric up to 10% coverage), and (iii) built-up areas.
Habitat Valuation Method (HVM)
The evaluation of the habitat quality from the biodiversity point of view was assessed using the Habitat Valuation Method (HVM), classifying them by plant species composition, and determining their value through expert assessment of eight ecological criteria (Seják et al. 2003). For the Czech Republic, habitats were grouped according to their degree of naturalness: natural and near-natural types, identified through habitat mapping (© NCA CR, 2015) and characterized in the Catalogue of Habitats of the Czech Republic (Chytrý et al. 2010), and degraded types, further subdivided into three categories (slightly degraded, significantly degraded and completely degraded), as defined within the HVM method (Seják et al. 2003, 2018).

Results
The analysis of the total MSA TOT (Fig. 1A) index showed that the Novohradské hory study area reaches an area-weighted mean value of 0.726, indicating a relatively well-preserved, although not uniformly intact, state of natural habitats. Most of the territory falls within the 0.5–0.75 (48.1%) and 0.75–0.9 (46.7%) classes, with higher values in the south and west and lower values in the agriculturally influenced north and east.
Among the partial CZ-GLOBIO3 indicators, MSA_LU (Fig. 1B) showed the lowest values, confirming that land use is the main factor reducing biodiversity integrity in the study area.
By contrast, MSA_F (Fig. 1C) indicates a much more favourable picture of the landscape structure. Categories 4 and 5 together cover 80.3% of the territory, with the highest values primarily associated with forest areas and permanent grasslands. Category 2, forming a fine-grained fragmentation network, also includes natural habitats such as L5.4 Acidophilous beech forests and L2.2 Ash-alder alluvial forests.
Habitat quality assessed using the Habitat Valuation Method (HVM) (Fig. 1D) according to Seják et al. (2018) yielded an area-weighted mean of HB = 20.1 points. The study area is dominated by slightly degraded habitats (76.6%), whereas natural and near-natural habitats together cover 15.1% of the territory, concentrated mainly in the southern and south-eastern parts.

Discussion
The combined CZ-GLOBIO3 and HVM assessment shows that the Novohradské hory are a relatively well-preserved mountain landscape, although their ecological quality is spatially heterogeneous. The Novohradské hory achieved an area-weighted MSA_TOT of 0.726, which is notably higher than the value of 0.62 reported for the entire Czech Republic (Pechanec et al. 2021) and well above the European estimate of 0.45 (Alkemade et al. 2009). Nevertheless, MSA_LU was the lowest partial indicator (0.478), confirming that land use remains the dominant biodiversity pressure even in this comparatively intact area. The favourable MSA_F values indicate that the landscape functions as a semi-natural mountain mosaic rather than pristine wilderness (MacDonald et al. 2000;). The results show that land use and land-use intensity are among the strongest predictors of local terrestrial biodiversity loss (Newbold et al., 2015) and that the recreational carrying capacity has not been exceeded yet in the Novohradské hory. The main limitation is the lack of visitor frequency data for the study area. Future work should prioritise visitor monitoring at sensitive sites and the incorporation of the climate change driver into CZ-GLOBIO3.

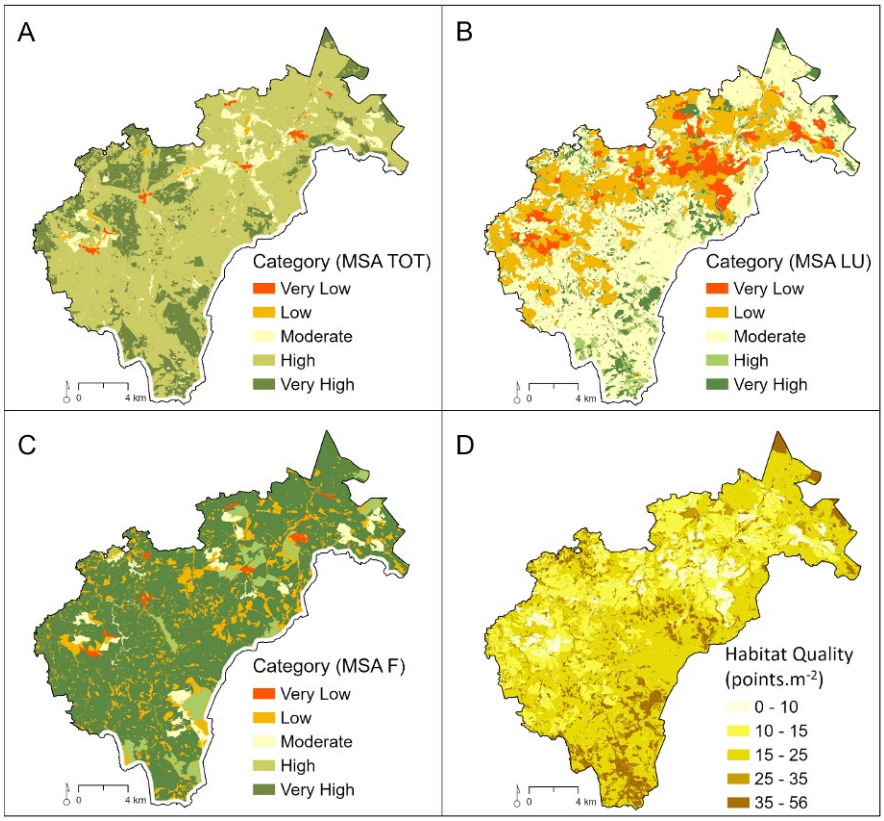

Fig. 1: Spatial distribution of Mean Species Abundance and habitat quality across the study area using HVM metod (Seják et al., 2018). (A) Total Mean Species Abundance (MSA TOT), (B) land-use related MSA (MSA LU), and (C) fragmentation-related MSA (MSA F), each classified into five ordinal categories ranging from Very Low (the worst value) to Very High (the best value). (D) Habitat quality expressed as point values per square meter.

Conclusion

The proposed framework combines the CZ-GLOBIO3 model, which assesses habitat naturalness and biodiversity endangerment from land use, infrastructure and fragmentation, with a CORINE-based land use change analysis (2006–2018) to identify areas at risk of further development. The Habitat Valuation Method enables monitoring of the most valuable and sensitive habitats to detect whether the recreational carrying capacity has been exceeded and to propose targeted measures for sustainable tourism. The application in the Novohradské hory confirmed that land use is the dominant pressure, while the overall ecological integrity remains relatively high.

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Souhrn
V horských oblastech rostoucí tlak turismu ohrožuje kvalitu přírodních biotopů, které paradoxně tvoří samotný základ atraktivity území pro návštěvníky. Cílem příspěvku je navrhnout metodologický rámec pro hodnocení a monitoring turistické zátěže a stavu biotopů v marginalizovaných horských územích, posouzení, zda došlo k překročení rekreační únosné kapacity území, a případné doporučení opatření na podporu udržitelného turismu. Pro hodnocení současného stavu a potenciálních rizik pro biodiverzitu doporučujeme použít modifikovaný model CZ-GLOBIO3, analýzu změn ve využití země na základě dat CORINE LC 2006–2018 a metodu hodnocení biotopů HVM, umožňující bodové hodnocení na základě osmi ekologických charakteristik. Metodický přístup je demonstrován na příkladu Novohradských hor. Analýza ukázala, že zájmové území dosahuje plošně váženého MSA_TOT = 0,726, což je výrazně vyšší hodnota než průměr České republiky (0,62). Hlavním faktorem ohrožení biodiverzity zůstává změna využití krajiny (MSA_LU = 0,478). Rekreační únosná kapacita území dosud nebyla překročena.

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SYNERGY OF EDUCATION AND RECREATION IN LANDSCAPE PROTECTION: INTEGRATING DENDROLOGICAL COLLECTIONS OF ARBORETUM MLYŇANY INTO UNIVERSITY CURRICULA

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Abstract
As global environmental challenges redefine the requirements for landscape architecture and forestry, the role of arboreta as “living laboratories” becomes vital. This paper explores the integration of the dendrological collections of Arboretum Mlyňany into higher education, and public recreation. Through a comparative analysis of Central European models (e.g., Prague, Křtiny, Košice, Zvolen), the study evaluates the current integration of Mlyňany's unique evergreen collections into curricula such as Systematic Dendrology and Landscape Management. The findings suggest that blending academic rigor with the site's aesthetic and recreative values significantly enhances protection. Furthermore, the study proposes that high-quality educational infrastructure can increase the site's attractiveness for paying visitors, generating resources for further gene pool conservation. The results highlight the necessity of transforming these specialized habitats into self-sustaining assets, indispensable for both scientific progress and the sustainable development of recreational landscapes.

Key words: Living laboratory, Dendrology, Public recreation, Environmental pedagogy, University education,

Introduction

The ongoing global environmental crisis and rapid urbanization are placing unprecedented pressure on landscape resilience and biodiversity. In this context, botanical gardens and arboreta have evolved from mere taxonomic collections into critical “living laboratories” that bridge the gap between scientific research and public awareness (Oldfield, 2009). These institutions serve as essential hubs for *ex-situ* conversation, but their role in modern society is increasingly defined by their ability to integrate education with public recreation (Ballantyne & Packer, 2016).

A fundamental challenge in landscape protection is moving beyond passive conservation toward active public engagement. The synergy of education and recreation – often termed “edutainment” in natural settings – allows for the transformation of protected areas into platforms for fostering environmental literacy (Packer & Ballantyne, 2016). For university students, these spaces provide a tangible and taxonomic framework that classroom lectures cannot replicate (Sellmann & Bogner, 2012).

Established in 1892, Arboretum Mlyňany (Slovak Academy of Sciences) represents a unique case study in Central Europe. Its vast collection of evergreen and exotic woody species provides an unparalleled resource for instruction in Systematic Dendrology, Phytopathology, and Landscape Management. Despite its historical and scientific prestige, the systematic integration of these collections into modern university curricula remains a developing process (Hoťka et al., 2013). Comparing the Mlyňany model with other regional institutions – such as the university-managed Arboretum Borová Hora or the urban-focused Botanical Garden of Prague – reveals diverse approaches to balancing academic rigor with visitor attractiveness (Morgan et al., 2009. This paper explores how a high-quality educational infrastructure cannot enhance student competencies but also increase the site's appeal for paying visitors, thereby generating resources for the continued protection of the gene pool.

Material and Methods

The research question for this work was: To what extent are the dendrological collections of Arboretum Mlyňany currently integrated into the curricula of relevant university degree programs (e.g., landscape architecture, horticulture)?

The research methodology employs a mixed-methods approach, combining qualitative content analysis with a comparative benchmarking study. This framework was designed to evaluate the integration of Arboretum Mlyňany's dendrological collections into university curricula and its subsequent impact on landscape protection and public recreation. The research process was divided into three distinct phases:

The first phase focused on the evaluation of current university programs at Faculty of Horticulture and Landscape Engineering (SUA in Nitra). We performed a content analysis of course syllabi for core

subjects, including: Dendrology, Protection of ornamental plants, and Landscape Management. The objective was to quantify the frequency of “living laboratory” session (field lectures) held at Arboretum Mlyňany versus standard classroom-based instruction. The curricula analysis covered the academic year 2024/2025.

To asses the standing of Arboretum Mlyňany, a benchmarking analysis was conducted against regional institutions within Central European context (table 2):

- Slovak institutions: Botanical Garden UPJŠ Košice and Arboretum Borová Hora Zvolen.
- Czech Institutions: Botanical Garden Prague (Troja) and Arboretum Křtiny (Mendel University in Brno).

The comparation criteria focused on Governing Body, Primary Strategic Focus, and the Integration Model (classified as Passive, Active – with active student participation, od Direct) (Table 2). The Passive-Academic model was defined as a standard educational visit consisting primarily of observation and identification, without direct student involment in collection management or maintenance tasks. In contrast, the Direct-Academic model (e.g., Arboretum Borova Hora) involves students as active participants in long-term research and stewardship. This allowed for the identification of best practices regarding the involment of students in the actual management and digital mapping of collections.

Finally, a Synergy Matrix, shown in Table 1, was developed to categorize the multifunctional roles of arboreta. This metrix linx specific Canservation Elements (e.g., introduced woody species) with their Recreational Function (e.g., sensory comfort) and Educational Outcomes (e.g., climate change adaptation).

Tab. 1: Synergy Matrix of Landscape Protection, Recreation, and Education

Conservation Element	Recreation Function	Educational Outcome
Introduced Woody Plants	Aesthetic experience, shade, and sensory comfort	Species identification, understanding adaptation to climate change
Landscape Composition	Space for relaxation, hiking, and mental regeneration	Principles of landscape planning and spatial protection
Protected Area	Building a personal connection to nature and heritage	Understanding legislative protection and environemntal management

Results and Discussion

The developed Synergy Matrix (Table 1) identifies how specific conservation elements, such as introduced woody species, serve dual purposes:

- Scientific Value: Providing a taxonomic framework for Dendrology and Phytopathology.
- Recreational Value: Enhancing visitor sensory comfort and aesthetic experience.

The integration of these roles is most advanced at Botanical Garden Prague and Botanical Garden Košice, where “edutainment” and thematic events (e.g., butterfly exhibitions or wine festivals) are used to found pedagogical staff and modern infrastructure. Our results suggest that Arboretum Mlyňany could adopt a similar strategy by utilizing its historical manor house and rhododendron collections to create “anchor events”. This would transition the institution from a passive recipient of state subsidies into a dynamic entity where recreational revenue directly subsidizes the protection at the gene pool.

The research confirms that while Arboretum possesses underutilized potential, the path forward lies in Institutional Linking and Digitalization. Implementing GIS-based systems and “educational hotspots” would concentrate student activities in specific areas, thereby protecting more sensitive research plots from the general public.

Comparative Analysis: Benchmaking Integration Models

To evaluate the current standing of Arboretum Mlyňany, we compared its integration strategies with other two Slovak and two Czech institutions (see table 2). The inclusion of Czech institutions provide a crucial regional benchmark, as they operate within similar ecological zones and legislative frameworks.

The evaluation of Arboretum Mlyňany in the regional context of Central European dendrological collections reveals a distinct “governance-integration” gap. As shown in Table 2, Arboretum Mlyňany operates under a Passive-Academic model, where university involvement is primarily limited to observational field trips.

Tab. 2: Comparative table (Slovak and Czech Institutions)

Institution	Governing Body	Primary Strategic Focus	Integration Model
Arboretum Mlyňany	Slovak Academy of Sciences	Research and Conservation	**Passive - Academic:** Indirectly supports various universities
BG Košice	UPJŠ University	Public Outreach and Education	**Active - Urban:** High public engagement thematic exhibition
Arboretum Borová Hora	TUZVO University	Forestry and Native Gene Pool	**Direct - Academic:** Practical lab for forestry students.
Arboretum Křtiny	Mendel University (CZ)	Functional Forestry	**Applied-Technical:** Focus on landscape management
BG Prague	City of Prague (CZ)	Tourism and Modern Edutainment	**Economic-Educational:** High tech visitor infrastructure

In contrast, university-managed institutions such as Arboretum Borová Hora (TUZVO) and Arboretum Křtiny (Mendel University) exhibit a Direct or Applied-Technical model. In these cases, students are active participants in long-term research plots and collections cataloguing. This aligns with the findings of Sellmann and Bogner (2013), who argue that tangible, hands-on frameworks in “living laboratories” provide educational outcomes that classroom lectures cannot replicate.
By blending academic rigor with the site's aesthetic values, Arboretum Mlyňany can achieve a self-sustaining cycle of conservation. As highlighted by Ballantyne and Packer (2016), the ability to integrate formal education with public recreation is increasingly defining the role of modern botanical gardens in society. Transforminng Arboretum Mlyňany into a self-sustaining asset is therefore indispensable for both specific progress and the sustainable development of recreational landscapes for future generations.

Conclusion

The research confirms that Arboretum Mlyňany possesses unique but underutilized potential for higher education. While the comparative analysis demonstrated that international institutions successtully integrate digital technologies and project-based learning, the model in Mlyňany remains largely at the level of passive field trips. The synergy of education and recreation represents a pathway to increasing the arboretum's social value without compromising its conservation function.
Institution Linking - Establishing strategic partnerships (Memorandums) with universities to define the arboretum as an “external campus” for selected courses.
Digitalization and Smart Education – Implementing an interactive information system (GIS, QR codes) providing students with professional dendrological data and general visitors with engaging popular-science content.
Zoning activities – Creating “educational hotspots”, like outdoor classrooms, to concentrate student activities in scientific areas, thereby protecting more sensitive research plots.
Student-Led Management – Involving senior students in the actual management of collections through their theses.
The development of high-quality educational infrastructure can significantly enhance the attractiveness of the site for paying visitors, thereby generating resources for future gene pool conservation. This self-sustaining cycle transforms the arboretum from a passive recipient of subsidies into a dynamic institution where the recreational experience directly subsidizes scientific research and conservation efforts.

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Souhrn
Výzkum potvrzuje, že Arboretum Mlyňany má jedinečný, ale nedostatečně využitý potenciál pro vysokoškolské vzdělávání. Zatímco srovnávací analýza prokázala, že mezinárodní instituce úspěšně integrují digitální technologie a projektovou výuku, model v Mlyňanech zůstává převážně na úrovni pasivních exkurzí. Synergie vzdělávání a rekreace představuje cestu ke zvýšení společenské hodnoty arboreta, aniž by byla ohrožena jeho ochranářská funkce.

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THE EFFECT OF VERTICAL ZONATION ON THE COMPOSITION OF ENTOMOCOENOSES IN THE SELECTED MEADOW BIOTOPES OF THE BESKYDY PROTECTED LANDSCAPE AREA (NW SLOVAKIA)

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Abstract
During the vegetation period (June – October) of 2020, we monitored the quantitative and qualitative composition of insect communities (*Insecta*) in a meadow biotop within the Beskydy Protected Landscape Area (NW Slovakia). The objective of the study was to determine the effect of vertical zoning on insect communities at two tourist-attractive sites with different altitudes: Trojmedzie Meadow (560 m a.s.l.) and Girová Meadow (840 m a.s.l.). Using the intact sticky trap method, we collected a total of 1212 individuals (indiv.) belonging to 73 species (spp.) from 9 orders and 35 families. The most represented orders of the class Insecta were Coleoptera (24 spp., 297 indiv.) and Lepidoptera (17 spp., 288 indiv.). At the higher altitude site (Girová, 840 m), 580 individuals were recorded, compared to 632 individuals at the lower-altitude Trojmedzie site (560 m). The research also provides data on the spectral sensitivity of individual insect orders to different color versions of sticky traps (transparent, yellow, and blue). Furthermore, the study includes results regarding the impact of tourism and human mobility restrictions during the Covid-19 period on the quantitative representation of entomocoenoses, which did not show statistically significant differences between the compared periods.

Key words: insect, vertical zonation, color spectrum, Girová, Trojmedzie, tourism

Introduction

The present study investigates the effect of vertical zonation of the studied area as a limiting abiotic factor on the composition of entomocenoses inhabiting two different meadow sites (Trojmedzie: 560 m a.s.l.) and (Gírová: 840 m a.s.l.), located in a touristically important Carpathian region of the Beskydy Protected Landscape Area (PLA) in NW Slovakia. Previous studies from the nearby Kysuce region (Kvasničák - Bestwinová, 2018) compared the abundance and diversity of entomocenoses on a deforested slope of Mt. Liesková (849 m a.s.l., Kysuce PLA). From the Orava region (Horná Orava PLA), the impact of tourism on the composition of entomofauna in recreationally attractive areas of the Babia hora and Pilsko Nature Reserves has been investigated (Kvasničák et al., 2021).From the Oravská Magura region (Magurka, 1107 m a.s.l.), results are also available concerning vertical zonation (Kvasničák – Dzureková, 2018), as well as the trophic and developmental fidelity of meadow beetle species that actively seek flowers for olfactory cues, food resources, mating sites, sun-exposed locations, and shelter. International studies have documented the influence of altitude on insect communities in the foothills of the Italian Alps (Chamberlain et al., 2015 and 2020) and in the Mexican region of Central America (Rivas-Arancibia, 2015). The effects of vertical zonation on beetle bioindicators have also been studied in the tropical forests of Ecuador (Dominguez, 2015), as well as biodiversity patterns in high-altitude regions (3400 m a.s.l.) of the Peruvian Andes (Maveety, 2013). Based on the aforementioned studies, we assume that communities of pterygote insects inhabiting meadow biotopes at higher altitudes occur in lower abundance compared to those in areas with lower elevations.The study also aimed to determine the spectral sensitivity and colour preferences of selected insect orders as potential pollinators with colour vision (Long, - Flint - Lepper, 2011), as well as to compare the effect of human mobility on the abundance of praticolous beetle species at tourist-frequented sites during the pandemic period (2020) and the non-pandemic period (Kvasničák - Bestwinová, 2018).

Materials and methods

The collection of entomological material was carried out in 2020 during the vegetation period (June–October) in the Beskydy PLA at two different recreational sites of meadow biotopes with an altitudinal difference of 280 m a.s.l. (Fig. 1). The first, lower-altitude site was a meadow at Trojmedzie (560 m a.s.l.), while the second site was a meadow on Mt. Gírová (840 m a.s.l.). Entomological material was collected using the method of impact sticky traps (Hagstrum, Dowdy, Lippert, 1994) without pheromone attraction. The traps were mounted on a wooden support at a height of approximately 60

cm above ground level. At each sampling site, a total of 30 sticky traps were arranged vertically, consisting of three colours of the visible spectrum (transparent: 10 units, yellow: 10 units, and blue: 10 units), coated with a non-degraded adhesive. The traps were positioned at each site at one-metre intervals along a 30-metre straight line (Fig. 2). Sampling was conducted monthly, always during the first half of the month, with traps left in place for 7 days at each selected site. The collected insect samples were taxonomically identified to the level of orders and families in a biological laboratory using standard entomological literature (Jelínek, 1993) and electronic identification keys (www.kerbtier.de; www.coleoptera.org; www.hmyzslovenska.info).

Fig. 1: Intact sticky traps in different color spectra (M. Bestwinová, 2020)

Fig. 2: Map showing the location of the study sites (A: Trojmedzie, 560 m a.s.l.; B: Gírová, 840 m a.s.l.) in the border area of the Beskydy PLA (Scale 1:40 000)

Results During the entomological survey conducted from June to October 2020, a total of 1,212 individuals of the class *Insecta* were collected at the selected sites, belonging to 9 orders, 35 families, and 73 species. From both qualitative and quantitative perspectives, the most represented orders of *Insecta* were *Coleoptera* and *Lepidoptera*. The order *Coleoptera* was represented by 10 families, 24 species, and 297 individuals (24.50%), while *Lepidoptera* comprised 7 families, 17 species, and 288 individuals (23.76%). Among the eudominant families (ED), *Pentatomidae* accounted for 10.89%. Dominant families (D) included *Coccinellidae* (8.32%), *Tortricidae* (5.36%), *Noctuidae* (6.02%), and *Hesperiidae* (6.19%). At the Gírová site (840 m a.s.l.), a total of 580 individuals were recorded, representing 47.85% of the total 1,212 individuals collected. At the lower-altitude site Trojmedzie (560 m a.s.l.), 632 individuals of the class *Insecta* were obtained, representing 52.15% of the total sample (Appendix 1). The observed differences between the sites with different altitudes were statistically significant ($p < 0.05$), confirming the effect of vertical zonation at the compared localities. This difference in abundance between the sites during the vegetation period (June–October) is also illustrated by the seasonal dynamics curve (Fig. 3). At the higher-altitude site Gírová (840 m a.s.l.), a summer peak in abundance was recorded in August (141 individuals), compared to the lower-altitude site Trojmedzie (560 m a.s.l.), where 157 individuals were recorded. Subsequently, an autumn minimum was observed at both sites in October, with a total of 183 individuals. In terms of coenotic characteristics, praticolous insect species dominated at both meadow sites (75%), with a predominance of mesophilic indicator values (84%).

A total of 64 species (spp.) were shared between the two studied localities. The Jaccard index of faunistic similarity reached a value of 87.67% for both sites. The Shannon-Weaver diversity index was 3.43 at the Gírová site (840 m a.s.l.) and showed a very similar value of 3.42 at the Trojmedzie site (560 m a.s.l.). According to Trnka (2020), both studied localities can be classified as ecologically stable environments without significant anthropogenic disturbance. Within the study, we also examined the colour preference of insects for sticky traps (Graph 4). In terms of the number of individuals recorded at both sites, a similar increasing preference for colour spectrum was observed in the following order: yellow (446 individuals), transparent (391 individuals), and blue (275 individuals). The orders *Orthoptera* (41 individuals), *Neuroptera* (10 individuals), *Coleoptera* (108 individuals), and *Diptera* (45%) showed a preference for yellow sticky traps (560–590 nm). The order *Hymenoptera* (55 individuals) preferred transparent sticky traps (300–400 nm). The orders *Lepidoptera* (114 individuals) and *Mecoptera* (10 individuals) preferred blue sticky traps (400–500 nm).

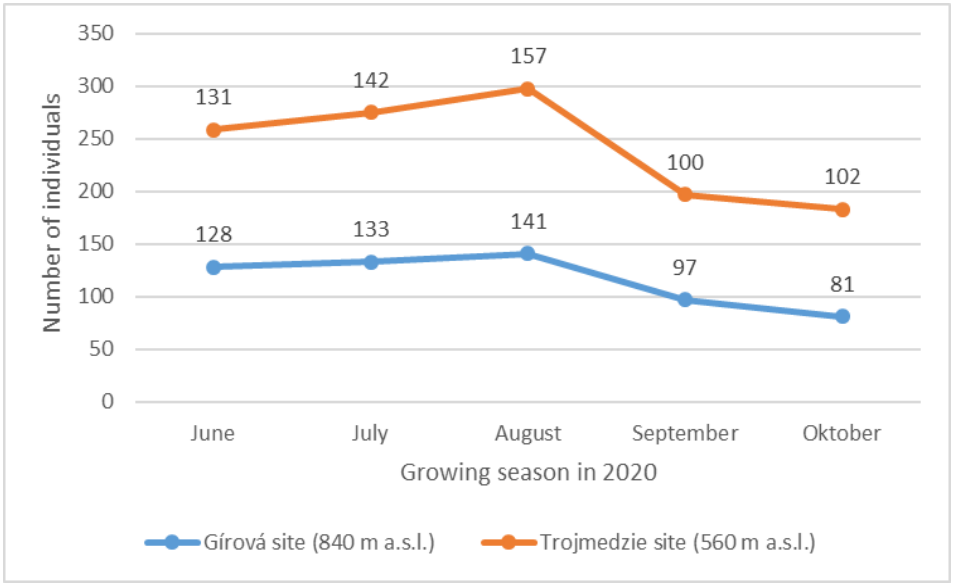

Fig. 3: Seasonal dynamics of insect occurrence at the compared sites with different altitudes.

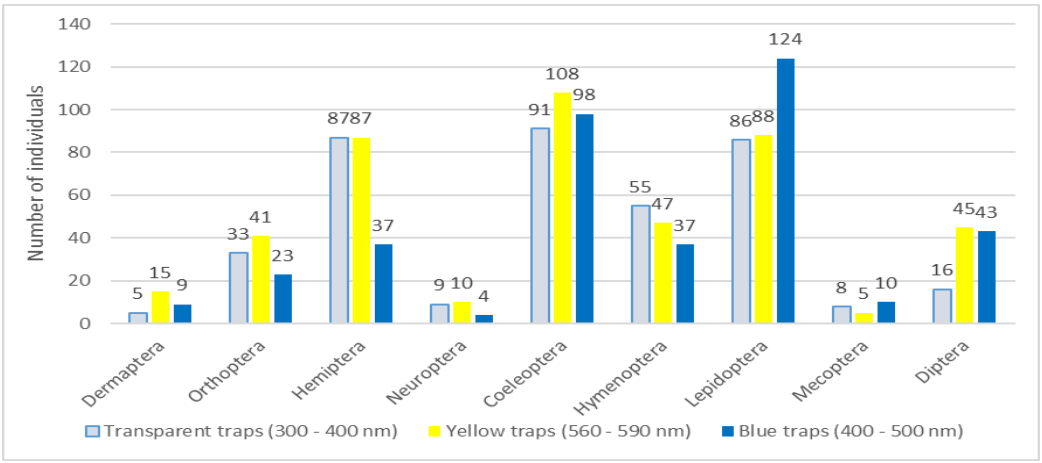

Fig. 4: Abundance (N) and spectral sensitivity of individual insect orders to different colors of the sticky traps.

The study also included a comparison of the abundance of individuals of the order Coleoptera obtained using transparent sticky traps at the study sites during the COVID-19 period with restricted tourism (2020) and a period without limitations on human mobility (2017) (Kvasničák - Bestwinová, 2018). The abundance of beetle individuals at the Gírová site (40 individuals) and Trojmedzie (51 individuals) during the pandemic period showed, on average, lower representation of coleopteran assemblages compared to two sampling sites (A, B) at Mt. Liesková (A = 59 individuals, B = 63 individuals) in the nearby Kysuce PLA, with comparable altitudes (849 m a.s.l. and 550 m a.s.l.). The observed differences in beetle abundance between the compared sites, despite the temporal gap, were not statistically significant ($p > 0.05$), indicating no significant effect of restricted human mobility on the quantitative representation of individuals of the order Coleoptera in the studied tourist-frequented area.

Discussion

The influence of altitude as an abiotic factor and the effect of vertical zonation on the composition of entomocenoses has been highlighted not only in Slovakia, particularly in studies from the Kysuce region (Kvasničák - Bestwinová, 2018) and the Horná Orava region (Kvasničák et al., 2021), but also in international research from various parts of the world. A study conducted in the foothills of the Italian Alps (Chamberlain et al., 2020) investigated biodiversity stability based on selected epigeic beetle species from the families *Geotrupidae* and *Aphodiidae*. Notable findings from Mexico were reported by Rivas-Arancibia et al. (2015), who examined the developmental fidelity of praticolous beetle and *Hymenoptera* species associated with the native deciduous tree *B. copallifera*, considering selected environmental factors such as temperature, humidity, and altitude. Similarly, recent synecological

studies from Central America by Dominguez et al. (2015) have focused on beetle bioindicators, whose occurrence is simultaneously limited by altitude, air temperature, and precipitation in tropical forest ecosystems of Ecuador. In contrast, biodiversity at high elevations (1400–3400 m a.s.l.) in the Peruvian Andes was studied by Maveety et al. (2013), who identified bioindicators of environmental stability within the order *Coleoptera* (family *Carabidae*), depending on both spatial structure (altitude) and temporal factors (wet and dry seasons) of mountainous habitats. Under Slovak conditions, future research could expand the experimental design by incorporating partial monitoring of entomocenoses across multiple meadow–forest ecotone sites with varying altitudes (e.g., a deforested meadow ski slope approximately 1000 m in length or a forest clearing influenced by meadow succession). Such an approach would enable more detailed qualitative assessment of vertical zonation effects across multiple sampling sites simultaneously, for example at 100 m altitudinal intervals, focusing on the composition of more narrowly defined insect communities, particularly praticolous beetle assemblages. Within coleopteran assemblages, an interesting comparison of beetle abundance can be observed on meadow slopes at different altitudes in the Malé Karpaty (Kvasničák - Štiavnická, 2014) and with different slope orientations (north–south). Factors such as heliophily and solar radiation (Kvasničák - Schmidtová, 2014), also influence the abundance of praticolous insect communities in the border region of Veľká Javorina (Biele Karpaty PLA).

Conclusion

The conducted research examined the effect of altitude on the quantitative and qualitative composition of insect communities at two tourist-recreational sites, Gírová (840 m a.s.l.) and Trojmedzie (560 m a.s.l.), located in the Beskydy PLA. The proposed hypothesis that vertical zonation influences the quantitative and qualitative composition of entomocenoses was confirmed. At the higher-altitude site, characterized by cooler climatic conditions, a lower abundance of insects was recorded during the vegetation period compared to the lower-altitude site with a warmer climate. It was demonstrated that an altitudinal difference of 280 m significantly affects both the abundance and species diversity of insect communities, as also reflected by the seasonal dynamics curve. At both sites, an increasing preference for the colour spectrum of sticky traps was observed among insect orders, as follows: yellow (*Orthoptera*, *Neuroptera*, *Coleoptera*, and *Diptera*), transparent (*Hymenoptera*), and blue (*Lepidoptera* and *Mecoptera*). No clear effect of human mobility on communities of pterygote beetles was confirmed during the pandemic period. Both studied sites (Gírová and Trojmedzie), despite their recreational use, currently represent ecologically stable environments without significant anthropogenic disturbance.

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Souhrn
Chráněná krajinná oblast Beskydy v současnosti představuje rekreační a turisticky vyhledávanou oblast situovanou v karpatské pohraniční oblasti Slovenska, Česka a Polska. Realizovaným výzkumem jsme během pětiměsíčního období roku 2020 zjišťovali vliv vertikální zonálnosti území na skladbu pratikolních entomocenóz. Jako výzkumné plochy byly zvoleny dva luční stacionáře s různou nadmořskou výškou a to v lokalitě Trojmezí (560 m n. m.) a Girová (840 m n.m.). Metodou intaktních lepových pastí jsme dohromady získali 1212 jedinců (ex.) hmyzu příslušejících k 73 druhům (spp.) z 9 řad a 35 čeledí. Četnost jedinců v níže položené oblasti (632 ex.) byla statisticky významně vyšší než na lokalitě s vyšší nadmořskou výškou (580 ex.). Uvedenou skutečnost vlivu vertikální zonálnosti srovnávaných stacionářů dokumentuje během vegetačního období i křivka sezónní dynamiky. Nejvíce zastoupenými řadami ze třídy hmyz byly Coleoptera (24 spp., 297 ex.) a Lepidoptera (17 spp., 288 ex.) s dominantou výskytu pratikolních druhů hmyzu s mezofilní indikační hodnotou. Na obou stanovištích evidujeme v počtu získaných jedinců i vzestupnou preferenci barevného spektra lepových pascí v pořadí: žlutá (446 ex.), bezbarvá (391 ex.) a modrá (275 ex.). Následně na srovnávaných stacionářích jsme jednoznačně nepotvrdili vliv lidské mobility na společenství koleopter během pandemického období, přičemž oba výzkumné stacionáře s turistickým využitím v CHKO Beskydy (Girová, Trojmezí) vykazují v současnosti ekologicky vyvážené prostředí bez výrazných antropogenních vlivů.

Appendix: 1: Orders and families of insect with the number of individuals (N), species (S), and their dominance (D) at individual sites

Orders and families	Gírová (840 m a.s.l.)				Trojmedzie (560 m a.s.l.)			
	N	D [%]	S	D [%]	N	D [%]	S	D [%]
Dermaptera								
Forficulidae	15	2,59	2	3,08	14	2,22	2	2,78
Orthoptera								
Phaneropteridae	8	1,38	2	3,08	2	0,32	2	2,78
Tettigoniidae	10	1,72	1	1,54	11	1,74	1	1,39
Gryllidae	16	2,76	1	1,54	22	3,48	1	1,39
Acrididae	13	2,24	2	3,08	15	2,37	2	2,78
Hemiptera								
Miridae	25	4,31	2	3,08	32	5,06	3	4,16
Pentatomidae	54	9,31	3	4,61	78	12,34	4	5,56
Aphididae	10	1,72	2	3,08	12	1,90	2	2,78
Neuroptera								
Chrysopidae	12	2,07	1	1,54	11	1,74	1	1,39

Coleoptera								
Carabidae	4	0,69	2	3,08	5	0,79	3	4,16
Staphylinidae	7	1,21	1	1,54	4	0,63	1	1,39
Cantharidae	18	3,10	2	3,08	26	4,11	2	2,78
Elateridae	7	1,21	2	3,08	3	0,47	2	2,78
Coccinellidae	50	8,62	4	6,14	51	8,07	4	5,56
Lucanidae	1	0,17	1	1,54	0	0	0	0
Cerambycidae	16	2,76	2	3,08	14	2,22	2	2,78
Chrysomelidae	20	3,45	3	4,61	23	3,64	4	5,56
Curculionidae	23	3,97	3	4,61	13	2,06	3	4,16
Scolytidae	7	1,21	2	3,08	5	0,79	2	2,78
Hymenoptera								
Ichneumonidae	22	3,79	1	1,54	24	3,80	1	1,39
Formicidae	25	4,31	2	3,08	32	5,06	2	2,78
Sphecidae	7	1,21	1	1,54	11	1,74	1	1,39
Apidae	8	1,38	3	4,61	11	1,74	3	4,16
Lepidoptera								
Tortricidae	36	6,21	1	1,54	29	4,59	1	1,39
Zygaenidae	4	0,69	1	1,54	13	2,06	2	2,78
Noctuidae	37	6,38	3	4,61	36	5,70	3	4,16
Nymphalidae	10	1,72	3	4,61	18	2,85	4	5,56
Hesperiidae	37	6,38	3	4,61	38	6,01	3	4,16
Lycaenidae	6	1,03	1	1,54	7	1,11	1	1,39
Pieridae	6	1,03	3	4,61	11	1,74	3	4,16
Mecoptera								
Panorpidae	16	2,76	1	1,54	7	1,11	1	1,39
Diptera								
Bibionidae	13	2,24	1	1,54	13	2,06	1	1,39
Syrphidae	20	3,45	2	3,08	23	3,64	2	2,78
Muscidae	0	0	0	0	3	0,47	2	2,78
Calliphoridae	17	2,93	1	1,54	15	2,37	1	1,39
SPOLU	580	100	65	100	632	100	72	100

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THE IMPORTANCE OF COMPOSED TREE FORMS IN RURAL AND URBAN ENVIRONMENTS

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Abstract
Vegetation, present in both urban and rural environments, constitutes a critical component that significantly enhances environmental conditions and ecological balance. High vegetation exerts a substantial influence on local climate and environmental quality and shapes the physiognomy of landscape sequences. When arranged in diverse spatial configurations, vegetation fulfills a wide range of functions, including biological, technical, aesthetic, and social roles. The effectiveness of composed tree stands is determined by the careful selection of species and the design of planting structures, encompassing both spatial composition and the internal structure of individual forms.

Key words: composed forms of trees, urban greenery, rural areas, mid-field woodlots, ecological balance of the landscape

Introduction

Vegetation in both urban and rural settings is a fundamental component that improves environmental conditions and supports ecological balance. Tall vegetation has a significant impact on climate regulation, environmental quality, and the visual character of landscape sequences. In urban areas, greenery softens architectural rigidity, reduces visual monotony, and enhances residents' well-being. In agricultural landscapes, which are often extensively modified and lack substantial forest complexes, integrated tree systems - such as those in fields, along roads, and near watercourses - provide environmental and economic stability, including positive effects on crop production [Fortuna-Antoszkiewicz 2019].
Greenery organized in diverse spatial configurations fulfills a range of documented biological, technical, aesthetic, and social functions [e.g. Hejmanowski et al. 1964; Niemirski 1973; Karg, Karlik 1993; Łuczyńska-Bruzda 1995; Karg 2003; Bell, Treshow 2004]. The effectiveness of composed tree stands for specific objectives relies on the careful selection of species and the design of planting structures, including spatial composition and internal structure [e.g. Milewski, Hejmanowski 1965]. Continuous observation and analysis of natural and anthropogenic landscape processes provide increasingly detailed insights. Long-term evaluation of design solutions and their outcomes expands the cognitive spectrum [e.g. Fortuna-Antoszkiewicz, Łukaszkiewicz 2018; Fortuna-Antoszkiewicz et al. 2018].

Material and methods

From 2015 to 2025 (ongoing), comprehensive research has been conducted on various forms of composite woodlots in both urban and rural contexts. Observations have focused on trees of different types and sizes, examining their functional roles, distribution patterns (as independent elements or within larger systems), and spatial structures, including complexity and species composition. Analyses have also considered habitat conditions, spatial context (such as surrounding development and available space for tree growth), and the condition of selected woodlots (including estimated age and tree health). This research has enabled evaluation of the effectiveness of different composite woodlot forms, with findings continuously validated or updated, and has been supported by a systematic review of relevant literature.

Results

To fulfill their intended functions, composed tree stands require appropriate **structural arrangement** at both the object and landscape (area) scales:
1/ Object scale:

- spatial forms: single trees, groups, rows, strips, patches;
- internal structure of individual forms: varied width, density, vertical arrangement – ensuring better tree exposure and favorable conditions for tree and shrub growth (less competition for nutrients);

2/ Landscape scale (area scale):

- spatial rigor within a given area: wooded areas with a specific structure, appropriately positioned relative to each other and the surrounding areas.

In agricultural areas, the following tree forms can be distinguished (following the basic classification by Hejmanowski et al. 1964):

- *a individual form* – individual trees or shrubs (solitary trees), loosely distributed among fields, meadows, and pastures; • group form – trees and shrubs in small clusters of any shape; occupying an area of up to 10 ares; composed of several to a dozen or so trees or trees and shrubs (Fig. 1);
- *a surface form* – groupings of trees and shrubs on an area exceeding 10 ares; located near cities, they can over time be incorporated into urban greenery resources and, after appropriate adaptation and reconstruction, transformed into so-called landscaped greenery (Fig. 3);
- *a row form* – a single row of trees or trees and shrubs; may occur as a single-sided or double-sided form, e.g., in the case of roadside or waterside trees; it is derived from natural linear arrangements (e.g., along watercourses), but in composed arrangements, it usually takes the form of a regular form (Fig. 5);
- *a belt form* – linear groupings of trees and shrubs in an irregular arrangement or in multi-row arrangements; The width of the strip in composed shelterbelt structures does not exceed 10 m.

Row and strip forms can also be built exclusively with shrubby plants → *hedges*: low hedges up to 1.0 m high; medium hedges 1.0-3.0 m high; tall hedges exceeding 3.0 m high (example: southern England – hedges, systematically and precisely connected in large areas, constitute the characteristic, traditional landscape of the local countryside).

The forms of shelterbelts located in rural areas find their counterparts in urban spaces (Fig. 1-6), where they have been given a slightly more refined and precise form, derived from classical elements and spatial arrangements used, for example, in 18th- and 19th-century parks and gardens [Fortuna-Antoszkiewicz 2019]:

- *a solitary tree* - it is a single tree or large shrub growing in a specific space within a landscaped interior. They occur in gardens, open landscapes, and urban areas. They are planted to create a specific effect (image, mood), and in such cases, they are valuable specimens from a dendrological and aesthetic perspective. They can also appear as spontaneous, accepted self-seeds that enrich the spatial composition (complementary elements with a spatial subdominant character, a form of opposition, and a type of visual information) (Fig. 2);
- *a group* – it is several or a dozen trees or shrubs that form a cohesive composition (a distinct volume) within a specific space within a landscaped interior. It can take various forms, taking into account formal and structural considerations (free or regular, loose or compact arrangement) (Fig. 4);
- *an avenue* – it is a pedestrian or vehicular path lined with regular rows of trees. It is one of the fundamental components of sophisticated garden compositions and urban designs, and can stand alone as a spatial structure with a rigorous composition (e.g., a street alley) (Fig. 6).
- *an espalier* – it is a regular, usually single-row arrangement of trees. In a garden, it typically takes the form of a compact wall exceeding 220 cm in height, and in an urban setting, it may serve as a single-sided border for a street or square. *Hedges*, or single- or multi-row, dense plantings of trees or shrubs up to 220 cm in height, are derived from espaliers. They can be shaped (trimmed) or unshaped, and can be single- or multi-species.

Woodlots vary in their **spatial construction** (vertical and horizontal) and **species selection**, which significantly influences their form [e.g. Hejmanowski et al. 1964, Fortuna-Antoszkiewicz 2019]. The spatial construction is determined by **the vertical structure** (story structure) and **the horizontal structure** (the arrangement of plants and the mixing of individual species). **The vertical structure** includes:

- single-story woodlots – where the trees exhibit little height variation, and the tree crowns are set at a similar level;
- two-story woodlots – where the trees form two distinct layers (story) of different heights, with the treetops of the lower story only slightly penetrating the upper story;
- multi-story woodlots – where the tree crowns interpenetrate.

Fig. 1: A single tree - *individual form* in a rural area, southern England / *Quercus robur* L. (photo: B. Fortuna-Antoszkiewicz)

Fig. 2: A *solitary tree* in an urban space, Warsaw / *Phellodendron amurense* Rupr. (photo: B. Fortuna-Antoszkiewicz)

Fig. 3: A loose group of trees - *surface form* in a rural area, southern England (photo: J. Łukaszkiewicz)

Fig. 4: *A group of trees* in an urban space, London (photo: B. Fortuna-Antoszkiewicz)

Fig. 5: An avenue - *row form of trees* in a rural area, central Poland (photo: B. Fortuna-Antoszkiewicz)

Fig. 6: *An avenue* in an urban space, Warsaw (photo: B. Fortuna-Antoszkiewicz)

When planning multi-story tree stands, it is necessary to consider the intended form and primary function, as well as to select tree and shrub species according to their biological characteristics (such as attainable size, growth rate, and root system type) and habitat requirements (including soil, water, and sunlight). Multi-story systems facilitate landscape integration due to their similarity to natural plantings and enhance environmental stability by providing greater system resilience and improved soil shading. These systems can be applied to all types and forms of tree stands; even the simplest single-row planting can incorporate multi-species, multi-story arrangements.

The horizontal arrangement is the spacing of individual plants (trees and shrubs) within a shelterbelt. This spacing depends on various factors – soil fertility, the species of trees and shrubs used, and the form and internal structure of the shelterbelt.

In terms of **a species composition**, single-species (monoculture) or multi-species (a composition of at least two different tree and shrub species, with various species mixes) are common. An effective species arrangement in a so-called tiered shelterbelt consists of trees and shrubs and typically contains about 90% primary species and about 10% admixed species. The species composition of shelterbelts depends primarily on specific spatial and habitat conditions (water, soil, climatic conditions, topography). For a long time, native species characteristic of a given area have been primarily used. The more species-diverse the woodlots (trees and shrubs), the richer the biological life of other organisms (increasing biodiversity [*EU Biodiversity Strategy 2030: Bringing nature back to our lives [COM(2020)0380]*, 2020]) and the greater the environmental stability. The appropriate selection of tree and shrub species determines not only the effectiveness of various types of woodlots, but also their durability and impact on the landscape's physiognomy, both in cities and rural areas [*The European Landscape Convention*, 2006].
The species composition of tree stands, combined with appropriate spatial structure (compactness), provides measurable social and ecological benefits. For example, **luminous stands** in urban parks enhance resident comfort by increasing safety and ensuring optimal lighting, thermal conditions, ventilation, and atmospheric air composition [e.g. Łukaszkiewicz 2019; Łukaszkiewicz et al. 2018; Bamwesigye et al. 2021]. In agricultural areas, more open, fully lit stands promote increased honey yields in certain tree species, as their crowns are more developed and bloom more abundantly than in compact stands [e.g. Fortuna-Antoszkiewicz, Łukaszkiewicz 2012, 2017]. This, in turn, supports the protection of bees and other pollinators, which is particularly important in the context of global concerns.

Conclusions
In both urban and agricultural areas, distinct spatial plant elements are formally and structurally analogous. This is evident in observations of various tree planting forms, such as those in the consistently maintained English landscape, where agricultural areas feature spatial forms similar to garden structures derived from classical landscape park compositions [Fortuna-Antoszkiewicz, Łukaszkiewicz 2016]. In these contexts, the agricultural landscape merges with garden spaces, contributing to a broader landscape composition aligned with the 18th-century concept of the "park landscape" in wooded agricultural regions. For composed trees used for specific purposes, regardless of their urban or rural location, effectiveness in aesthetic-spatial, functional-technical, and ecological-landscape terms is determined by the appropriate selection of species and planting structure, taking into account both spatial composition and the internal structure of individual forms.

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Souhrn
Vegetace, která se vyskytuje jak v městském, tak ve venkovském prostředí, představuje klíčovou složku, která významně zlepšuje podmínky životního prostředí a ekologickou rovnováhu. Vysoká vegetace má podstatný vliv na místní klima a kvalitu životního prostředí a utváří fyziognomii krajinných sekvencí. Je-li uspořádána do rozmanitých prostorových konfigurací, plní vegetace širokou škálu funkcí, včetně biologických, technických, estetických a sociálních rolí. Účinnost komponovaných stromových porostů je dána pečlivým výběrem druhů a návrhem výsadbových struktur, zahrnujícím jak prostorovou kompozici, tak vnitřní strukturu jednotlivých forem.

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THE INSTITUTIONAL FRAMEWORK OF EDRM IN SIMANJIRO DISTRICT (TANZANIA) AND ITS IMPLICATIONS FOR TOURISM STABILITY

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Abstract
The increasing intensity of environmental threats necessitates robust institutional environmental disaster risk management (EDRM). This study analyses the structure and performance of EDRM institutions in the Simanjiro District of Tanzania, focusing on how this may impact the vital tourism sector. The EDRM research employs a qualitative approach, combining primary data from field observations and interviews with a secondary analysis of national guidelines. The primary threat in the district is extreme drought, which directly devastates biodiversity and Maasai culture – the two fundamental pillars of local tourism. The absence of proactive management and insufficient coordination weakens the districts' resilience to climate change disasters. The reactive approach of institutions fails to ensure the protection of wildlife migration routes or the stability of Maasai communities, which may lead to a decline in Simanjiro's attractiveness as a tourist destination. The study confirms that although a strong institutional framework exists, its actual effectiveness remains subpar. To preserve tourism, it is essential to strengthen technical capacities, resources, and the mutual coordination of local institutions so that they can not only address risks but also prevent them.

Key words: climate change, sustainable tourism, institutional coordination, extreme drought, Maasai culture

Introduction

The increasing frequency of natural disasters is destabilising the pillars of sustainable development globally, with sub-Saharan Africa remaining the most vulnerable region due to limited institutional capacities and weak infrastructure (FAO, 2021; Guha-Sapir et al., 2015). The solution to this vulnerability, exacerbated by climate change and environmental degradation, lies in a shift from reactive aid to robust institutional environmental disaster risk management (EDRM) capable of keeping risks at an acceptable level (UN/ISDR, 2014; Rivera et al., 2020). Although Tanzania has a central coordination framework, the effectiveness of EDRM at the local level faces technical and socio-economic barriers, which are particularly pronounced in Simanjiro District (Adenle, Ford, 2017). As district-level institutions are key to disaster prevention and mitigation, this study analyses the structure and performance of both formal and informal actors in Simanjiro to identify barriers and success factors in protecting local resources from environmental threats (Vogel, Koch, 2010).

Materials and methods

In the study, we used primary data obtained through face-to-face interviews with key informants, focus group discussions (FGDs), and secondary data on completed and ongoing DRM projects from the Simanjiri District Council website. In addition, 19 representatives from non-governmental organisations and the private sector were selected based on their involvement in EDRM. Focus group discussions (FGDs) were conducted to ascertain how communities perceive and cooperate with both formal and informal EDRM institutions, by measuring perceived effectiveness and gaps in institutional response, and by identifying contextual and socio-cultural factors that influence institutional performance. Secondary data were collected through a thorough review of relevant documents related to the study. The documents reviewed included Tanzania's National Disaster Risk Management Strategy for 2022–2027, published articles, and various district reports on EDRM. A qualitative approach to data analysis was employed in the study. Primary data obtained through interviews with key informants and focus group discussions were analysed using inductive thematic analysis. This method of analysis provides a comprehensive mechanism for deriving meaningful patterns and themes from qualitative data (Braun, Clarke, 2019).

Results

Environmental extremes, particularly cyclical droughts and flash floods, pose an existential threat to tourism in Simanjiro, as they directly degrade its key pillars: biodiversity and Maasai culture.

Threats to wildlife tourism and migration routes

The Simanjiro plains are an integral part of the Tarangire National Park's migration ecosystem. However, climate instability and environmental degradation (Morita, 2014; Shah et al., 2023) are destabilising this system:

Disruption of migration cycles: Irregular rainfall patterns and droughts disrupt the natural migration of wildebeest and zebras. This makes them harder to locate, reduces the visual appeal of safaris, and weakens the destination's competitiveness.

Loss of biodiversity: Extreme droughts lead to the drying up of key waterholes and the degradation of pastures, which increases mortality rates among animal populations and disrupts the integrity of the unique ecosystem.

Negative impact on cultural tourism

Environmental disasters act as a catalyst for the cultural erosion of the Maasai, whose identity is ontologically linked to a pastoral way of life.

Devaluation of authenticity: The decimation of herds (over 92,000 head of cattle died in 2022) is forcing young Maasai to flee to the cities. This brain drain is causing the demise of living traditions, thereby depriving tourism of its most valuable element – an authentic cultural experience.

Decline in service quality: Scarcity of water and raw materials limits the production of material culture (jewellery, artefacts) and makes it impossible to maintain hygiene standards for visitors.

Infrastructure destruction and economic instability

Climate events degrade the districts' physical assets, creating technical and financial barriers for operators:

Critical impassability: Torrential rains regularly damage unpaved roads, isolating accommodation facilities (tented camps) and preventing access to key attractions.

Physical damage and technical wear and tear: Extreme weather directly damages lodge structures, whilst high dust levels and humidity accelerate the deterioration of technical systems (solar panels, boreholes). Constant repair work increases fixed costs and reduces the area's competitiveness.

Health and safety risks

Climate instability increases the destination's risk profile, which directly deters international visitors:

Epidemiological threats: Floods correlate with an increase in waterborne diseases (cholera) and vector-borne diseases (malaria, dengue), raising concerns about the biological safety of visitors.

Escalation of conflicts (Human-Wildlife Conflict): Water scarcity forces wildlife to migrate towards human settlements, increasing the risk of dangerous encounters. At the same time, the declining availability of grazing land exacerbates tensions between communities and park management, creating an unstable social environment.

Logistical uncertainty: The impassable terrain prevents rapid evacuation or access to healthcare, which increases tourists' subjective perception of risk.

Assessment of institutional preparedness in the Simanjiro district

Although the district has a legislative framework, its actual effectiveness in managing environmental risks is low:

Reactive management: Institutions focus on addressing consequences rather than proactive prevention, which is ineffective in the face of cyclical droughts.

Fragmentation and coordination: The lack of links between state structures, NGOs, and Maasai institutions weakens the region's overall resilience.

Institutional blindness: Current risk management fails to adequately reflect the specific needs of the tourism sector, leading to a failure to protect migration corridors and community stability.

Capacity deficit: A chronic shortage of technical and financial resources prevents the implementation of effective early warning systems.

Discussion

The study's findings point to the mediocre performance of the Environmental Disaster Risk Management (EDRM) system in Simanjiro District, reflecting deeper systemic shortcomings in the institutional framework. A key problem is the critical fragmentation and weak horizontal coordination

among actors, which, according to Hkh et al. (2023), prevents the achievement of synergistic effects in crisis management. The absence of a unified strategy in Simanjiro causes undesirable duplication of tasks in certain sectors, whilst other vulnerable areas remain without the necessary coverage. This situation is exacerbated by the reactive nature of the system, which, under pressure from financial and technical constraints, prioritises immediate crisis response (mitigation) over long-term preparedness and recovery (Shah et al., 2023). Such an approach is in direct contradiction to the priorities of the Sendai Framework, which defines investment in preparedness as the most cost-effective tool for building resilience (UNDRR, 2020).

Another significant finding is the marginalisation of non-governmental organisations and informal traditional institutions, which, despite their high level of activity on the ground, remain excluded from the district's official decision-making processes. This 'inclusivity deficit' is not unique to the African context, as confirmed by comparative studies from Zimbabwe and Uganda (Mubaya, Mafongoya, 2017). In Simanjiro District, this problem appears as untapped potential; whilst state authorities struggle with a lack of resources, the capacity and expertise of non-state actors are utilised only on a voluntary basis without formal integration. Effective transformation of EDRM in the district, therefore, requires a shift towards a participatory governance model that integrates informal structures into the official hierarchy (Scottish Water, 2020). Only formal recognition and a clear distribution of tasks among all stakeholders can, in conditions of limited resources, ensure the stability of the district and protect its key economic sectors, including tourism.

Conclusion

Although Tanzania has a strong institutional framework for EDRM, its implementation at the local level remains below par. Its effectiveness at the district level is limited by weak integration and coordination among stakeholders and insufficient technical and financial resources. Furthermore, both formal and informal institutions tend to be reactive, prioritising response and mitigation over preparedness and recovery, which are fundamental aspects of ensuring resilience to the risks of environmental disasters. Overall, this study concludes that effective EDRM in Tanzania depends not only on the existence of policies, legal instruments, and institutions, but also on their functional capacity, coordination, and ability to respond at the local level.

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Souhrn
Tato studie analyzuje systém řízení environmentálních rizik (EDRM) v tanzanském okrese Simanjiro a jeho vliv na stabilitu cestovního ruchu. Region čelí extrémním suchům a povodním, které devastují biodiverzitu a masajskou kulturu – klíčové pilíře místního turismu. Výsledky ukazují, že i přes existující legislativu je systém EDRM neefektivní kvůli fragmentaci, slabé koordinaci a reaktivnímu přístupu, který upřednostňuje řešení následků před prevencí. Nedostatečná ochrana migračních tras zvěře a destabilizace masajských komunit vedou k erozi autenticity destinace. Studie doporučuje přechod k proaktivnímu, participativnímu modelu řízení a formální integraci místních komunit do rozhodovacích procesů.

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THE POTENTIAL FOR UTILIZING HISTORIC GREEN SPACES WITHIN THE RESIDENTIAL URBAN STRUCTURE

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Abstract
In the contemporary urbanized landscape, historic green spaces often represent the only continuous vegetation areas of significant scale within residential zones. With increasing urban density, historic parks and gardens in direct relation to housing are gaining importance as key nodes of public recreation and social interaction. This paper evaluates the functional integration of selected revitalized historic green spaces in Slovakia, focusing on the relationship between preserved historical values and current user demands.
The study is based on the concept of "value tolerance", understood as the balance between the preservation of historical composition and the accommodation of contemporary social and ecological needs. Through comparative spatial and functional analysis, the research examines the extent to which these spaces achieve a balance between landscape conservation and public recreation. By confronting original values with actual patterns of use, the study identifies key challenges in adapting cultural heritage to contemporary public space. The results highlight the potential of historic green spaces to function as high-quality components of urban green infrastructure, strengthening social resilience while preserving cultural identity.

Key words: historic park, residential zone, public space, functional integration, Slovakia

Introduction

Urbanization has intensified the importance of green spaces as key components of urban environments, influencing public health and environmental quality. As populations grow, the availability and structure of urban vegetation are shaped by processes driving both the loss and transformation of green infrastructure (Kondo et al., 2018; Chen et al., 2025). Urban green spaces provide essential ecosystem services, including climate regulation, air quality improvement, and biodiversity support, while contributing to the livability of residential areas (Vinczeová, Tóth, 2025; Bihuňová et al., 2021). They also support physical and mental health and social interaction, although their perception and use vary depending on spatial and socio-demographic factors (Veckalne, Saidkhodjaev, Tambovceva, 2025; Li, Dong, 2025). The role of natural elements in shaping emotional responses further highlights their importance (Yi et al., 2025).
Urban landscapes represent systems integrating natural, cultural, and social values that shape place identity and support diverse uses (Halajová et al., 2016; Kristianova, Štěpánková, 2012). Historically significant environments contribute to urban identity and strengthen residents' sense of belonging (Zhang et al., 2024), particularly in historically significant green spaces, which often represent the only continuous green areas of substantial scale within residential structures. Unlike contemporary parks, many historic sites originally fulfilled economic, symbolic, or representational roles (Bowen, 2013; Tóth, 2021). Over time, they have undergone functional transformation to accommodate recreational use while preserving their historical values and unique natural structures, such as mature trees (Fröhlich et al., 2024; Ouyang et al., 2024).
Historic parks and gardens link spatial and vegetative features with social practices and collective memory. Their significance has enabled their preservation as components of green infrastructure, yet their integration into planning remains challenging due to complex and often conflicting heritage values (Saratsi, White, Holyoak, 2016). This challenge is particularly evident in Slovakia and Central Europe, where historic parks and manor landscapes form a characteristic component of settlement structures. In regions such as Nitra, these spaces are frequently under-maintained or insufficiently integrated into contemporary environments (Kubišta, Supuka, 2005). Landscape architecture reflects the interactions between aesthetic, ecological, and socio-economic processes that shape cultural landscapes (Supuka, Billiková, 2018).
Increasing pressure on these spaces highlights the tension between recreation and landscape protection, which recent approaches address through multifunctional planning strategies (Tóth et al., 2014). At the same time, broader urban transformations often lead to the commodification of heritage environments (Ercan, 2025). Despite growing research, the post-revitalization performance of historic

green spaces in residential contexts remains insufficiently explored, especially in Central and Eastern Europe. This paper evaluates the functional integration of selected revitalized historic green spaces in Slovakia, focusing on the relationship between historical composition and current user demands. Using the concept of value tolerance, it examines how these spaces balance landscape conservation with public recreation.

Material and methods

The research examines a sample of 30 historical parks and gardens in Slovakia, listed as National Cultural Monuments (NKP) or heritage-protected objects. The selection criterion was a completed comprehensive restoration within the last 20 years, reflecting contemporary approaches to integrating heritage into the urban fabric. The methodology employs qualitative functional classification to assess site adaptation within the urban context. Based on operational analysis, sites were classified into four categories by their dominant function (user-oriented function):

A. Cultural-representative – prioritizing heritage presentation, tourism, and official functions.

B. Intensive recreational – areas adapted for active and passive leisure with high infrastructure density.

C. Commercial-residential – historical greenery serving as a backdrop for private accommodation and gastronomic services.

D. Educational-social – sites integrated into educational, healthcare, or social service complexes.

Results

The analysis of 30 selected historical landscape architecture sites in Slovakia restored after 2006 (Tab. 1) demonstrates a diverse range of functional integration into contemporary urban fabrics . Their spatial distribution (Fig. 1) reflects a nationwide trend toward heritage revitalization, where value tolerance—the capacity of a site to accommodate new uses without degrading its historical essence—emerges as a decisive factor for successful restoration.

The primary findings, based on the dominant user-oriented functions, are as follows:

- Intensive recreational function (43%, 13 objects): This represents the most frequent category within the sample. These areas, situated in direct proximity to residential zones, have been successfully transformed into key nodes of public life. The high prevalence suggests that the spatial tolerance of these sites is substantial, as they have effectively integrated modern infrastructure—such as playgrounds and urban furniture—while preserving their fundamental historical character.
- Cultural-representative function (37%, 11 objects): Comprising 11 sites, this category focuses on the presentation of monumental heritage values and tourism. In these locations, functional tolerance is lower; the priority remains the preservation of authenticity, which naturally limits the scope of invasive activities in favor of passive recreation and official functions.
- Commercial-residential function (13%, 4 objects): Represented by 4 sites, this model manifests value tolerance through a strategic balance between private economic interests and the preservation of the historic *genius loci*. In these cases, the historical greenery provides a high-quality functional and aesthetic backdrop for private hospitality services.
- Educational-social function (7%, 2 objects): The smallest group (2 sites) demonstrates a specialized form of functional adaptation where the historical environment serves as a framework for educational, healthcare, or social service processes.

The research confirms that restoration processes since 2006 have shifted the focus of historic parks from purely symbolic or private representational roles toward multifunctional public assets. A key observation is that the degree of value tolerance is not static; it increases in correlation with the proximity to residential urban structures. The identified models indicate that historical sites are no longer isolated monuments with heritage value, but active social spaces and resilient components of contemporary urban green infrastructure.

No.	Object	Location	District	Origin	Current Prevailing Style	Current Area (ha)	Original Use	Current Use
1	**Park Hotel Tartuf**	Beladice	Zlaté Moravce	Late 19th cent.	Engl. Land. (Neoclassic.)	5.2	Residential (nobility)	Hotel, gastro, gallery, park
2	**Bratislava Castle Garden**	Bratislava	Bratislava	18th cent. (rest. c. 1740)	Baroque (geometr.)	3	Representational	Public park (represent.)
3	**Medical Garden**	Bratislava	Bratislava	Late 18th cent. (1770)	Baroque (reconstr.)	0.8	Representational	Public park
4	**Janko Kráľ Orchard**	Bratislava	Bratislava	1774–1776 (oldest public park)	Engl. Land. (classicist)	3.5	Residential (summer)	Public municipal park
5	**Grassalkovich Garden**	Bratislava	Bratislava	18th cent. (c. 1760)	Engl. Land. (classicist)	42	Public orchard (floodplain)	Public park
6	**Budatín Park**	Budatín	Žilina	18th cent. (Baroque), 19th cent. (Landscape)	English Landscape	4.7	Residential (fortif.)	Public park with restricted access
7	**Park at Dolná Krupá Manor House**	Dolná Krupá	Trnava	Late 18th/early 19th cent. (1793–1820)	English Landscape	17	Residential / Cultural	Museum, tourism
8	**Park at Dolná Strehová Manor**	Dolná Strehová	Veľký Krtíš	1st half of 19th cent.	English Landscape	4.5	Residential	Park, Museum, memorial site
9	**Dudince Spa Park**	Dudince	Krupina	20th cent. (spa development)	English Landscape	15	Spa-related	Park, Spa recreation
10	**Park at Gbeľany Manor House**	Gbeľany	Žilina	1st half of 19th cent.	English Landscape	4.2	Residential	Public park, Hotel, gastro
11	**Park at Hanušovce Manor House**	Hanušovce	Vranov nad Topľou	18th cent. (Baroque-Landscape)	Baroque, Engl. Land.	3	Residential	Park, Museum, education
12	**Hlohovec Castle Park**	Hlohovec	Hlohovec	Late 18th/early 19th cent. (1790–1800)	Engl. Land. (Empire)	16	Residential	Public park, Culture, observatory
13	**Park at Humenné Manor House**	Humenné	Humenné	18th–19th cent.	English Landscape	7.5	Residential	Park, Museum, skansen, leisure
14	**Košice Municipal Park**	Košice	Košice	1860s	English Landscape	10	Public municipal orchard	Park, Recreation, sport
15	**Lednické Rovne Park**	Lednické Rovne	Púchov	Late 18th cent. (1799)	English Landscape	18.5	Residential / Botanical	Public park, Educational, recreation
16	**Malinovo Park**	Malinovo	Senec	1st half of 19th cent.	English Landscape	12	Residential	Public park (in process), Education
17	**Park at the Manor House**	Moravany nad Váhom	Piešťany	19th cent.	English Landscape	5	Residential	Park, Artist residence, gallery
18	**Predná Hora Area**	Muráň	Revúca	Early 20th cent. (c. 1912)	Engl. Land. (eclect.)	9	Hunting / Residential	Sanatorium area, Healthcare
19	**Sihot Park**	Nitra	Nitra	1st half of 19th cent. (1831)	Engl. Land. (municipal)	20	Economic / Public	Public municipal park
20	**Park at Nová Ves n. Ž. Manor House**	Nová Ves nad Žitavou	Nitra	19th cent.	English Landscape	5	Residential	Social services
21	**Park at Oponice Manor House**	Oponice	Topoľčany	1st half of 19th cent. (c. 1844)	Landscape (English)	8.5	Residential	Publicly accessible park, Hotel, gastro
22	**Piešťany Municipal Park**	Piešťany	Piešťany	1820–1830 (est. by Jozef Erdődy)	Landscape (spa-related)	22	Spa-related	Spa park, Culture, wellness
23	**Historic Park at Snina Manor House**	Snina	Snina	Late 18th cent. (1781)	Landscape (classicist)	4	Residential	Public park, Municipal gallery
24	**Park in Strážky**	Spišská Belá	Kežmarok	19th cent. (English park)	English Landscape	6.5	Residential	Park, Gallery, tourism
25	**Park at Stupava Manor House**	Stupava	Malacky	18th cent. (Baroque), 19th cent. (rest.)	Landscape (Baroque)	20	Residential	Public park, Social services, markets
26	**Trebišov Municipal Park**	Trebišov	Trebišov	Late 18th cent. (1790 and later)	English Landscape	62	Residential / Represent.	Public park, Museum, sport
27	**Rose Park**	Trnava	Trnava	20th cent. (interwar)	Combined	1.5	Public space	Public park, representation
28	**Park at Voderady Manor House**	Voderady	Trnava	Late 18th cent. (orig. Baroque)	English Landscape	14	Residential	Park (restricted access), Hotel
29	**Želiezovce Park**	Želiezovce	Levice	Late 18th cent. (1783 – Esterházy)	English Landscape	12	Residential	Culture, municipal park
30	**SNP Orchard**	Žilina	Žilina	Late 19th cent. (c. 1891)	Engl. Land. (Secess./Ecl.)	1.8	Public space	Park, Transit, short-term leisure

Tab. 1: Overview of analysed objects of historical landscape architecture in Slovakia restored after 2006

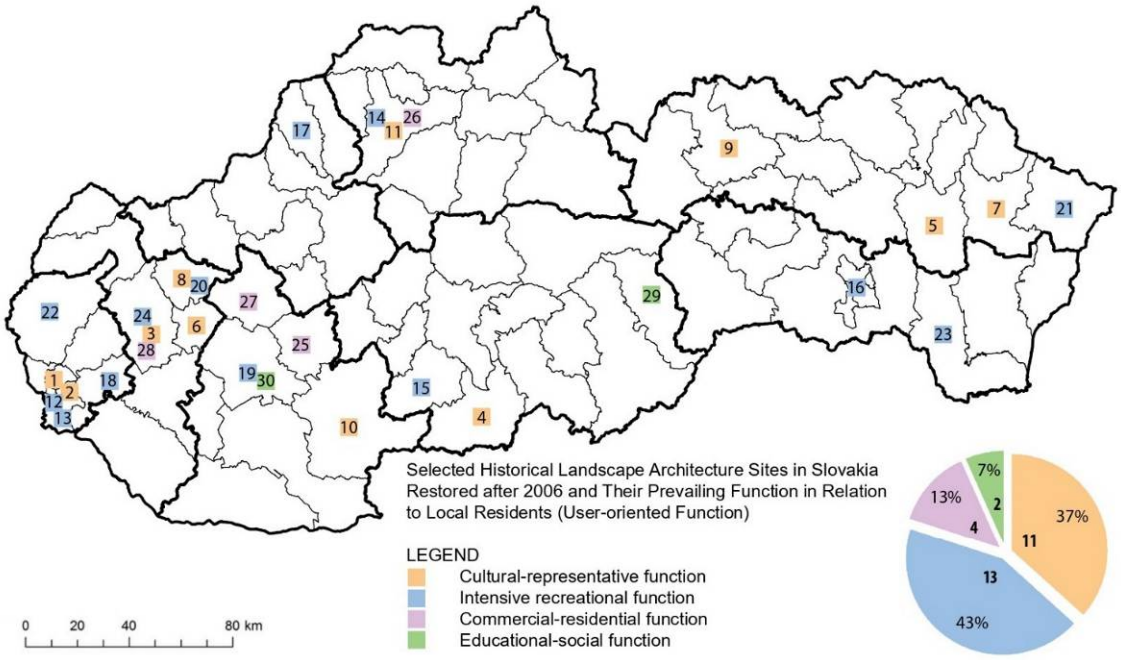

Fig. 1: Spatial distribution of historical green space sites in Slovakia with their prevailing functions and corresponding chart (Author, B. Poljak Lamrichová, 2026)

Discussion

Research findings confirm that historical landscape architecture sites are integral to urban structures, with their post-2006 functional transformation reflecting contemporary user needs. The dominance of intensive recreational functions suggests these spaces are vital public hubs capable of meeting the demand for high-quality outdoor environments within urbanized landscapes. A significant point of discussion is the large number of unaddressed historical sites in Slovakia, many of which lack formal heritage protection. This "grey zone" holds substantial potential for urban development; the absence of strict protection may paradoxically allow for more innovative uses, including commercial-residential models or specialized social support systems.

However, the objective should remain the perception of historical values as added value that enhances location attractiveness for both residents and investors. The core theme remains value tolerance—determining where functional adaptation ends and the degradation of historical essence begins. Historical values, including compositional axes and biotic elements, should be viewed as a framework for new functions rather than a hindrance to development. Supporting these sites through public and private resources is essential for preserving cultural identity and providing ecosystem and social services. Effective management of historical greenery requires a sensitive balance: utilizing these assets for public benefit while strictly respecting their historical integrity.

Conclusion

Historical landscape architecture sites represent an irreplaceable goldmine of potential for enhancing the quality of life within contemporary urban fabrics. The analysis of 30 selected sites restored after 2006 clearly demonstrates that thoughtful functional integration provides profound added value, transforming historical greenery into a fundamental pillar of urban resilience. The 43% dominance of recreational functions confirms that even heritage-protected areas can successfully absorb high urban pressures when value tolerance is strategically established. This approach ensures that monuments do not remain static relics of the past but instead become vibrant, living components of the modern city.

Simultaneously, it is necessary to advocate for the intensified restoration of additional historical parks and gardens in Slovakia that currently remain in poor condition. Their untapped social and ecological potential should not be viewed as a burden, but as a strategic opportunity for settlement development. The successful adaptation of the studied sites serves as a powerful argument for prioritizing historical greenery in urban planning as fundamental components of green infrastructure. These sites are apable of providing a wide range of ecosystem services—from microclimate regulation to supporting social cohesion and the mental well-being of residents.

Ultimately, working with cultural heritage demands a visionary equilibrium between preserving historical values and meeting contemporary social demands. Properly managed and professionally executed restoration is not merely an act of respecting history; it is, above all, a bold investment in a resilient and attractive future. This research confirms that when restoration is approached with methodological precision, cultural heritage and modern urban life can exist in a productive symbiosis. This mutual link not only enhances the quality of the living environment but also preserves the unique cultural narrative of our country for future generations.

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Souhrn
Článek analyzuje funkční integraci historické zeleně do soudobých obytných struktur měst na příkladu 30 revitalizovaných lokalit na Slovensku. Výzkum prokazuje, že tyto plochy nejsou pouze památkovými relikty, ale klíčovými pilíři sociální interakce a kulturní identity, přičemž dominantní (43 %) je jejich intenzivní rekreační využití. Hlavním přínosem práce je aplikace konceptu „value tolerance“ (tolerance hodnot), který definuje míru přípustné funkční adaptace bez degradace historické podstaty díla. Výsledky naznačují, že správně manažovaná obnova zvyšuje odolnost městského prostředí a kvalitu života obyvatel. Práce zároveň apeluje na systémovou revitalizaci doposud opomíjených areálů, které představují strategickou investici do udržitelného rozvoje sídel a zachování kontinuity kulturní krajiny.

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THE ROLE OF CONIFEROUS PLANTS IN ENHANCING ADAPTABILITY, AESTHETIC AND RECREATION VALUES OF URBAN LANDSCAPES

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Abstract
Urban environments present unique climatic challenges, necessitating the use of coniferous plants to optimize the recreational bioclimate in large parks and public spaces. This study examines the adaptive capacities, year-round aesthetic value, and structural utility of gymnosperms within Poland's urban landscapes. By integrating extensive field inventories (2008-2025) with detailed evaluations of tree stand parameters, the research analyzes how species composition and canopy closure influence the phytoclimate of urban stand interiors. The findings indicate that strategically managed coniferous plantings can create luminous, loose stands that provide high recreational comfort, optimal lighting, and effective air ventilation. Additionally, such spatial structures support denser, more resilient undergrowth with increased tolerance to intensive recreational use and trampling. However, the vitality and aesthetic quality of urban gymnosperms are continually threatened by severe environmental stressors, including soil compaction, increasing salinization, and prolonged drought. To balance environmental landscape protection with intensive public use, provenance-aware species selection and the development of diverse, multi-layered stands are strongly recommended. These integrated strategies are essential for establishing self-regulating, sustainable green systems that enhance both long-term ecological resilience and daily leisure utility in modern cities.

Key words: canopy closure, environmental stress, gymnosperms, leisure spaces, plant provenance

Introduction

Gymnosperms represent a significant taxonomic group within the Polish flora, contributing substantially to both historic and contemporary landscape architecture. The ongoing process of urbanization introduces challenges such as air pollution, soil degradation, and increased frequency of extreme weather events. In this context, a thorough analysis of the botanical characteristics, aesthetic value, and structural applications of coniferous trees and shrubs in urban greenery is essential for the effective design of parks, gardens, and other green infrastructure [Konijnendijk et al., 2005].

Long-term assessments of park stands and street trees demonstrate that gymnosperm trees and shrubs provide unique year-round aesthetic value and play essential roles in shaping the urban recreational bioclimate [Nowak & Dwyer, 2007; Łukaszkiewicz, 2019]. However, increasing human impact and climate change complicate their suitability for heavily used public spaces. While these species are valued for morphological and physiological traits that, in theory, confer stress tolerance, traditional monocultures of gymnosperms exhibit significant adaptive limitations under rapidly changing climatic conditions. This raises concerns regarding their resilience and safety in public leisure areas [Allen et al., 2009; Dyderski et al., 2017]. In alignment with the conference theme of balancing landscape protection and public recreation, this paper critically evaluates the adaptive capacity, structural utility, and aesthetic values of gymnosperms under urban environmental stress, with emphasis on their role in optimizing public recreational spaces.

Material and methods

This study combines a systematic literature review with extensive field inventories to critically examine the botanical traits of gymnosperms and their current applications in urban greenery. Initially, a synthesis of information on the adaptive capacities of selected species and their utility in urban revitalization was compiled using international and national databases (Web of Science, Scopus). A meta-analysis of empirical studies on species resistance to drought, pollution, and salinity was conducted to identify knowledge gaps and select taxa for field investigation.

Field investigations were conducted between 2008 and 2025 across urban parks, gardens, avenues, and small leisure green spaces in Poland [Łukaszkiewicz, 2019; Fortuna-Antoszkiewicz, 2019]. Dendrometric measurements included tree height, trunk circumference at 1.3 m (DBH), and crown dimensions. Recreational utility was assessed by evaluating canopy closure, light permeability to the forest floor, and the resilience of undergrowth to recreational movement and trampling. Health and vitality assessments adhered to standardized protocols, including defoliation, dieback, and bark

damage. The habitat dataset included soil characteristics and anthropogenic indicators such as surface type, mechanical compaction, and available root substrate volume [Łukaszkiewicz et al., 2022].

Results

Shaping the Recreational Bioclimate and Stand Structure. Coniferous trees occupy a dominant position in Polish plant communities and possess distinct morphological traits that influence their role in the cultural landscape. In urban parks, the structure of coniferous tree stands directly affects the recreational bioclimate. Field analyses indicate that strategically managed species, such as *Pinus sylvestris* and *Larix decidua*, can be used to create luminous, loose stands. These spatial arrangements permit adequate sunlight penetration and air ventilation, thereby optimizing thermal comfort for park visitors. Additionally, lower canopy closure encourages the development of a denser, multi-layered undergrowth. Observations confirm that this herbaceous layer demonstrates significantly greater tolerance to mechanical damage, including intensive recreational trampling, compared to undergrowth in dense, unmanaged coniferous thickets.

Adaptive Traits and Vulnerability to Urban Stressors. Although gymnosperms possess anatomical and physiological adaptations to manage water stress, such as thick cuticles and small needle surfaces, their performance in urban environments is limited. Field inventories reveal that intensive urbanization adversely affects conifer health, frequently resulting in dieback and diminished aesthetic value [Gillner et al., 2014]. Major challenges to their maintenance in public spaces include mechanical soil compaction [Tracy et al., 2011], restricted rooting volumes (for example, tree pits within paved surfaces and root damage from earthworks) [Łukaszkiewicz et al., 2022], and chemical pollution, particularly salinization from de-icing agents.

Prolonged droughts in recent decades have led to increased mortality among native species such as *Picea abies*, which have been traditionally used in urban plantings [Allen et al., 2009; Dyderski et al., 2017]. While species such as *Pinus nigra* and introduced taxa like *Pseudotsuga menziesii* exhibit greater localized adaptation potential, their resistance is variable. The decline of these trees directly diminishes the visual quality of leisure spaces and compromises public safety through structural weakening, the accumulation of deadwood, and an increased risk of windthrow.

Discussion

The findings reveal a significant discrepancy between gymnosperms' theoretical drought tolerance and their actual survival in highly compacted, polluted urban soils. It is an oversimplification to claim that the anatomical traits of coniferous plants guarantee universal resistance in urban environments. Traits that promote stable growth in natural forest ecosystems may, in fact, increase vulnerability for trees planted along transportation corridors or in heavily trampled recreational areas [Gillner et al., 2014].

From a recreational standpoint, the inclusion of conifers in public spaces is highly advantageous. These species provide year-round greenery, enhance psychological well-being, reduce noise, and filter particulate matter (PM2.5, PM10) through their evergreen needles [Nowak & Dwyer, 2007; Wolf, 2017]. However, the effectiveness of these ecosystem services is strongly influenced by crown morphology and spatial arrangement. Dense, unthinned monocultures do not provide adequate shading or ventilation and restrict spatial readability, thereby limiting safe recreational access. In contrast, incorporating conifers into mixed-species plantings increases ecosystem resilience and stability, supports a wider range of ecological niches, and reduces the risk of large-scale dieback.

To effectively balance landscape protection with public use, urban planting design should avoid homogeneous conifer groupings. The adaptive capacity of conifers is significantly affected by their genetic provenance. Consequently, it is essential to prioritize planting stock from controlled, stress-tested sources and to match the vigor of specific taxa to the available rooting volume to ensure long-term biomechanical stability and recreational safety [Łukaszkiewicz et al., 2022].

Conclusion

The incorporation of gymnosperms in urban greenery remains highly relevant, especially for enhancing the aesthetic and climatic quality of public leisure spaces. However, successful integration necessitates a shift from perceiving these species solely as ornamental elements to recognizing their functional role within the urban bioclimate. To maximize ecological benefits and recreational utility, the following recommendations are proposed:

- integrate conifers into diverse, multi-layered mixed planting schemes rather than monocultures;
- form loose, luminous stands that support air ventilation and the growth of trampling-resistant undergrowth;

- select resilient taxa based on genetic provenance and documented tolerance to urban stressors (compaction, salinity, drought);
- provide adequate volumes of rooting soil and implement long-term monitoring of structural stability to ensure the safety of park users.

Implementing these strategies will foster self-regulating, sustainable green systems that effectively balance landscape protection with daily public recreation.

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Souhrn

Tento článek analyzuje úlohu jehličnatých rostlin při vytváření optimálního rekreačního bioklimatu v městských parcích, přičemž usiluje o rovnováhu mezi ochranou krajiny a intenzivním veřejným využíváním. Ačkoli strategicky spravované, řídké porosty jehličnanů poskytují vynikající tepelný komfort a podporují růst podrostu odolného proti pošlapání, jejich životaschopnost je vážně ohrožena městskými stresovými faktory, jako je zhutnění půdy, zasolení a sucho. Aby byla zajištěna dlouhodobá ekologická odolnost a bezpečnost pro rekreaci, studie důrazně doporučuje rozmanité, vícevrstvé smíšené výsadby a pečlivý výběr druhů na základě genetického původu.

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THE ROLE OF DESIGN AND QUALITY CONTENT IN THE LANDSCAPE- ARCHITECTURAL PROPOSAL OF AN EDUCATIONAL TRAIL

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Abstract
Horseback riding tourism is still a relatively unknown phenomenon in Slovakia. The Paper brings overview of the issue of hippotherapy in Slovakia. It also presents landscape-architectural proposal of the horse trail in Nitra region, with the aim to arouse interest in this type of recreation and highlight the harmony between humans, animals, and the nature. The proposed route, with a total length of 63.5 km, connects eight villages and four key ranches, and is logistically designed to allow for shorter, thematically coherent stages. Given its length and the attractiveness of the environment, it is not intended exclusively for riders, but functions as a multifunctional corridor that offers a full experience for hikers as well.

Key words: leisure time, recreational and educational activities, horse trail, Nitra region

Introduction

Rural tourism encompasses a broad range of activities carried out in natural and rural settings. Unlike mass tourism, it focuses on tranquility, authenticity, and direct contact with local residents. According to Gúčik (2012), the fundamental characteristic of rural tourism is its integration into the rural environment, with the range of services closely tied to local traditions and the landscape. Equestrian tourism is a modern form for different categories of tourists, who are searching for entertainment or recreational adventure or activities, or therapeutic tourism in the open landscape (Petroman, 2015). Equestrian tourism is a growing sector that uses horses as the main attraction for visits to the countryside. It can be divided into three basic categories: 1. Recreational riding: Outings in nature (leisure trails). 2. Competitive equestrian tourism: Participation in horse races or training courses. 3. Hippotherapy: A therapeutic method using the movement of a horse for rehabilitation (Krajňák, 2022). These forms of tourism generate what is known as a multiplier effect. They boost employment in rural areas, support local artisans, and encourage environmental protection.
Designing of the educational trails represents a valuable means of environmental education, sustainable tourism, and public engagement with natural and cultural heritage (Juško et al., 2025). Design stratégy should leads to fostering the relationship between humans and their environment, to support the Genius loci of the locality, to create the connection between „users“ and „landscape“ (Tóth et al., 2018).

Material and methods

The study area represents a characteristic section of the Ponitrie cultural landscape, where the flat terrain of the Danubian Hills meets the first foothills of the Tribeč Mountains. The landscape structure is defined by the striking dynamics of the relief and the alternation of various forms of land use, creating a visually attractive and spatially diverse environment for equestrian tourism.
The route begins in the flat agricultural landscape around Malý Lapáš. It gradually transitions into gently rolling hills, dominated by slopes with vineyards. This rhythm of alternating open fields and cultivated vineyards gives the route a dynamic feel. In the final section, the route climbs into the Tribeč mountain range. Although the terrain is uphill, the slope is long and gentle, which is ideal for recreational cycling as well as for hikers seeking a moderate physical challenge.
The route follows existing infrastructure consisting of a diverse network of roads:
• Built-up areas in the villages: Paved asphalt surfaces ensure smooth passage through villages and access to ranches.
• Agricultural landscape: Unpaved roads with natural soil surfaces.
• Forest areas: Narrower forest trails with soft ground, which are gentle on horses' musculoskeletal systems and provide shade and protection from the wind.
This mix of surfaces and environments makes the route multifunctional and ensures that, even at its length of 63.5 km, it remains constantly stimulating for visitors.

Results

The proposed equestrian trail is designed as a comprehensive system that combines recreational activities with education and artistic interpretations of the landscape. The trail is designed as an educational path that guides visitors through the world of horses. Along the trail, there are 8 thematic panels covering a wide range of specialized and cultural topics:

1. The Horse as a Therapeutic Partner: An Introduction to Hippotherapy.
2. Shepherding Traditions and Working with Horses: The Region's Cultural Heritage.
3. Landscape, Meadows, and Pastures: The Importance of Preserving the Landscape's Character.
4. Horse Breeds and Their Characteristics: Diversity and Genetic Potential.
5. Communicating with Horses: Basics of Safety and Understanding.
6. The Roots of Horsemanship Around the World: The Historical Development of the Relationship Between Humans and Horses.
7. Equestrian Disciplines: From Sport to Recreation.
8. Common Myths About Horses: Educational Outreach for the General Public.

For the comfort of both cyclists and hikers, unique mobiliar has been designed:
Rest areas: Benches and trash bins with a design that blends in with the rural environment. Specific features: Horse tethers located near information boards and rest areas, allowing riders to stop safely. Orientation: Map boards at key intersections facilitate navigation and divide the route into smaller sections.

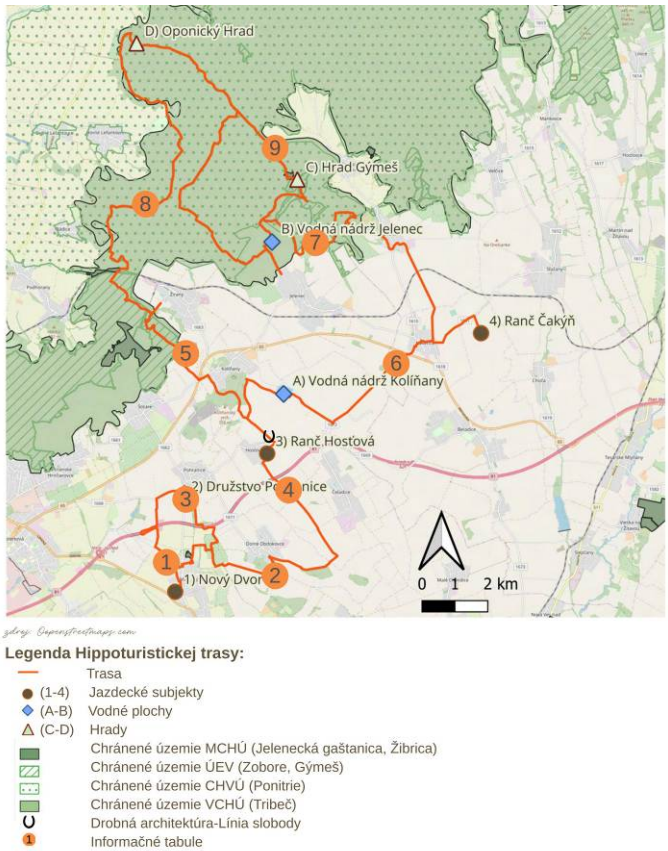

Fig. 1: Landscape-architectural proposal of the trail with the placement of the educational boards (numbers refer to the thematic stops)

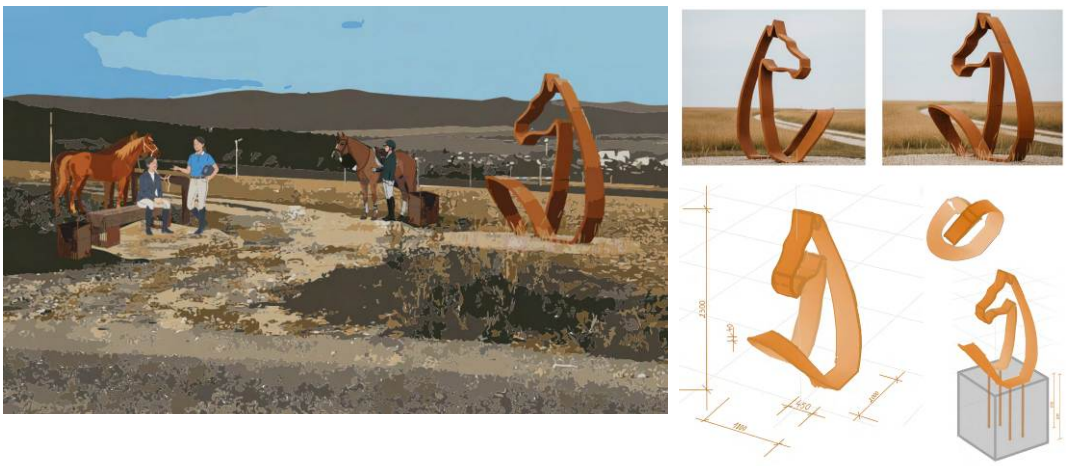

Fig. 2 and 3: Visualisation of the place of relax and sketch of the art element

The project's sustainability is based on close cooperation with local entities. The proposed model involves dividing the trail into sections managed by individual ranches (Čakýň, Nový Dvor, Hosťová).
Monitoring: As natural hubs of activity in the area, the ranches regularly monitor the condition of "their" section of the trail, ensuring it is clean and passable.
Logistical support: Cooperation with the Pohranice Cooperative provides technical support, trail surface maintenance, and agricultural resources for forage.
Inclusion: The ranches also serve as a first point of contact for families with children, where initial education and a safe introduction to horses take place.

Discussion and Conclusion

Horseback tourism remains a relatively unknown phenomenon in Slovakia. The main goal of the project is therefore not only to mark a trail through the countryside, but above all to spark interest in this type of recreation and highlight the harmony between humans, animals, and nature. The proposed route, with a total length of 63.5 km, connects eight municipalities and four key ranches, and is logistically designed to allow for shorter, thematically cohesive stages. Given its length and the attractiveness of the surroundings, it is not intended exclusively for riders, but functions as a multifunctional corridor that offers a full-fledged experience for hikers as well.
Petroman (2015) proposes, with the aim of reducing the negative impact on horse back riding on tourism paths or roads the need to develop a management strategies for both path size preservation and tourists. Hrůza et al (2025) studied regulation of horse riders' movement, whose activities may interfere with the idea of leisure by other forest visitors and with forest operations. On the other hand Godosi, Picuno (2024) pointed on the current growing interest in rediscovering places of cultural and natural interest and the possibility of a recovery of the old rural routes, linked to local cultural traditions. Also consider them as essential to raise awareness of landscape resources poorly perceived (Tóth et al., 2018).
The Ponitrie Agritourism Route is not merely a transportation link connecting eight villages, but a new vision for experiencing the Slovak countryside. The project demonstrates that modern agritourism can successfully build upon the foundations of historical heritage—from the medieval castles of Gýmeš and Oponice to the royal traditions of Hosťová.
The main benefit of the proposal is the transformation of a fragmented landscape into a coherent, functional whole that respects nature while offering people a space for peace, harmony, and freedom. The creation of a safe and educational infrastructure opens the region not only to professional riders but also to families with children and people with special needs.
The design philosophy rests on three pillars: peace, harmony, and freedom. The route strategically leads to historical landmarks (Gýmeš and Oponice Castles) and natural spots (water reservoirs), while an important social aspect of the project is raising awareness about hippotherapy. The goal is not to create a closed therapeutic facility, but a "healing landscape," where visitors naturally learn about the positive impact of horses on human physical and mental health. The project thus offers a new vision for the use of the Ponitrie rural landscape, combining tradition, sports, and modern agritourism.

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Souhrn
Turistika na koních je na Slovensku stále relativně neznámým jevem. Hlavním cílem projektu proto není pouze vyznačit trasu vedoucí krajinou, ale především vzbudit zájem o tento druh rekreace a zdůraznit harmonii mezi člověkem, zvířaty a přírodou. Navrhovaná trasa o celkové délce 63,5 km spojuje osm obcí a čtyři klíčové ranče a je logisticky navržena tak, aby umožňovala kratší, tematicky ucelené etapy. Vzhledem k její délce a atraktivitě okolí není určena výhradně pro jezdce, ale funguje jako multifunkční koridor, který nabízí plnohodnotný zážitek i pro pěší turisty.
Filozofie návrhu spočívá na třech pilířích: klidu, harmonii a svobodě. Trasa strategicky vede k historickým památkám (zámky Gýmeš a Oponice) a přírodním lokalitám (vodní nádrže), přičemž důležitým společenským aspektem projektu je zvyšování povědomí o hipoterapii. Cílem není vytvořit uzavřené terapeutické zařízení, ale „léčivou krajinu“, kde se návštěvníci přirozeně dozvídají o pozitivním vlivu koní na fyzické a duševní zdraví člověka. Projekt tak nabízí novou vizi využití venkovské krajiny Ponitrie, která kombinuje tradici, sport a moderní agroturistiku.

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TREES IN PUBLIC AND RECREATIONAL SPACES AS A RISK FACTOR UNDER WEATHER ANOMALIES

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Abstract
Trees constitute a key component of urban landscapes and green infrastructure, providing numerous ecosystem services and enhancing the attractiveness of public recreational spaces. At the same time, their presence in intensively used areas—such as parks, promenades, squares, and pedestrian routes—requires careful consideration of public safety. In the context of climate change and the increasing frequency of weather anomalies, particularly severe windstorms, the issue of managing tree-related risk has become increasingly important.
The aim of this paper is to present the scale of hazards associated with trees in public spaces in Poland compared with England, in the context of balancing recreational use and landscape protection. The study compiles statistics on accidents and damages caused by trees during strong wind events in the years 2000–2022. Based on these data, a regional risk coefficient related to windthrows and uprooted trees was developed.
The results indicate that both the number and the consequences of tree-related incidents in Poland remain comparable to those observed in England and can be considered relatively low. The findings confirm that rational tree management, based on assessment of tree condition and potential risk, allows the reconciliation of public safety requirements with the need to preserve trees as an important element of the landscape and recreational environments. The results may contribute to the development of sustainable strategies for managing urban trees, supporting both landscape protection and improved quality of life in cities.

Key words: urban trees, public recreational spaces, windthrows and uprooting, trees and windstorms, tree risk management, fallen trees

Introduction

Public awareness of the important role of trees in the natural environment and cultural landscape has existed for centuries, but it is particularly significant today in the era of progressing climate change (Rosłon-Szeryńska 2019). Numerous scientific studies confirm the wide range of environmental, social, health, cultural, aesthetic, and economic benefits provided by trees, often expressed in monetary terms, enabling their inclusion in urban development strategies. Consequently, in many countries trees are recognized as national assets and green capital of cities (Szczepanowska, Sitarski 2015). The concepts of “ecosystem services” (Solon et al. 2017) and “green infrastructure,” with trees as key elements, have been widely discussed (Szulczewska 2018) and constitute an important priority in spatial policies worldwide, including in Asian countries (Mizgajski, Stępniewska 2009). Trees also play a significant climate-regulating role in cities (Czerwieniec, Lewińska 2000). Research shows that the benefits of trees outweigh their potential drawbacks (Rosłon-Szeryńska 2019).
Nevertheless, in Poland, trees in human environments are often perceived as a safety threat, which contributes to increasing numbers of tree removal decisions (Krynicki, Witkoś 2016). Public perception is frequently influenced by misconceptions regarding risks associated with windthrow and uprooting (Rosłon-Szeryńska 2019). This is further linked to the financial liability of landowners for damages caused by trees in cases of negligence. According to the Nature Conservation Act (Dz. U. 2022, item 916, as amended), trees posing threats to safety or infrastructure may be removed without fees (Art. 86.1, points 4–5 u.o.p.). However, the lack of precise risk assessment criteria leads to misuse.
The subject of this study is windthrow and uprooting in urban areas, understood as risks resulting in damage to property, health, or human life (Rosłon-Szeryńska 2019). The main objective is to present tree-related risk in Poland and explore its management. The study addresses the following research questions: 1) When does a tree constitute a hazard, and when is it merely damaged property due to weather anomalies? 2) What is the level of risk associated with windthrow in Poland? 3) How can risk be assessed at national and regional scales? 4) How can this knowledge be applied in urban tree management?
The main hypothesis assumes that identification of hazards and quantification of tree-related risk are fundamental for effective tree management systems. As part of this study, statistics on tree-related

accidents and damage during windstorms between 2000 and 2022 were compiled, which were contextualized in the context of climate change, including the increasing frequency of windstorms between 1979 and 2018. A regional risk index for windfall and uprooting was developed, which can be used as a tool for tree management. Risk management guidelines were presented. The research results, in addition to their cognitive value, can be used to more effectively manage trees in urban areas and improve human living conditions in cities.

Research Method and Data Sources

Tree-related risk is analyzed based on windstorm frequency (Lorenc 2012; Chmielewski, Szer 2018) and the frequency and scale of damage caused by falling trees (Rosłon-Szeryńska 2019; National Tree Safety Group 2011; Taszarek, Brooks 2015).

Risk is defined as the possibility of loss or occurrence of a harmful event, characterized by a known probability distribution. Risk assessment includes probability and severity of consequences. Both qualitative (risk matrices, indicators) and quantitative methods (event trees, statistical and simulation methods) are used (Romanowska-Słomka, Słomka 2002).

The study applies the **Risk Score method**, where:

$R = S \times E \times P$

where:

- S – severity of consequences,
- E – exposure,
- P – probability.

Potential consequences (S) are determined by the arithmetic mean of the human and material losses assessed on a scale of 1 to 100 points. A minor loss (1 point) is considered to be the provision of first aid and a material loss of less than PLN 5,000. A very major loss (15 points) is associated with a fatality equivalent to material losses of PLN 5,000 to 5 million. A major disaster is considered (100 points) to be multiple fatalities or a loss estimated at over PLN 30 million.

The duration of exposure (E) of the impact of harmful factors on humans is measured on a scale of 0.5 to 10; the lowest value is obtained with negligible exposure (exposure once a year), and the highest value (10 points) with constant contact between the potential target and the source of the threat. Occasional exposure, with a frequency of once a week, is considered a major disaster.

As part of the study, the **P index** was estimated. The probability of a human hazard (P) is based on combinatorics and is measured on a scale of 0.1–10 points. The probability of an event occurring (0.0001%) to high (50%). The probability of a catastrophic event (A) is localized by the locations of fatalities and all names of residents |Ω|, an area calculated as follows:

$P(A)=|A|/|\Omega|$ (2)

where:

|A| - to the number of favorable events (emergency casualties |A|)

|Ω| - to the number of all accidental events (total number of residents |Ω|)

The risk value (R) is measured on a scale of 0.05–10,000. A risk value >400 indicates a very high risk and indicates the need to remove trees that pose a safety risk and take intervention measures to improve safety. A negligible risk is defined as a very low risk when R <20.

Our own research analyzed the frequency of windstorms and their effects, including those caused by windfalls and uplifts. Data from the Institute of Meteorology and Water Management (IMGW) and daily reports from the Government Center for Security were used. Information on accidents caused by falling trees was supplemented with details about the circumstances, location, and victims based on local press reports.

From IMWM reports, the frequency of winds during the growing season, i.e., during full leaf-out, in Poland from 1979 to 2018 was analyzed to assess climate change. Data on windstorms with wind speeds above 15 m/s (recognized by the Government Center for Security and Climate Change) from 23 years, from 2000 to 2022, was collected from press reports. The frequency of damage caused by windfalls and uplifts was assessed. The locations and regions of the country where such events most frequently occur were analyzed, and the results were compared with data from England (National Tree Safety Group 2011).

Based on data on the population of the country and individual voivodeships, and on the number of deaths from windfall and uprooting, a regional risk factor was estimated, which is an algorithm that determines the probability of an event occurring per million inhabitants.

Results

Tree as a Hazard vs. Property Loss

Strong winds are the primary source of hazard, while trees are often elements affected by wind forces. According to Lorenc (2012), destruction of even healthy trees may occur at ≥29 m/s, while extensive damage appears above 33 m/s. Other classifications (Eiber, TORRO, Fujita) indicate that only very strong winds (>50 m/s) damage stable trees. Strong winds cause natural disasters, which are covered by the National Crisis Management Program. The Government Security Center (RCB) monitors events such as "strong winds," defining three levels of threat posed by strong winds: (I) first degree - V avg > 15 m/s and gusts > 20 m/s, which damage buildings and break branches and trees; (II) second degree, with V avg > 20 m/s and gusts > 25 m/s, which break and uproot trees; (III) third degree, with V avg > 25 m/s or gusts > 35 m/s, which causes significant damage to trees.

The above data indicates that wind speeds exceeding 15 m/s pose a "threat" as a potential threat to human health, life, or property or the environment. The source, and therefore the cause, of the threat in this case will be the wind. A damaged tree, building, or other structure constitutes damage and is considered property damage. A falling tree, as a source of danger (not a consequence), will apply to damage at lower wind speeds.

Insurance practice recognizes wind speeds above 17.5 m/s or 24.5 m/s as thresholds for random events (Maciążek 2005). At this speed, even healthy trees and their parts can break. Otherwise (at lower wind speeds), the tree's condition may have been neglected.

Risk in Poland

A report prepared by the Institute of Meteorology and Water Management indicates that the number of days with violent gales with wind speeds ≥ 25 m/s is estimated at approximately 40 per year in the southern part of Poland. Observations show that on average, about 15 cycles per year pass through Poland, during which wind gusts reach at least 11 m/s (Lorenc 2012). This means that the share of days with such winds is approximately 5% of the year. The highest winds can occur in December, January, and March – an average of two per month. Some regions in Poland are more frequently hit by gales from November to March than others. Foehn and foehn winds blow from October to February. During the summer (or from May onwards), the activity of tornadoes, defined as rotating columns of air in contact with the ground and clouds, increases (Lorenc 2012). Based on reports from the Institute of Meteorology and Water Management, the frequency of winds blowing during the growing season, i.e., during full leaf-out, in Poland from 1979 to 2018, was analyzed. These are most common tornadoes, with an average annual number of 4 between 1979 and 2000. A significant increase in the number of tornadoes was observed between 2003 and 2018. The number of tornadoes in the last quarter-century has almost doubled compared to the 1980s, which is associated with an increased risk of damage caused by windbreaks and upheavals (Fig. 1).

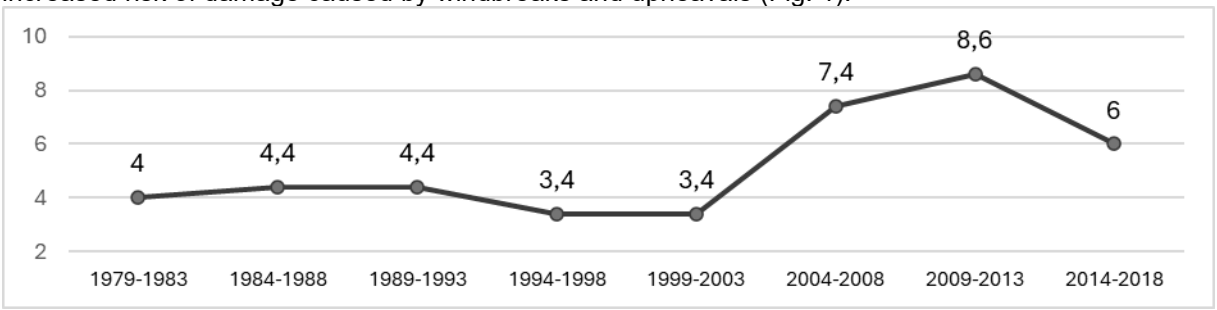

Fig. 1: Average annual number of tornadoes in five-year periods from 1979 to 2018 in Poland. Source: prepared based on RCB reports.

Analysis of data from 2000–2022 shows an average of 8.1 major windstorms per year. The average number of injuries over the 23-year period was 23. However, these data reflect injuries from all storm events, not just those involving trees. An increased number of injuries due to windfalls was observed in 2002, 2007, 2009, 2015, and 2017. The average annual number of fatalities from falling trees is 3.8. Other causes (e.g., falling roof tiles during storms) account for an average of two deaths per year. This means that every other storm ends in a fatal accident involving trees. Each storm results in more than three injuries, with nearly two-thirds of these fatalities involving trees (Fig. 2).

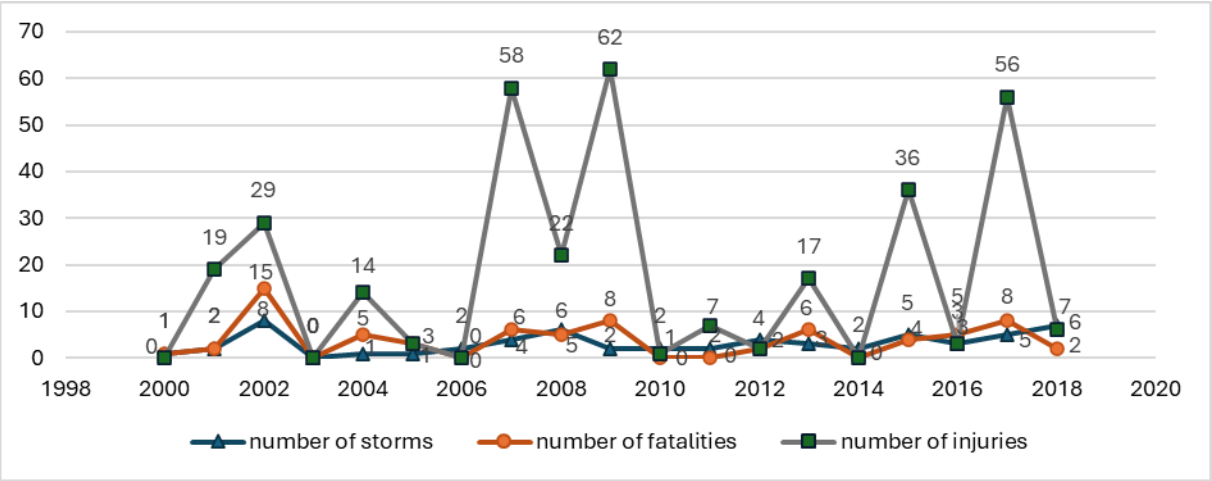

Fig. 2: Average annual number of storms and their consequences (fatalities and injuries caused by falling trees) in the period from 2000 to 2022 in Poland (Rosłon-Szeryńska 2023).

Although every second windstorm results in a fatal accident involving trees, the overall number of such incidents remains low compared to other risks. According to the statistical yearbook of the voivodeships, in 2020 the total number of fatal accidents at work amounted to 190 people, the number of fatalities in road accidents was 2491(e.g., road accidents; GUS 2021).

The locations where such incidents most frequently occur were analyzed and the results compared with data from England (National Tree Safety Group 2011). Vehicle-involved tree accidents most often occur on roads and car parks (Fig. 3). In Poland most incidents occur on roads and parking areas (51.3%), similarly to England (National Tree Safety Group 2011). Fatalities resulting from falling roadside trees on pedestrians in Poland account for 17.6% of incidents, compared to 10% in England. Compared to England, a lower percentage of accidents in Poland involve falling trees on motorcyclists and cyclists (4.2%), and slightly more accidents occur in forests and parks (7.6% each) and in unmanaged green areas (4.2%). Isolated incidents occur in single-family home gardens (2.5%) and in school gardens and playgrounds (0.8%).

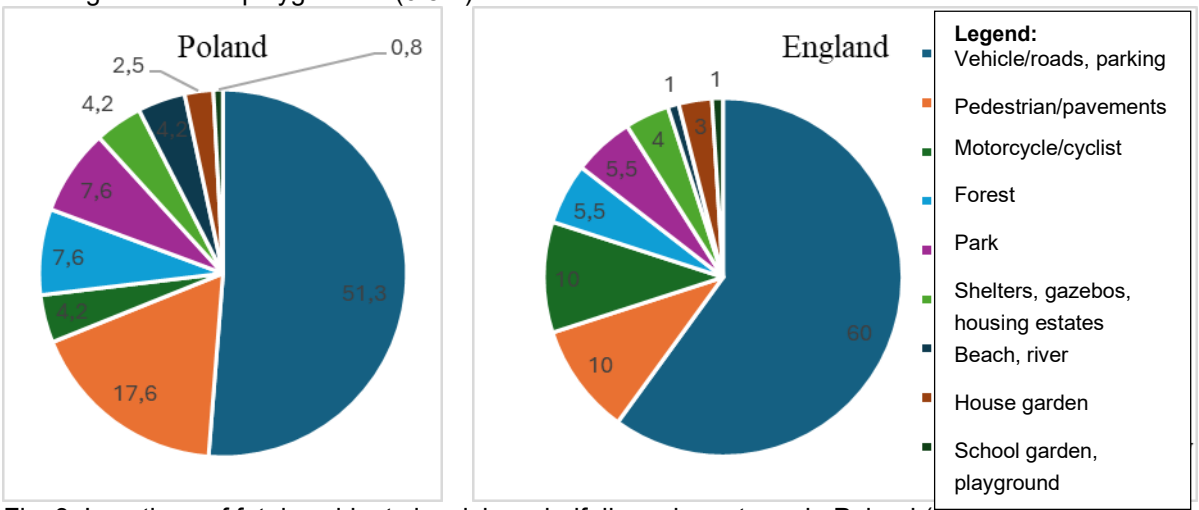

Fig. 3: Locations of fatal accidents involving windfalls and overturns in Poland (from 2000 to 2022) and England from 2000 to 2008 (data update, Rosłon-Szeryńska 2019).

National Risk Assessment

A windbreak and overturning risk index was calculated for the country based on data on windstorms and accidents from 2000-2022. The accident risk index (Risk Score) was used, defined as the product of three parameters (event consequences, hazard exposure, and probability of occurrence):

$R = 15 \times 2 \times 0.1 = 3$

The S (effect severity) value is 15, indicating very high damage associated with fatalities and property damage of PLN 500,000-5,000,000;

The E (hazard exposure) value is 2 for central Poland (windstorms once a month), 2.5 for the northern part (on average twice a month), and 3 for the southern part of the country (three times a week).

The P value (accident probability) is 0.1, indicating a theoretically possible event and a chance of less than 1 in 1,000,000 that a fatal accident will occur due to falling trees. The probability of a fatal accident due to a falling tree in Poland is 1 in 10,162,921.
A value of 3 indicates a negligible risk (widely accepted). In principle, there is no need for intervention. Monitoring is recommended. Similar accident statistics and the level of risk associated with the presence of trees in urban areas are observed in England, where the NTSG [National Tree Safety Group] presented the results of research on the effects of windfall and uprooting from 1999 to 2008. The overall risk to society from falling trees is very low, with the probability of a tree or part of a tree causing a fatal accident being approximately 1 in 10 million (NTSG, 2011).

Regional Risk Assessment

Windfall and uprooting accidents from 2010 to 2022 were analyzed in terms of their distribution across the country's voivodeships (Table 1).

Tab. 1: Effects of storms from 2010-2022. Number of fatalities and injuries from this period, along with an estimate of the probability of the event (P)

region/ area	Fatalities due to windfalls		Numer of inhabitants	Population density	Numer of inhabitatants in millions (N) per event	Average annual wind speed (m/s)	Regional risk factor (P=1/N)
	Total numer in years 2010-2022	Average annual number					
Dolnośląskie	6	0,462	1994670	145	4,32	5,5	0,231
Kujawsko-pomorskie	0	0,067	1797134	115	26,96	3	0,037
Lubelskie	1	0,077	2512246	83	32,66	3,5	0,031
Lubuskie	3	0,231	1398793	72	6,06	4	0,165
Łódzkie	1	0,077	1821895	134	23,68	3,5	0,042
Małopolskie	1	0,077	1518279	225	19,74	2,5	0,051
Mazowieckie	5	0,385	3555847	153	9,25	4	0,108
Opolskie	1	0,077	941187	104	12,24	3,75	0,082
Podkarpackie	2	0,154	1784576	119	11,60	3,75	0,086
Podlaskie	1	0,077	2018702	58	26,24	3	0,038
Pomorskie	13	1,000	1832368	128	1,83	4,5	0,546
Śląskie	2	0,154	1233309	364	8,02	3,75	0,125
Świętokrzyskie	1	0,077	1171050	105	15,22	2,75	0,066
Warmińsko-mazurskie	1	0,077	2417347	59	31,43	3,75	0,032
Wielkopolskie	2	0,154	2982650	117	19,39	3,5	0,052
Zachodniopomorskie	1	0,077	2290472	74	29,78	2,75	0,034
Polska	**40**	**3,077**	**31270525**	**122**	**10,16**	**-**	**0,098**

The collected data indicate that the area with the most frequent accidents caused by windfall and uprooting is the Pomeranian Voivodeship, where a total of 13 fatalities were recorded, or an average of one per year. This means that the risk of a fatal accident caused by trees is 1 in 1,832,368. This is still a broadly tolerable risk level, at a minimal (negligible) level, but it is more than five times higher than the national average. Increased numbers of fatal accidents also occurred in the Lower Silesian Voivodeship (6 in total, with an average of 0.46 per year), the Mazowieckie Voivodeship (5 in total, with an average of 0.38 per year), and the Lubusz Voivodeship (3 in total, with an average of 0.23 per year). Safe voivodeships, with low or zero fatalities resulting from windstorms during the study period, include the Kuyavian-Pomeranian Voivodeship (0), Lublin Voivodeship, Łódź Voivodeship, Lesser Poland Voivodeship, Podlaskie Voivodeship, and Opole Voivodeship (1). The lowest probability of a

fatal accident caused by windbreaks and upheavals occurs in the Lublin Voivodeship and the Warmian-Masurian Voivodeship. Here, the chance of an undesirable event is 1 in 32 million.

Risk Monitoring in Urban Tree Management

Safety management can be divided into several stages. The foundations include risk analysis, risk identification, which involves determining the type of risk, its characteristics, and duration, and quantification, which involves measuring its level. Decisions and actions taken to improve safety will be proportionate to the risk. Tree removal is a last resort, acceptable in the event of a catastrophic risk. In the case of minimal or very low risk, risk control, including ongoing tree monitoring, is crucial.

Data on the effects of storms and interventions related to damaged trees can be used at the local level to assess the situation of local government units or even specific buildings (e.g., a historic park). This is made possible by statistics maintained by fire departments. Based on this data, it is possible to determine the locations where accidents occur most frequently and where trees require more intensive inspections and maintenance due to the high rate of tree breakage in a given location.

For effective tree management, a good solution is to create a map of the municipal area containing so-called risk zones, i.e., zones with varying risk levels within the unit. In addition to knowledge about interventions related to damaged trees, the terrain classification developed by Rosłon-Szeryńska (2012) was used, based on the ISA (International Society of Arboriculture) classification used in tree diagnostics. Trees growing in high-risk zones, e.g. along main roads, at intersections or in heavily frequented city centre areas, are inspected more often than trees in low-risk zones (growing in home gardens or in sparsely frequented areas).

Conclusion

The benefits of trees should be balanced with associated risks. Identification and quantification of risk are essential for effective tree management. The study confirms that tree-related risk in Poland is low and socially acceptable (approx. 1 in 10 million).

However, risk cannot be eliminated entirely, as even healthy trees may fail under extreme conditions. Therefore, management should focus on monitoring and proportional actions rather than excessive removal.

The proposed guidelines for risk management at regional and local levels can improve urban tree management, enhance safety, and contribute to better living conditions. Future research should address economic losses related to tree damage and removal.

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Souhrn
Stromy představují klíčovou součást městské krajiny a zelené infrastruktury, poskytují řadu ekosystémových služeb a zvyšují atraktivitu veřejných rekreačních prostor. Současně však jejich přítomnost v intenzivně využívaných oblastech – jako jsou parky, promenády, náměstí a pěší trasy – vyžaduje pečlivé zvážení otázky veřejné bezpečnosti. V kontextu klimatických změn a rostoucí četnosti meteorologických anomálií, zejména silných vichřic, nabývá otázka řízení rizik spojených se stromy na významu.
Cílem tohoto článku je představit rozsah rizik spojených se stromy ve veřejných prostranstvích v Polsku ve srovnání s Anglií, a to v kontextu vyvážení rekreačního využití a ochrany krajiny. Studie shrnuje statistiky o nehodách a škodách způsobených stromy během silných větrných událostí v letech 2000–2022. Na základě těchto údajů byl vypracován regionální rizikový koeficient týkající se polomů a vyvrácených stromů.
Výsledky ukazují, že jak počet, tak následky incidentů souvisejících se stromy v Polsku zůstávají srovnatelné s těmi, které byly pozorovány v Anglii, a lze je považovat za relativně nízké. Zjištění potvrzují, že racionální správa stromů, založená na posouzení stavu stromů a potenciálního rizika, umožňuje sladit požadavky na veřejnou bezpečnost s potřebou zachovat stromy jako důležitý prvek krajiny a rekreačního prostředí.

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TRENDS IN SUPPORTING OUTDOOR PHYSICAL ACTIVITY IN PUBLIC SPACES BASED ON WARSAW PARTICIPATORY BUDGETING (WPB)

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Abstract

The growing importance of recreation, which enhances the health and well-being of city dwellers, is driving changes in public spaces: they are becoming more open to a wider range of outdoor physical activities, including those supported by social initiatives. To examine the extent to which this issue is important to the residents of Warsaw (Poland), projects implemented as part of the Warsaw Participatory Budget (WBP) between 2015 and 2024 were analysed in terms of their role in supporting outdoor physical activity in the following categories: recreational and bicycle paths, parks, squares and pocket green spaces, children's playgrounds, sports facility, rest equipment, physical exercises and training courses. The results show that across the 10 WBP editions studied, 496 projects related to outdoor physical activity were carried out. They gained in importance in the first years of the WPB operation, but the number of projects implemented fell significantly during the COVID-19 pandemic. However, despite the identified decline, the approximately 10% share of outdoor physical activity projects among all completed in the WBP between 2015 and 2024 underscores their importance to residents and provides guidance on the direction of public spaces development.

Key words: urban public spaces, green spaces, recreation, health and well-being, public participation, placemaking

Introduction

Physical activity is assessed as a health-enhancing behaviour positively associated with improved physical and psychosocial health. Recreation, as one of the popular functions of urban public spaces, including green areas, is an important contributor to human development and well-being, whose role has increased significantly in recent years (Djukic et al., 2025). It comprises various activities undertaken by people in their free time for pleasure, voluntarily, to develop their personality, or to increase their psychological and physical capacity (Meyer, 2018), and becomes especially important during the Covid-19 pandemic (Kimic et al., 2024; Freire et al, 2025). A rich recreational offer may transform public spaces into vibrant, functional, socially cohesive, and multi-functional areas. Appropriate infrastructure supports active lifestyles and reduces health risks (Lopez-Haro et al., 2024). The city of Warsaw has extensive green spaces and diverse recreational facilities. They enable residents to spend their free time outdoors, which has become a priority for the city government. The operational objective 2.2. 'We spend time actively in our neighbourhood' is a part of the #Warsaw2030 Strategy (2018). It covers the creation of free local activity areas, the development of infrastructure in all districts, and the promotion of sports. One of the popular programs supporting the development of recreational opportunities in public spaces is Warsaw Participatory Budgeting (WPB), implemented to meet Varsovians' needs and expectations (Smaniotto Costa et al. 2024; Polko et al. 2025). This placemaking tool, operating in Warsaw since 2014, supports many initiatives, allowing city residents in an easy and inclusive way to decide how a part of the city's budget is spent by submitting proposals to improve their neighbourhoods, verification by city officials, public voting, and implementation of the winning projects (General information …, 2026). Recreation and relaxation are primary needs strongly emphasised in Participatory Budgets in many Polish cities. However, research on whether and to what extent the WPB supports residents' physical development has not yet been conducted.

Material and methods

The study aimed to determine whether the Warsaw Participatory Budget (WPB) supports the development of outdoor physical activity among city residents in urban public spaces. The study used quantitative data to identify and analyze completed outdoor physical activity projects selected through public voting across ten fully completed editions of the WPB conducted between 2015 and 2024. Projects from the 2025 edition were excluded because some are still not implemented. The data source was the official, open-access WPB database managed by the City of Warsaw (Projekty, 2026), providing standardized information on each project. In the first stage of selection, projects were

identified using three main keywords related to physical activities (leisure, recreation, and sport) in project titles and descriptions. This approach resulted from the database's structure and search limitations. All identified entries were individually verified to remove duplicate records and confirm their relevance to the study's topic. The selected projects were classified into seven categories based on the scale and scope of physical activities and/or their supporting elements. The categories are as follows: 1. Recreational and bicycle paths, 2. Parks (activities organized and introduced in large-scale green areas), 3. Squares and pocket green spaces (activities organized and introduced in small-scale green areas), 4. Children's playgrounds (separate area or part of the school garden), 5. Rest equipment (supporting physical activity, such as benches, lighting, roofing for playing fields, or retrofitting an existing facility), 6. Sport facility (sport field, outdoor gym, climbing wall, etc.), 7. Physical exercises and training courses (gymnastics, tai chi, and yoga, cycling training courses, etc.).
The quantitative analysis compared the number of projects implemented within and between categories to identify the most popular among city residents. The analysis of projects implemented across the 10 studied editions also revealed a leading trend in the use of the WPB to support residents' physical activity, including before, during, and after the Covid-19 pandemic.

Results
Across the 10 studied WPB editions implemented between 2015 and 2024, a total of 496 projects related to outdoor physical activities were carried out (Table 1). The overall summary shows that projects supporting outdoor physical activities gained importance in the first years. The fewest projects were implemented in the first edition in 2015 (only 15). However, in the 2016 edition, 82 projects were implemented, and in 2017 and 2018, they exceeded 90. Their number decreased significantly during the Covid-19 pandemic due to restrictions on access to public spaces. In the 2019 edition, implementation remained stable at 66 projects. In the 2020 and 2021 editions, the number of projects did not even reach 30 in either. In 2022, after a small increase to 40 projects, a further decline was observed: in 2023, only 26 projects were implemented, and in 2024, only 23. The average percentage share of implemented outdoor physical activity projects across 10 studied editions of the WPB is 9.44%. In the editions from 2016 to 2018 and in 2022, it slightly exceeded 10%.

Tab. 1: Projects on outdoor physical activities implemented in the Warsaw Participatory Budget between 2015 and 2024

WPB edition	All projects implemented			Project category						
	In WPB	Supporting outdoor physical activities		Recreational and bicycle paths	Parks	Squares and pocket green space	Children's playgrounds	Rest equipment	Sport facility	Physical exercises and training courses
2015	336	**15**	4,46 %	1	3	1	2	1	7	-
2016	644	**82**	12,73 %	7	10	6	7	9	33	10
2017	770	**97**	12,60 %	12	6	6	14	10	36	13
2018	881	**94**	10,67 %	7	6	3	6	10	35	27
2019	850	**66**	7,76 %	10	8	2	10	11	13	12
2020	414	**29**	7,01 %	3	3	1	-	4	15	3
2021	359	**24**	6,69 %	3	2	2	-	8	5	4
2022	349	**40**	11,46 %	8	6	-	3	6	11	6
2023	326	**26**	7,98 %	2	8	-	1	1	8	6
2024	325	**23**	7,08 %	3	4	-	1	3	8	4
Total:	**5254**	**496**	**9,44 %**	**56**	**56**	**21**	**44**	**63**	**171**	**85**

The results show that most implemented outdoor physical activity projects (171) belonged to the sport facility category. They included mainly the construction of new facilities or the comprehensive renovation of existing ones, outdoor gyms, climbing walls, boules stations, pumptracks, as well as table games, durable, permanently installed concrete fixtures such as chess and checkers, table tennis (ping pong), and outdoor-rated foosball tables. Most of them were built as single facilities surrounded by greenery and located close to housing estates.
The second-largest group, comprising 86 projects, was the physical exercises and training courses category. These activities included a variety of outdoor activities and courses to improve physical health. The most popular were yoga, tai chi, and dance courses, one-day or weekend cycling courses for youth and adults, and gymnastics for people of all ages, especially older adults.
Projects in the rest equipment category accounted for a moderate share in WPB – 63 were implemented across the 10 studied editions. Many public spaces gained new equipment, such as benches and hammocks. Some sports facilities received new lighting or had their spectator areas

roofed to extend their availability and improve safety. Selected sports fields were partially or fully modernized.
Another 56 projects were implemented in the recreational and bicycle paths category. Selected urban forests received new recreational and educational paths, but this category was dominated by the development of existing bicycle path systems in public spaces – new sections with supporting infrastructure were constructed. The same number of projects were implemented in the parks category – selected parts of large urban green spaces were developed to create new recreation zones.
Projects implemented from the children's playgrounds category had a smaller share – 44 of them were identified, involving the construction of new playgrounds and the modernization of existing ones. Squares and pocket green spaces category accounted for only 21 projects. Most of them included minor initiatives supporting recreation in small green spaces and residential areas. Only a few involved the construction of new squares with a limited recreational program.

Discussion
Warsaw Participatory Budget is typically a good indicator of social processes that demonstacte citizen engagement, and the number of submitted and implemented projects refers to social needs. The Covid-19 pandemic also affected the development limitations of this tool during the period from 2019 to 2021. At the same time, the social needs for outdoor recreation are changing. In that context, the popularity of small or individual recreational and sports facilities in the analyzed WPB projects is understandable, as their costs are low and implementation time is short. Increasing attractiveness of public spaces, especially in green areas, through improved recreational and sports infrastructure also promotes a sense of safety (Polko, Kimic, 2021; Polko, Kimic, 2022; Šerý et al., 2024). It is also easy to organize one-time or recurring outdoor exercise and training courses that help people of all ages improve their health through physical activity (Pharr et al., 2019), especially for older people (Van Puyvelde et al., 2025). Group activities also provide contact with others, which is another positive aspect of safety (Kimic, Polko, 2022; Kimic, Polko, 2023).
The share of almost 10% of outdoor physical activity projects implemented in the 10 studied WPB editions is significant. The general trend shows an increase in the urban community's interest in outdoor physical activity before the COVID-19 pandemic. Much research confirms that participation in sport and recreation in the post-COVID-19 period is critical for re-engaging people in health-enhancing behaviours (Ainsworth, Li, 2020; Sallis et al., 2020; Hasson et al., 2021). However, the trends observed in the WPB do not support this approach. At the same time, many new recreational facilities were created, and existing ones were modernized in the first editions of WPB, but these were mainly small-scale projects. The downward trend after 2022 indicates that public interest in outdoor physical activity projects has waned, despite the consistently high need for expanding multifunctional recreational infrastructure in the city. Residents' expectations are also changing – they are seeking functionally diverse public spaces, while complex projects require larger funds that are beyond the participatory budget. The current situation may also suggest that this placemaking tool has reached its limit. Warsaw scores high on the civic-oriented ranking but has low voter turnout in the WPB (Szczepańska et al., 2022).

Conclusion
The research demonstrates the importance of creating and maintaining recreational and sports facilities in urban public spaces, including green spaces, through the residents' involvement. Despite a recent decline in the popularity of outdoor physical activity projects in the WPB, investing in public spaces for recreation and sport remains an important part of this participatory tool in supporting the physical and mental health and well-being of Warsaw residents.

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Souhrn
Rostoucí význam rekreace, která přispívá ke zdraví a pohodě obyvatel měst, je hnací silou změn ve veřejných prostranstvích: ta se stávají přístupnějšími pro širší škálu venkovních fyzických aktivit, včetně těch, které podporují sociální iniciativy. Abychom zjistili, do jaké míry je tato otázka důležitá pro obyvatele Varšavy (Polsko), byly analyzovány projekty realizované v rámci Varšavského participativního rozpočtu (WBP) v letech 2015 až 2024 z hlediska jejich role při podpoře fyzické aktivity venku v následujících kategoriích: rekreační a cyklistické stezky, parky, náměstí a malé zelené plochy, dětská hřiště, sportovní zařízení, odpočinkové vybavení, cvičení a tréninkové kurzy. Výsledky ukazují, že v rámci 10 zkoumaných ročníků WBP bylo realizováno 496 projektů souvisejících s fyzickou aktivitou venku. Jejich význam rostl v prvních letech fungování WBP, ale počet realizovaných projektů během pandemie Covid-19 výrazně poklesl. Navzdory zjištěnému poklesu však přibližně 10% podíl projektů v oblasti fyzické aktivity venku na všech projektech dokončených v rámci WBP v letech 2015 až 2024 podtrhuje jejich význam pro obyvatele a poskytuje vodítko pro směřování rozvoje veřejných prostor.

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UNDERSTANDING ECOLOGICAL ROLES OF ORGANISMS AMONG KINDERGARTEN CHILDREN: IMPLICATIONS FOR ENVIRONMENTAL EDUCATION

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Abstract
Understanding ecological relationships among living organisms represents an important foundation for environmental education, as knowledge about ecosystem functioning can foster more responsible attitudes toward nature. This study explores how children perceive living organisms in relation to three dimensions: identification, understanding of ecological roles, and perceived importance for nature. Data were anonymously collected from 60 children attending three state kindergartens. Children were individually presented with visual representations of selected organisms representing different trophic levels within an ecosystem. They were asked to identify the organisms, explain their ecological roles, and evaluate their importance for natural systems. Relationships among these dimensions were analysed using correlation analysis, while potential gender differences were examined using multivariate analysis (MANOVA). The results revealed a positive correlation between identification and understanding of ecological roles ($r = 0.517$, $p < 0.001$). However, perceived importance was not significantly associated with either identification or understanding of ecological roles. Multivariate analysis did not reveal statistically significant gender differences (Wilks' $\lambda = 0.949$, $F(3,56) = 1.00$, $p = 0.399$). These findings highlight the importance of strengthening ecological literacy as a foundation for environmental education in early childhood.

Key words: ecological literacy; early childhood learning; biodiversity awareness; ecosystem functioning; environmental education

Introduction

Ecology as a scientific discipline provides a basic framework for understanding the relationships between organisms and their environment, as well as the processes that ensure the functioning of ecosystems. Biodiversity plays a key role in the stability and functioning of ecosystems, and its disruption may lead to significant changes in the provision of ecosystem services (Hooper et al., 2005; Millennium Ecosystem Assessment, 2005). Current environmental challenges, including biodiversity loss and ecosystem degradation, point to the need for a deeper understanding of ecological processes and relationships in nature (IPBES, 2019). Ecological knowledge is followed by an environmental dimension, which reflects the relationship between humans and the natural environment and emphasizes the need for its protection. For this reason, environmental education is characterized not only by the transmission of knowledge, but also by the formation of attitudes and values of individuals (Stapp, 1969). From this perspective, the integration of ecological understanding with environmental thinking can be considered essential.

Particular attention should be paid to early childhood, as it represents an important phase in the formation of basic ideas about nature. Research indicates that children already develop ideas about the relationships among organisms during this period; however, these ideas are often incomplete or simplified (Leach et al., 1996; Washinawatok et al., 2017). At the same time, research has confirmed that although children are able to identify organisms, their understanding of ecological roles and relationships is more limited. Despite the growing interest in environmental education, the relationship between ecological understanding and the evaluation of the importance of organisms in children remains insufficiently explored. Existing findings suggest that the evaluation of the importance of organisms is not necessarily directly linked to the level of ecological knowledge, but may also be influenced by other factors, such as experience or preferences (Melis et al., 2020). Based on the above, there is a need for a deeper examination of the relationships between knowledge, understanding, and the evaluation of natural phenomena in early childhood. Therefore, the aim of the present study is to analyse how preschool children perceive selected living organisms in terms of their identification, understanding of ecological roles, and evaluation of their importance for nature. The study also focuses on examining the relationships among these dimensions.

Material and methods

Research Design and Data Collection

Data were collected using individual semi-structured interviews with children. The interviews were conducted in a quiet and familiar environment within the kindergarten (e.g., classroom or relaxation area) in order to ensure that the children felt comfortable and relaxed during the conversation. At the beginning of each interview, the researcher established rapport with the child through simple introductory questions such as asking the child's name or whether they liked animals and plants. These introductory questions were used only to create a relaxed atmosphere and were not included in the research data. During the interview, children were gradually shown six pictures representing different living organisms commonly found in nature: a bumblebee, earthworm, squirrel, tree, mushroom, and wolf. These organisms were selected to represent different ecological roles within ecosystems, including producers, consumers, and decomposers, similar to previous studie investigating children's perception of ecological roles of organisms (Melis et al., 2020). To avoid order bias, the sequence in which the pictures were presented varied between interviews. Each child was asked the same set of questions for every organism. The interview consisted of three main types of questions. Children were first asked to identify the organism shown in the picture using the question: *"What is shown in the picture? What is it called?"* To verify familiarity with the organism, a follow-up question was asked: *"Have you ever seen it in real life? Where?"*

Responses were scored according to accuracy:

- 2 points – correct identification
- 1 point – partially correct identification (e.g., calling a bumblebee a bee)
- 0 points – incorrect answer or no answer

If the child could not identify the organism, the researcher provided the correct name before continuing with the interview. Children were then asked to evaluate the importance of the organism for nature using the question: *"Do you think this organism is very important for nature, somewhat important, or not very important?"*

Responses were scored as:

- 2 points – very important
- 1 point – somewhat important
- 0 points – not important

Children were then asked to explain their reasoning: *"Why do you think so? What is it good for in nature?"* Children were encouraged to elaborate on their answers, but the interviewer avoided suggesting possible explanations. After discussing all six organisms, children were asked to compare them directly. They were asked: *"Which of these would nature miss the most?"*,*"Which would nature miss the least?"* Children were then asked to arrange the cards from the most important organism to the least important organism. The final order was recorded for further analysis.

Coding of Explanations

Children's verbal explanations were transcribed and categorized according to a predefined coding scheme. Responses were classified into five main categories:

1. Ecological understanding – references to ecological processes or ecosystem functions (e.g., pollination, oxygen production, decomposition).
2. Anthropocentric usefulness – explanations referring to benefits for humans (e.g., food production).
3. Emotional evaluation – statements expressing sympathy, fear, or aesthetic judgments.
4. Misconceptions or irrelevant answers – statements not related to ecological roles.
5. No answer / "I don't know."

For quantitative analysis, responses indicating ecological understanding were coded as **1**, while all other responses were coded as 0.

Data Analysis

The collected data were analysed using descriptive and inferential statistical methods. First, descriptive statistics were calculated for the three evaluated dimensions: organism identification, understanding of ecological roles, and perceived importance for nature. Differences between boys and girls were analysed using multivariate analysis of variance (MANOVA). To explore relationships between the evaluated dimensions, Pearson correlation analysis was performed. Correlation coefficients were visualised using a heat map, which provided a graphical representation of the relationships among the studied variables. All statistical analyses were conducted using standard statistical software, with the significance level set at $p < 0.05$.

Results

Descriptive statistics of the evaluated variables

The descriptive statistics revealed differences in the average scores obtained for the three evaluated dimensions: organism identification, understanding of ecological roles, and perceived importance for nature. The highest mean value was recorded for identification (M = 1.76), followed by ecological role understanding (M = 1.51) and perceived importance for nature (M = 1.41). These results indicate that children were generally able to recognize the organisms presented in the images more successfully than they were able to explain their ecological function or evaluate their importance for nature. Overall, these descriptive results provide an initial overview of children's abilities to identify organisms, understand their ecological roles, and evaluate their importance for nature. When analysing the perceived importance of individual organisms, the highest average ranking was attributed to the earthworm (M = 4.17), followed by the squirrel (M = 3.47) and bee/bumblebee (M = 3.47). Slightly lower mean values were recorded for tree (M = 3.47) and mushroom (M = 3.50), while the wolf received the lowest average score (M = 2.93). These results suggest that children tended to attribute greater ecological importance to organisms that are either more familiar or perceived as directly related to ecosystem processes.

Differences between boys and girls

The comparison of boys and girls showed only minor differences in the average scores for the three evaluated dimensions. Boys achieved slightly higher scores in organism identification, whereas girls showed marginally higher scores in perceived importance for nature. However, multivariate analysis did not reveal statistically significant gender differences across the evaluated variables (Wilks' λ = 0.949, $F(3, 56) = 1.00$, $p = 0.399$). This suggests that the perception of ecological roles and the importance of organisms for nature was comparable between boys and girls in the studied sample. Figure 1 illustrates the mean values for identification, ecological role understanding, and perceived importance for nature according to gender.

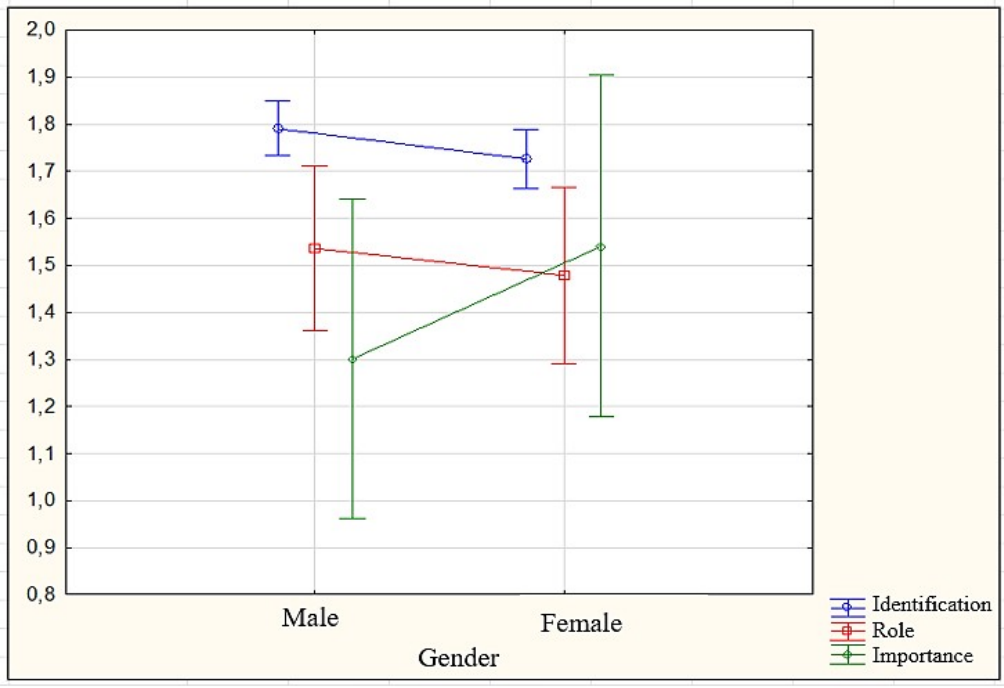

Fig. 1: Mean values of organism identification, ecological role understanding, and perceived importance for nature by gender.

Relationships between identification, ecological understanding and perceived importance

The relationships between the three evaluated variables were examined using correlation analysis. A moderate positive correlation was found between organism identification and ecological role understanding ($r = 0.517$, $p < 0.001$). This indicates that children who were better able to identify organisms also tended to demonstrate a better understanding of their ecological roles. In contrast, perceived importance for nature was not significantly correlated with either identification ($r = –0.091$, $p = 0.487$) or ecological role understanding ($r = 0.089$, $p = 0.495$). These findings suggest that children's evaluation of the importance of organisms for nature was relatively independent of their ability to correctly identify the organisms or explain their ecological functions. To provide a clearer visual

representation of these relationships, the correlation matrix is presented in Figure 2 in the form of a heat map.

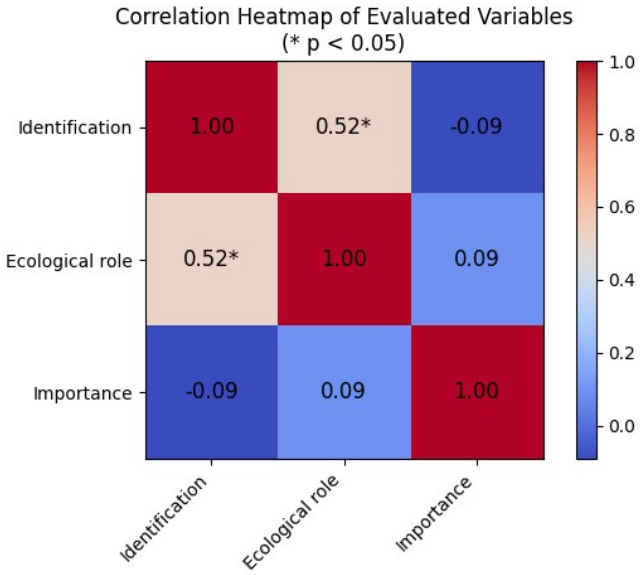

Fig. 2: Heat map of correlations between organism identification, ecological role understanding, and perceived importance for nature. Values represent Pearson correlation coefficients. Significant correlations ($p < 0.05$) are marked with an asterisk (*).

Discussion

The present study focused on analysing how preschool children perceive selected living organisms in terms of their identification, understanding of ecological roles, and evaluation of their importance for nature. The results indicate that children were generally more successful in identifying organisms than in explaining their ecological functions or evaluating their importance. This pattern suggests that while basic recognition of organisms is relatively well developed at an early age, deeper ecological understanding and evaluative reasoning remain less developed. The observed difference also corresponds with previous research, which points to the incompleteness of children's ideas about ecological relationships (Leach et al., 1996; Washinawatok et al., 2017). Similarly, Melis et al. (2020) report that although children are able to recognize common organisms, their explanations of ecological roles are often incomplete or based on simplified reasoning. The presented findings therefore point to the assumption that the development of ecological literacy requires more than mere contact with individual organisms, while at the same time highlighting the need to include the gradual development of understanding of ecological processes. Understanding ecological relationships thus represents a fundamental prerequisite for the development of ecological literacy, which involves the ability to comprehend the integrity of natural systems and their interconnections (Orr, 1992). A key finding of this study is the absence of a significant relationship between the evaluation of the importance of organisms for nature and their identification, as well as ecological understanding. This result suggests that children's evaluation of the importance of organisms is largely independent of their level of cognitive understanding of ecological roles, meaning that children may assign importance based on factors other than ecological knowledge. This conclusion corresponds with research indicating that environmental knowledge, attitudes, and behaviour are related, but their relationship is not necessarily strong or direct (Blaikie, 1993). This observed discrepancy may point to a broader trend in which the cognitive and affective components of environmental perception develop at different rates, potentially influenced by emotional and anthropocentric factors. Children tended to assign higher importance to organisms that are closer to them or associated with visible processes in nature, such as earthworms, squirrels, or bees, whereas organisms such as wolves were evaluated as less important, which is in line with findings emphasizing the role of emotional responses and personal experience in shaping environmental attitudes (Borg et al., 2017).

The interpretation of the results may also be approached from the perspective of ecological literacy. As Cutter-Mackenzie and Smith (2003) argue, environmental education has long faced the problem of insufficient levels of ecological literacy, with emphasis often placed more on the formation of attitudes than on the systematic development of content knowledge. This trend may contribute to a situation in which children develop a positive relationship with nature, yet their understanding of ecological

processes remains limited. The absence of a relationship between ecological understanding and the evaluation of the importance of organisms may thus reflect a broader issue of insufficient integration between the cognitive and value-based components of education. In this context, it is also necessary to consider the selective perception of nature, particularly the phenomenon of “plant blindness”, which refers to the tendency to overlook plants and underestimate their importance compared to animals (Wandersee & Schussler, 1999; Knapp, 2019), as similar tendencies have been identified in children who often do not perceive plants as key components of ecosystems (Amprazis et al., 2021). From an educational perspective, these findings highlight the need to integrate the cognitive and affective dimensions of environmental education. As noted by Erdoğan (2011), educational approaches that connect ecological knowledge with emotional experience and personal engagement may contribute to the development of more consistent environmental understanding and responsible behaviour. At the same time, research by Ayotte-Beaudet et al. (2023) suggests that experiential and contextualized forms of teaching can support a deeper understanding of ecological relationships, which creates space for bridging the gap between knowledge and evaluation identified in this study. Despite the contributions of this study, its limitations should also be considered, as the research was conducted within a relatively narrowly defined educational context involving children from a single type of educational environment, which limits the generalizability of the findings. Future research could therefore focus on expanding the sample to include different types of kindergartens, such as forest kindergartens, Montessori settings, or other alternative educational approaches, as well as larger and more diverse samples to allow for a more comprehensive understanding of the development of ecological thinking.

Conclusion

The results of the present study indicate that although preschool children are relatively successful in identifying selected organisms, their understanding of ecological roles and their evaluation of the importance of these organisms for nature remain more limited and mutually unconnected. The observed absence of a relationship between ecological understanding and the evaluation of organism importance suggests the need for a more systematic integration of cognitive and affective components of environmental education already in early childhood. Strengthening ecological literacy thus appears to be a key prerequisite for the development of environmentally responsible thinking, with emphasis placed on a deeper understanding of ecological relationships and the functions of organisms within ecosystem processes.

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Souhrn
Výsledky předkládané studie poukazují na to, že ačkoli děti předškolního věku dokážou relativně úspěšně identifikovat vybrané organismy, jejich porozumění ekologickým rolím a hodnocení jejich významu pro přírodu zůstává omezenější a vzájemně nepropojené. Zjištěná absence vztahu mezi ekologickým porozuměním a hodnocením významu organismů naznačuje potřebu systematičtějšího propojení kognitivní a afektivní složky environmentálního vzdělávání již v raném věku. Posilování ekologické gramotnosti se tak jeví jako klíčový předpoklad pro rozvoj environmentálně odpovědného myšlení, přičemž důraz by měl být kladen na hlubší porozumění ekologickým vztahům a funkcím organismů v kontextu fungování ekosystémů.

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UNVEILING THE IN-BETWEEN: A TYPOLOGICAL FRAMEWORK FOR REGENERATING URBAN VOIDS

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Abstract
Urban voids, frequently perceived as residual or dysfunctional fragments of compact cities, remain insufficiently addressed within systematic urban regeneration frameworks. Despite growing interest in adaptive reuse and green infrastructure, a clear typological and scenario-based model for their reintegration is still lacking. This paper addresses this gap by proposing a spatial classification of urban voids according to their position within the urban structure and by developing scenario-based transformation models applicable to different morphological contexts. The research combines typological analysis with a qualitative comparative case-study method, examining selected international examples of successful regeneration through eco-stabilizing and socially responsive design strategies. The study evaluates spatial configuration, functional adaptability, ecological integration, and social activation as key performance parameters. The findings demonstrate that small-scale, strategically designed interventions can significantly enhance urban resilience, biodiversity, and community interaction when embedded within coherent planning frameworks. The proposed model contributes a transferable analytical tool for identifying and transforming in-between spaces from neglected gaps into structurally integrated and environmentally productive components of the urban fabric. The research expands contemporary discourse on sustainable urban regeneration by linking morphological typology with adaptive design strategies and policy-oriented planning approaches.

Key words: urban gaps, adaptive reuse, regeneration strategies, sustainability, resilience

Introduction

The ongoing transformation of contemporary cities is often accompanied by the emergence of underutilized or abandoned spaces, commonly referred to as urban voids. These spaces, which include vacant lots, residual gaps between buildings, and inner-block areas, are typically perceived as disruptions within the urban fabric. However, in the context of sustainable urban development, they represent significant opportunities for ecological enhancement, social interaction, and the expansion of public space. In recent years, increasing attention has been given to adaptive reuse, green infrastructure (Tóth, 2016), and small-scale urban interventions as tools for improving environmental quality and urban livability (Tóth, 2022). Urban voids offer a unique potential to support biodiversity, improve microclimatic conditions, and provide accessible spaces for everyday recreation (Bellérová and Hus, 2025; Bihuňová et al., 2017). The transformation of such spaces is often linked to participatory approaches and bottom-up initiatives, which can significantly contribute to the creation of meaningful public environments (Miklášová et al., 2021). Despite this growing interest, a clear typological framework that would enable their systematic identification and transformation is still lacking. This paper addresses this gap by proposing a spatial classification of urban voids based on their position within the urban structure and by developing scenario-based models for their regeneration. The research focuses on compact urban environments, where spatial constraints intensify the need for efficient and multifunctional use of available space.

Materials and methods

Urban voids exhibit diverse characteristics in terms of size, shape, form, and function. Their nature varies depending on location, ownership, and intended use (permanent or temporary). This research develops a categorization of urban voids based on spatial typology and their position within the urban structure. To support this framework, a set of representative scenarios was conceptualized and graphically interpreted (Fig. 1).

Three primary urban contexts were identified:

1. **City Centre** – characterized by a compact urban structure, including historic city centers and dense built-up areas.

2. **Inner City** – comprising inner-block spaces, campuses, larger residential complexes, and transitional zones between the city center and suburbia.
3. **Outer City and Peripheral Areas** – including industrial zones, brownfields, and undeveloped land.

Based on these contexts, five typical scenarios of urban voids were defined:

- **Scenario 1 – Linear gap:** A passable space between two buildings, open on both sides. In some cases, one side may be visually enclosed by a retained façade, while the space behind remains accessible.
- **Scenario 2 – Setback micro-space:** A small space created by a building setback from the street line. Its depth varies and it is typically unsuitable for further construction.
- **Scenario 3 – Inner-block void:** A hidden space located within a block, accessible through a narrow passage between buildings. These spaces are often secluded and weakly connected to surrounding urban activity.
- **Scenario 4 – Narrow residual gap:** A constrained space between structures, often too narrow for development but potentially usable as a transitional or ecological corridor.
- **Scenario 5 – Edge void:** An open space located at the termination of a built structure, typically at street corners or edges of urban blocks.

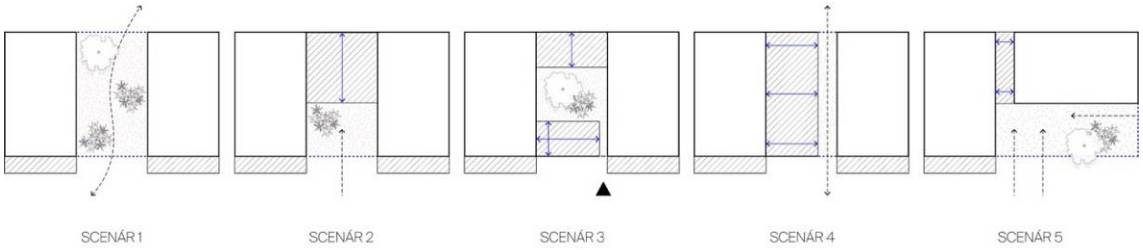

Fig. 1: Typology of urban voids located within compact urban structures. Various scenarios that may vary in real conditions. Source: author.

The proposed scenarios represent common spatial conditions and origins of urban voids in contemporary cities. They are expressed through simplified graphic schemes to enhance clarity and support comparative analysis. The morphology of these spaces remains inherently variable, reflecting the dynamic and evolving nature of urban environments. Their applicability is further illustrated through selected case studies focused on compact urban contexts.

Case-study method: For the purposes of this article, three case studies were selected to illustrate the regeneration and integration of urban voids into compact urban structures through eco-stabilizing and sustainable design strategies. The case study method enables the comparison of analogous spatial situations in different urban contexts.

Results

The selected case studies represent different spatial scenarios of urban voids within compact urban structures and serve to illustrate the applicability of the proposed typological framework. Each example reflects a specific morphological condition and demonstrates how targeted, small-scale interventions can transform underutilized spaces into functional and ecologically responsive environments. The analysis focuses on key parameters, including spatial configuration, functional adaptability, ecological integration, and social activation. Particular attention is given to the role of vegetation, microclimatic improvements, and the capacity of these spaces to support everyday urban life within dense city contexts.

Fahle Gallery Street

Scenario: 1
Location: Tallinn, Estonia
Authors: LUMIA, studio ARGUS
Year of completion: 2020
Area: 740 m^2

The Fahle Gallery Street in Tallinn, Estonia (Fig. 2), represents the transformation of a linear urban void through adaptive reuse with a strong ecological dimension. The former industrial passage has

been converted into a semi-enclosed space integrating vegetation, which contributes to improved microclimatic conditions and environmental quality. The introduction of greenery within a dense urban structure enhances biodiversity and creates a more comfortable and attractive environment for users. The space now functions as a multifunctional corridor supporting social interaction and everyday use. This case demonstrates the potential of small-scale interventions to transform residual urban spaces into ecologically responsive and socially active environments.

Fig. 2: Fahle Gallery Street in Tallinn, Estonia. Source: archdaily.com

Paley Park
Scenario: 2
Location: New York, USA
Authors: Zion & Breen Associates
Year of completion: 1967
Area: 390 m^2

Paley Park in New York (Fig. 3) represents a transformation of a small residual urban space into a highly functional green environment. The integration of vegetation and a cascading water feature improves microclimatic conditions, reduces noise, and enhances environmental quality within a dense urban setting. Despite its limited size, the space supports strong social use and provides a restorative environment for users. This case highlights the role of small-scale green interventions in improving urban livability, biodiversity, and everyday public space experience.

Fig. 3: Paley Park. Source: paleypark.org

Pocket Park on Xinhua Road
Scenario: 4
Location: Shanghai, China
Authors: SHUISHI
Year of completion: 2020
Area: 106 m^2

The Pocket Park on Xinhua Road in Shanghai (Fig. 4) represents the transformation of a small urban void into a multifunctional green space. The intervention integrates vegetation and flexible design elements, enhancing biodiversity and improving environmental conditions within a dense urban context. Despite its limited size, the space supports both recreational and cultural functions, strengthening social interaction and user engagement. This case demonstrates how small-scale interventions can effectively activate residual urban spaces and contribute to ecological and social sustainability.

Fig. 4: Pocket Park on Xinhua Road in Shanghai, China. Source: archdaily.com

Conclusion
The analysis confirms that the proposed typological framework reflects common spatial conditions of urban voids in compact urban environments and can serve as a useful tool for their interpretation and regeneration. Although the selected case studies differ in scale, context, and design approach, they share several common features. In all cases, small-scale interventions improved the environmental quality of the space, introduced ecological elements, and strengthened its social function within the urban structure. The comparison shows that the success of urban void transformation depends primarily on spatial configuration, accessibility, and the ability to combine ecological and social functions. Vegetation and water elements contribute to biodiversity and microclimatic regulation, while flexible and human-scaled design supports everyday use and community interaction. These findings suggest that urban voids should not be understood as residual fragments of the city, but as spaces with regenerative potential. When integrated into coherent planning frameworks, they can become environmentally productive and socially active components of the urban fabric. The proposed typological model therefore offers a transferable basis for future scenario-based design strategies in compact urban contexts.

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Souhrn
Městské prázdnoty představují potenciál pro ekologickou stabilizaci a sociální aktivaci v kompaktních městských strukturách. Studie navrhuje typologii těchto prostorů a scénáře jejich transformace na základě případových studií. Výsledky ukazují, že malé, cílené zásahy mohou významně zlepšit kvalitu prostředí, biodiverzitu a každodenní využití těchto míst.

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URBAN FORESTS AS BIODIVERSITY REFUGEES IN CULTURAL LANDSCAPES

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Abstract
Urban forests provide many ecosystem services for people, including recreational activities. As biodiversity in rapidly changing urban areas is very dynamic, we need a better understanding of long-term biodiversity changes in urban forests. This study analysed the long-term change in bird-species richness in a temperate Central European urban forest over a time span of 37 years. Bird community investigated in 2023–2024 was compared with older field data from 1987. The high local alpha diversity of the bird community as well as the high long-term stability in bird richness indicates the importance of the studied urban forest as a stable biodiversity refugium in a dynamic urbanized landscape. Therefore, urban forests can be considered very stable biodiversity refugia in dynamically changing urban areas.

Key words: Birds as bioindicator, bird counting, floodplain forest, urban recreational park.

Introduction

Urban forests (UF) are essential for recreational activities of people living in cities. The cultural ecosystem services (including recreation) of urban forests are based on biodiversity functioning of these managed forest ecosystems (Yang et al., 2020). Thus, understanding biodiversity patterns in UFs is vital for sustainable urban forest management strategies aimed at maintaining and developing ecosystem services as well as for urban planning aimed at urban green infrastructure.
Birds are valuable bioindicators in environmental assessments of how management practices affect biodiversity in urban forests (Sallabanks et al., 2000). Environmental heterogeneity is a major predictor of high bird-community diversity in European cultural landscapes (Vickery et al., 2012). In urbanized areas, habitat heterogeneity is significantly supported by the preservation of biological heritage. The main biological heritage features in urban areas are very large old trees (Barth et al., 2015). Other types of biological heritage (e.g., remnants of large dead trees standing or lying on the ground, uprooted trees, etc.) are very rare in managed forests.
Urban forests are located in highly dynamic urbanized landscapes. Various ecological and socioeconomic drivers have an impact on cities and their surroundings. Land cover and land use in urban areas change rapidly on both temporal and spatial scales. Additionally, changes in the biodiversity of urban forests can occur relatively quickly, reflecting landscape changes and the synantropization of many forest bird species (Evans et al., 2011). Despite our current detailed knowledge of bird diversity in urban parks, we still know little about patterns of bird diversity change in urban forests.
Understanding such long-term changes in urban forests ultimately requires long-term ecological studies (Lindenmayer et al., 2012). But long-term bird studies on bird diversity changes in urban green areas are still very rare in Central Europe; all of them that that have been conducted are limited to urban parks, which are managed differently than urban forests. Thus, we focused on the case study of birds in a temperate Central European urban forest. This study is based on assessment of long-term data, over a 37-year period, by comparing the findings of a 1987 bird census and a 2023–24 bird census.

Material and methods

The study area was the Michalov urban forest (13.73 ha) located in the town of Prerov, Czech Republic (49.4624400N, 17.4574767E). The forest habitat type is a Central European temperate lowland (210 m a. s. l.) hardwood floodplain forest, managed as urban forest with important recreational function.

In the 2023 and 2024 breeding seasons, a bird census was conducted in the study area using the line-transect counting method. The field data from the line-transect census was used to calculate the absolute counts and relative dominance (%) of bird species in the study area.
Data from the 2023–2024 census were compared to the findings of the 1987 census, which was conducted in the same area using the identical line-transect method. This comparison revealed changes in bird-species richness in the urban forest study area over a 37-year timespan (1987–2024).
Sörensen's index (QS) was calculated based on the critical value of this index for Central Europe to analyze changes in the species diversity and Jaccard's index (Ja) to compare the faunistic similarity of bird communities in the study area between the compared years (1987 and 2023–2024). Data were statistically analysed using a standard t-test for two samples.

Results

A total of 42 bird species were recorded during the 2023–2024 breeding season in the study area. There were six dominant species (with a dominance value > 5 %) in the urban forest's bird community: *Sturnus vulgaris*, *Parus major*, *Fringilla coelebs, Turdus merula, Phylloscopus collybita,* and *Columba palumbus*. This result was predictable in the study area, because all the dominant species are common in Central European green spaces in urbanized areas. The high availability of suitable nesting cavities in old trees in the study area for the first two dominant species and the generally high numbers of the other four dominant species in the cultural landscape clearly explain these results. The dominance of most species is typically low (≤ 5 %), as is visible in the dominance distribution curve (Figure 1). The lack of significant breaks in the curve suggests a well-balanced distribution of dominance and species composition of the current bird community in the study area.
A statistical comparison of current bird-species richness (2023–2024) with the older bird-species richness recorded 37 years ago, using a t-test, did not indicate any statistically significant differences ($P > 0.05$).
The bird-species richness in the study area increased; 36 bird species were recorded in 1987 and 42 species in 2023–2024 (Table 1). In 2023–2024, six bird species present in 1987 were not detected, whereas 14 bird species were identified that were not recorded in the earlier study. The results of the analysis of bird-community change in the study area over a 37-year period, based on the calculation of faunal similarity indices, are shown in detail in the Table 1. The Sörensen similarity index for species richness reached a value of QS = 74,44, which means a significant similarity between the species diversity of the compared bird communities in 1987 and 2023–2024. The calculated Jaccard's faunal similarity index (as a modification of the QS index) revealed a value of Ja = 59.2 %, confirming a similarity in bird- species richness in 1987 and 2023–2024.

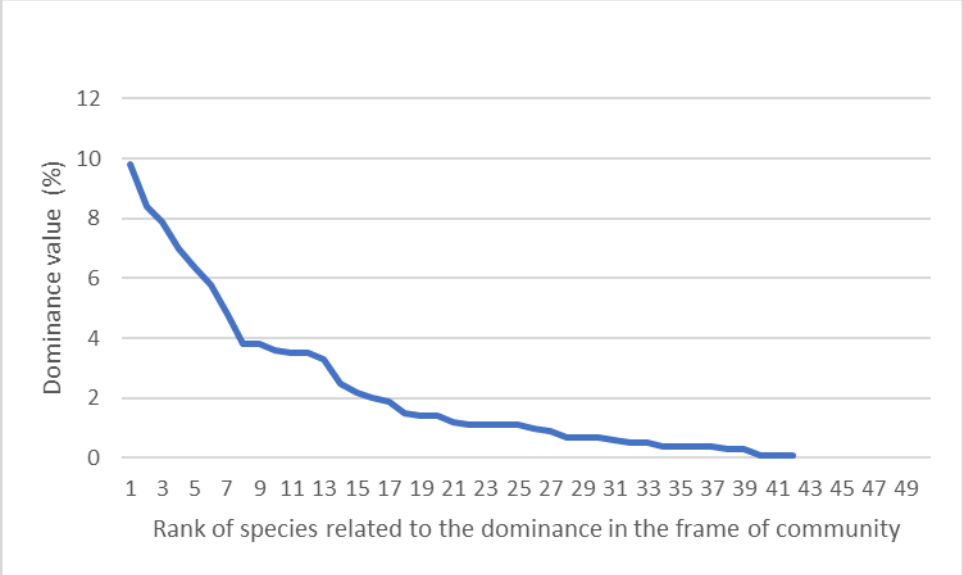

Fig. 1: Distribution of dominance values in the study area's bird community

Tab. 1: Changes in bird-species richness in the study area (from 1987 to 2023–2024)

Total number of bird species in 1987	Total number of bird species in 2024	Number of identical bird species in both years	QS index calculated as comparison of both years	Jaccard index (%) calculated as comparison of both years
36	42	29	74.4	59.2

Discussion

The results of this study (in details see also Machar, 2025) are clearly limited by the methodology we chose to conduct the bird census. Line transect is not considered the best ornithological method for precise bird counting compared to territory mapping. Traditionally, the method for determining the species diversity of birds nesting in a specific location is the mapping of nesting territories combined with direct nest searching (Nielsen et al., 2014). However, as we aimed to compare recent results (from 2023–2024) with previously published data from 1987, we had to use the same method, that is, the line-transect method. On the other hand, line transect is an adequate method for determining bird abundance and dominance, which was the focus of our study.

The results of this study do not provide any information about long-term continuous changes in bird diversity, but only a comparison between two different period of time. Nonetheless, such long-term comparison is valuable because it offers basic insights into long-term trends in bird-species richness.

In the studied urban forest, bird species richness was higher in 2023–2024 (42 species) than in 1987 (36 species). The predominant species (with dominance ≥ 5 %) in 2023–2024 were common bird species, which are the most abundant bird species in urban areas in the Czech Republic (Reif et al., 2010). The species composition of urban bird communities usually refer to an urbanization level in the frame of urbanization gradients—for example, the most abundant species in more urbanized sites in neotropical cities is *Passer domesticus*, and urban parks in Eastern Europe are dominated by *Columba palumbus* and *Streptopelia decaocto* (Sakhvon et al., 2010); our findings confirm the latter.

The results of this study revealed that bird-species richness in the urban forest has been relatively stable (without significant changes) for over 37 years. The quantitative characteristics (abundance and dominance) of the urban bird species in the study area are highly similar to those of nesting bird communities in natural broadleaf lowland forests in the Morava River basin (Horak et al., 2013). This observation indicates that the human-made mosaic of habitats in urban forests may be as valuable in terms of bird biodiversity as semi-natural lowland forests.

Ornithologists have long been known that large urban green habitats, such as historic manor parks, are exceptionally valuable locations in terms of bird biodiversity within the cultural landscape. This fact has gained importance, especially in the context of the creation of the European Natura 2000 network of protected areas, where it has been shown that the biodiversity of Central European lowland broadleaf forests is strongly linked to the open structure of habitats similar to open “savanna-type” forests. Modern conservation efforts are therefore focused on finding methods for restoring and managing deciduous forests. Urban forests, with large areas resembling open forests with a high proportion of very large old solitary trees, can contribute to maintaining the biodiversity of species that were originally associated with historic forest management.

Conclusion

The results of the study revealed that bird-species richness in an urban forest has been relatively stable (without significant changes) for over 37 years. It supports the emerging awareness of the high importance of urban forests as a key structure of urban green spaces for biodiversity maintenance in urbanized areas. If urbanization continues to progress at its current rate, the importance of urban forests as biodiversity refugees will increase.

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Souhrn
Tato studie analyzovala dlouhodobé změny v druhové rozmanitosti ptáků v městském lese mírného středoevropského podnebí v časovém rozpětí 37 let. Ptačí společenstvo zkoumané v letech 2023–2024 bylo porovnáno se staršími terénními údaji z roku 1987. Vysoká lokální alfa diverzita ptačího společenstva i vysoká dlouhodobá stabilita druhové bohatosti ptáků naznačují význam studovaného městského lesa jako stabilního útočiště biodiverzity v dynamické urbanizované krajině. Městské lesy lze proto považovat za velmi stabilní útočiště biodiverzity v dynamicky se měnících městských oblastech. Výsledky této studie odhalily, že druhová bohatost ptáků v městském lese je již více než 37 let relativně stabilní (bez významných změn). Městské lesy jsou nejheterogennějšími biotopy v rámci městské zelené infrastruktury. Vysoká heterogenita biotopů velkých městských lesů vysvětluje skutečnost, že tyto biotopy, stejně jako městské parky, jsou hotspoty biodiverzity v urbanizovaných krajinách. To podporuje rostoucí povědomí o vysokém významu městských lesů jako klíčové struktury městských zelených ploch pro zachování biodiverzity v urbanizovaných oblastech. Pokud bude urbanizace pokračovat současným tempem, význam městských lesů jako útočišť biodiverzity poroste.

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URBAN TREES FOR PEOPLE AND CLIMATE: BALANCING ECOSYSTEM SERVICES AND LONG-TERM VITALITY IN PUBLIC SPACES

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Abstract
Urbanization and climate change significantly intensify the Urban Heat Island (UHI) effect, directly impacting the quality of public recreation. Green spaces, particularly tree vegetation, represent one of the most effective nature-based solutions, bridging the gap between environmental protection and human thermal comfort. Studies indicate that well-designed green spaces can reduce urban air temperatures by 2-4 °C (locally up to 8-10 °C compared to impervious surface) and significantly mitigate temperature extremes during heatwaves.
However, for recreation and protection to go “hand in hand”, a strategic approach is required. A key factor is the proper selection of tree species – prioritizing those with a high Leaf Area Index (LAI) and resilience to urban stressors (e.g., *Tilia, Acer platanoides, Carpinus betulus, Quercus, Ulmus, Alnus glutinosa*, or *Zelkova*).
Furthermore, the long-term sustainability of these benefits depends on an integrated maintenance system (regular irrigation, crown pruning, and root protection). This paper analyses functional green spaces in European cities to demonstrate how systematic management enhances tree vitality while providing high-quality recreational environments. The proposed principles aim to optimize green infrastructure as a resilient framework for climate adaptation.

Key words: urban heat island, nature-based solutions, recreational comfort, greenery maintenance, climate change adaptation

Introduction

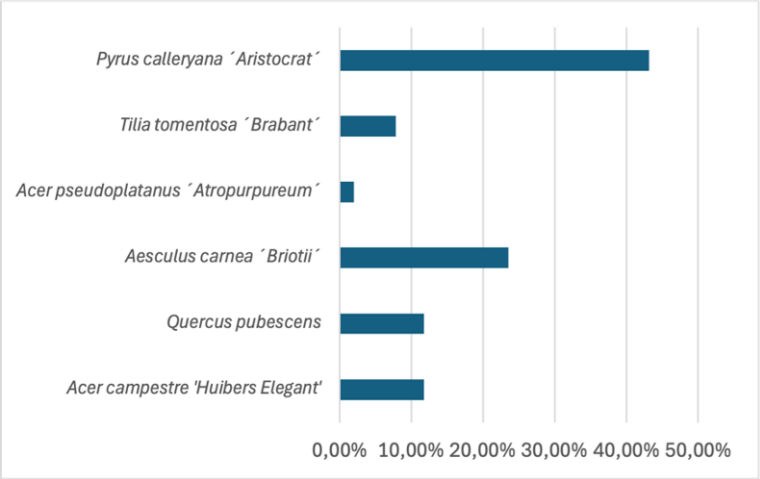
Climate change and urbanization are changing the shape of cities, exposing them to increasing risks and worsening thermal impacts. Although many cities have the resources to adapt, designing resilient urban environments remains a challenge due to accelerating climate change, increasing biotic hazards, and rapid urbanization. Tree plantings are widely used in urban areas as a natural solution to mitigate the effects of climate change and, at the same time, contribute to the sustainable development of cities and the improvement of human health and well-being. In addition to the correct selection of trees, the technological basis of planting and the maintenance itself, the latest studies show that community involvement is also a significant element. The participation of the lay public significantly improves the lay public's understanding of how long trees last for future generations (Esperon-Rodrigues, 2025). Trees are among our best allies in the fight against climate change and biodiversity loss. Although we often think of trees in connection with forests, most of our interactions with trees take place in urban environments, where they provide us with shade, moderate heat, mitigate floods, act as a sound barrier, eliminate pollution, enhance the attractiveness of the environment, and much more. However, to preserve and enhance these diverse benefits, we urgently need to rethink the selection of trees for the urban environment to include those species and origins that are best suited to environmental conditions and able to withstand the stress of a rapidly changing and unpredictable climate, spreading pests, and emerging tree diseases. At the same time, it is necessary to emphasize the choice of assortment, which is diverse (Kuczman et al., 2022). By choosing a richer composition of woody plants, the overall resistance of the vegetation to pests and climatic extremes can be significantly increased (Kowalski et al., 2024; Bechera et al., 2022). As reported by Cimburová et al. (2021), trees in urban spaces offer people several benefits, including regulatory, cultural, supply and support services, which are a great benefit for the sustainable development of cities and an attractive attribute for a better quality of life for residents. Improving the benefit level of a better life for users is also the ability of woody plants to capture fine dust particles $PM_{2.5}$, which has a direct impact on air quality. Studies have shown that, for example, Platanus, Acer and Tilia species are among the effective species in this regard (Xiao et al., 2015). As stated in the study by Livesley et al. (2016) the resistance of young trees to urban stressors is the subject of intensive research. Modern approaches include the use of special substrates, innovative planting systems (eg structural soils) and intelligent irrigation technologies. Integrated green planning that takes climate change and extreme weather events into account is key to ensuring the long-term vitality of urban trees.

Materials and methods

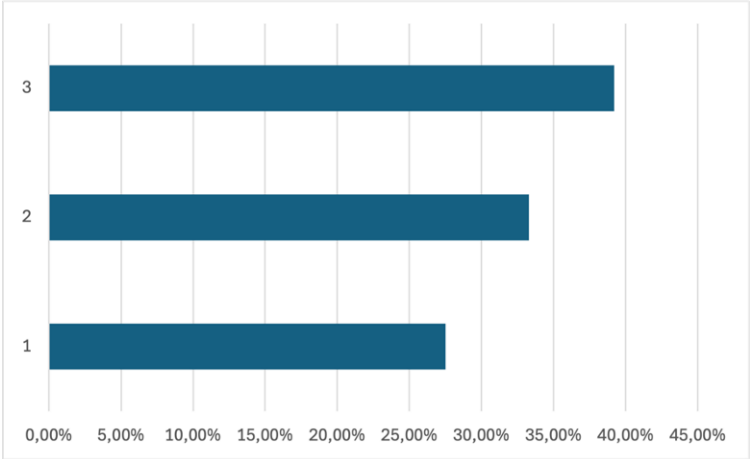
New plantings in cities increase biodiversity and improve the quality of the environment in urbanized areas. The sustainability of biodiversity brings irreplaceable economic and ecological values to humanity. Biodiversity is a prerequisite for the preservation of life on Earth. Trees also have an irreplaceable place in nature, as do many other organisms, and fulfil many functions. Many other organisms also exist directly or indirectly thanks to woody plants, because no animal, human, or plant can survive in isolation from its surroundings. The work is focused on the collection and evaluation of dendrometric data, data on the health status of trees, and on biotechnological procedures during planting and maintenance based on the methodology we have established. Partial results will be published continuously. The findings will lead to an evaluation of the survival rate of new tree plantings and identify the most common damage to them. The contribution of the work will be the evaluation of the correctness of the selection of tree species for the urban environment, the evaluation of individual inventory indicators, together with the proposal of the application of biotechnical measures that will lead to the elimination of adverse environmental effects and contribute to increasing the survival rate and quality of newly planted trees. It is important in the future to identify the determining factors that affect the survival rate of new plantings. These criteria include lack/excess of available water in the soil space, compaction, soil type, lack of soil air, soil contamination, heat island effect, reduced growth space, range and quality of planting material on green areas in urbanized areas.

Results

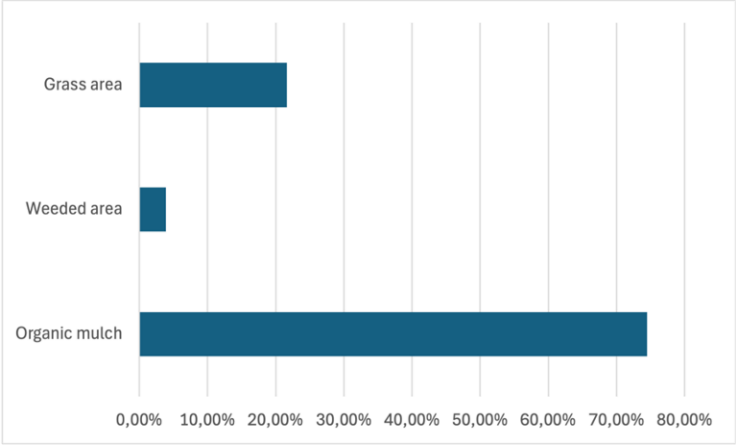
The research problem is defined by the high mortality of trees in public greenery, i.e. the factors that influence it. Increased death of newly planted trees in the first years after planting has been observed for a long time in the public gardens of settlements. This high mortality of trees significantly reduces the efficiency and return on investment in planting, negatively affects the aesthetic, ecological and air-conditioning function of greenery. The causes of the failure and death of plantings are diverse - from inappropriate species composition, through technological mistakes in planting, insufficient watering, and incorrect follow-up care. As a model area, an area of greenery in an urbanized environment in the village of Neunkirchen (Lower Austria) was selected. A total of 51 young trees were evaluated in the model area, which were planted between 2018 and 2020. The percentage representation of trees is shown in graph 1. The planting of the area was carried out by a local private company, and the emphasis was also on the continuity and continuity of the positive relationship to greenery and trees on the part of the users and residents of the new housing complexes. However, the subsequent care of the trees after their planting was not completely consistent, and a total of 11 trees fell in the area, which were not included in our study due to their death. Other trees have minor damage, which we observe mainly in the case of damage to the trunk by a support round in the case of trees with one or two perpendiculars. Most woody plants have a system of three mooring poles, as shown in graph 2. In the model area, most of the trees are mulched with wood chips. We also see areas that are weedy or have grass, as shown in graph 3. The largest increases were observed in trees from weedy areas, which did not even have an irrigation bag installed. Water management is therefore efficient, and the green soil cover can be effectively used by trees in the dry stage.



Graph 1: Share of woody plants in the evaluated area



Graph 2: Percentage representation of the number of mooring poles



Graph 3: The tree root bowl cover

Discussion

In cities, trees are exposed to many stress factors, such as air pollution, limited space for the root system, increased temperatures (urban heat island effect) or soil salinization during the winter season (Gillner et al., 2015). New plantings in cities increase biodiversity and improve the quality of the environment in urbanized areas. The sustainability of biodiversity brings irreplaceable economic and ecological values to humanity. Biodiversity is a prerequisite for the preservation of life on Earth. Trees also have an irreplaceable place in nature, as do many other organisms, and fulfil many functions. Many other organisms also exist directly or indirectly thanks to woody plants, because no animal, human or plant can survive in isolation from its surroundings.

Conclusion

Trees and green spaces in the urban environment represent the primary pillar for the sustainable development of metropolises and the well-being of their inhabitants. They provide a wide range of ecosystem services, including air quality improvement, microclimate regulation, and the essential support of physical and psychological health of recreational users. This study highlights that for recreation and nature protection to truly go „hand in hand," there must be a profound respect for the biological needs and long-term vitality of trees within the demanding conditions of public spaces.

The high mortality of young plantings observed in our research underscores the consequences of neglecting this balance. Effective planning, the selection of resilient taxa (such as *Tilia*, *Quercus*, or *Zelkova*), and proper technological maintenance are not just technical requirements, but acts of respect toward nature that ensure these living organisms can fulfil their recreational role for decades. Furthermore, involving the lay public and fostering their awareness of the significance of urban greenery is crucial for creating a shade responsibility for our environment.

Ultimately, only an integrated approach that prioritizes tree vitality can transform urban green infrastructure into a resilient framework for climate adaptation. By protecting the health of our urban forests, we directly protect the quality of human reaction, ensuring that both can coexist in a sustainable and mutually beneficial harmony.

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Souhrn
Stromy a zelené plochy v městském prostředí představují základní pilíř udržitelného rozvoje metropolí a kvality života jejich obyvatel. Poskytují širokou škálu ekosystémových služeb, mezi které patří zlepšování kvality ovzduší, regulace mikroklimatu a v neposlední řadě zásadní podpora fyzického i psychického zdraví uživatelů při rekreaci. Tato práce a následné hlubší studium ukazují na naléhavou potřebu nastolit rovnováhu mezi významem těchto benefitů a zajištěním vitality stromů v náročných podmínkách veřejných prostranství.
Aby rekreace a ochrana přírody v městském prostředí kráčely skutečně „ruku v ruce", je nezbytný hluboký respekt k biologickým potřebám dřevin. Vysoká mortalita mladých výsadeb, kterou jsme v rámci výzkumu zaznamenali, podtrhuje důsledky opomíjení této rovnováhy. Efektivní plánování, výběr odolných taxonů a správná technologická péče nejsou pouze technickými požadavky, ale projevem respektu k přírodě, který zaručuje, že tyto živé organismy budou moci plnit svou rekreační roli po celá desetiletí.
Považujeme za velmi důležité zapojit do tohoto procesu i laickou veřejnost a podporovat její povědomí o významu městské zeleně. Pouze dlouhodobý a komplexní přístup, který prioritizuje vitalitu stromů, může zajistit, že městská zelená infrastruktura bude fungovat jako odolný rámec pro adaptaci na změnu klimatu. Ochranou zdraví našich městských stromů přímo chráníme kvalitu rekreace pro člověka a zajišťujeme, aby obě tyto složky mohly existovat v udržitelném a vzájemně prospěšném souladu.
Jedním z mých oblíbených citátů je myšlenka profesora Machovce (1982): *„Porosty stromů v urbánním prostoru jsou tím nejhodnotnějším bohatstvím, které v zahradně-architektonické praxi máme, proto je důležité porosty dřevin chránit."*

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URBAN VOIDS AS LIVING LABORATORIES: AN EDUCATIONAL FRAMEWORK FOR RESEARCH-BASED REGENERATION

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Abstract
Urban voids—often perceived as neglected or residual spaces—can serve as valuable platforms for experimental learning and applied urban research. This paper presents an educational framework that utilizes urban voids as living laboratories for research-through-design approaches in landscape architecture education. The study focuses on a vacant lot located on Jesenského Street in Nitra, Slovakia, where spontaneous successional vegetation has gradually occupied an unused gap within the compact urban structure. The site served as a model territory for an intensive one-week educational workshop involving landscape architecture students. The workshop followed a structured research-based design process that included on-site observation, spatial documentation, and a questionnaire survey capturing perceptions of the site and its potential uses. Based on the collected data, students conducted basic spatial analyses and developed experimental design proposals exploring different transformation scenarios. Rather than producing a single solution, the workshop generated a set of conceptual strategies representing diverse spatial approaches—from minimal interventions preserving spontaneous vegetation to more structured systems and gradual transformation scenarios redefining the relationship between wilderness and designed public space. The synthesis of these proposals resulted in a series of design principles and recommendations applicable to the regeneration of small urban voids.

Key words: research through design, participatory workshop, urban gaps, successional vegetation, urban greenery

Introduction

The transformation of contemporary cities is often accompanied by the emergence of underutilized or abandoned spaces, commonly referred to as urban voids. These spaces, typically perceived as residual or dysfunctional elements of the urban fabric, represent a significant yet underexplored potential for ecological, social, and spatial regeneration (Čibik, 2024; Čibik, 2025a). Recent research highlights their role as flexible and adaptive environments capable of supporting new forms of public space and urban greenery (Vinczeová et al., 2025; Žolobaničová et al., 2025). In the context of sustainable urban development, increasing attention has been given to small-scale interventions, green infrastructure, and the reactivation of forgotten spaces as tools for improving environmental quality and urban livability (Čibik and Jankechová, 2023; Kuczman and Paganová, 2024). Urban voids, due to their fragmented distribution within compact city structures, offer unique opportunities for experimental approaches that integrate ecological processes with design strategies. These approaches often combine bottom-up initiatives, participatory processes, and educational activities, contributing to the creation of socially responsive public spaces (Miklášová et al., 2021; Porvazník et al., 2025; Paganová and Kuczman, 2025). At the same time, the integration of vegetation and landscape elements into urban environments plays a crucial role in enhancing biodiversity, microclimatic regulation, and recreational potential (Kuczman et al., 2022; Bihuňová and Štěpánková, 2024). This is particularly relevant in the context of small and neglected urban spaces, where even minimal interventions can significantly influence environmental performance and user experience (Čibik, 2025b). Despite these developments, there is still a lack of structured frameworks that would connect research, design, and education in the context of urban void regeneration. This paper addresses this gap by proposing an educational model that treats urban voids as living laboratories for research-through-design processes. Through a case study of an intensive student workshop conducted on a vacant site in Nitra, Slovakia, the study explores how experimental design approaches can generate diverse spatial scenarios and contribute to a deeper understanding of the regenerative potential of urban voids.

Materials and methods

Materials: The research was conducted on a vacant urban plot located on Jesenského Street in Nitra, Slovakia (48.317653, 18.085006). The site represents a typical urban void within a compact city

structure, characterized by a narrow gap between adjacent buildings and the presence of spontaneous successional vegetation. Due to its morphology and location, the space reflects common conditions of underutilized inner-city parcels with limited functional use and accessibility. The site served as a model territory for an intensive one-week educational workshop involving students of landscape architecture. The workshop was organized as part of a research-oriented teaching process, where the urban void was approached as a living laboratory for experimental design and applied research. The selected location provided suitable conditions for observing the interaction between spontaneous natural processes and potential design interventions within a constrained urban environment.

Methods: The research was based on a research-through-design approach, combining analytical and experimental methods within the framework of an educational workshop. The process consisted of several consecutive phases. The initial phase focused on on-site observation and spatial documentation, including the analysis of spatial configuration, vegetation structure, and existing patterns of use. This was followed by a questionnaire survey aimed at capturing user perceptions of the space, its current qualities, and potential future uses. Based on the collected data, students conducted basic spatial analyses and developed conceptual design proposals exploring different transformation strategies. The proposals varied in their level of intervention, ranging from minimal approaches preserving spontaneous vegetation to more structured spatial systems introducing new spatial organization.

Results

The final phase involved the synthesis of individual proposals into a unified matrix of scenarios, representing a spectrum of spatial approaches and intervention intensities. This matrix served as an analytical tool for comparing different strategies and identifying recurring design principles. The evaluation of the proposals was based on key parameters, including spatial configuration, functional adaptability, ecological integration, and social activation.

The workshop resulted in a set of experimental design proposals exploring different approaches to the transformation of the selected urban void. Rather than converging towards a single solution, the individual outputs revealed a wide range of spatial strategies reflecting diverse interpretations of the site and its potential.

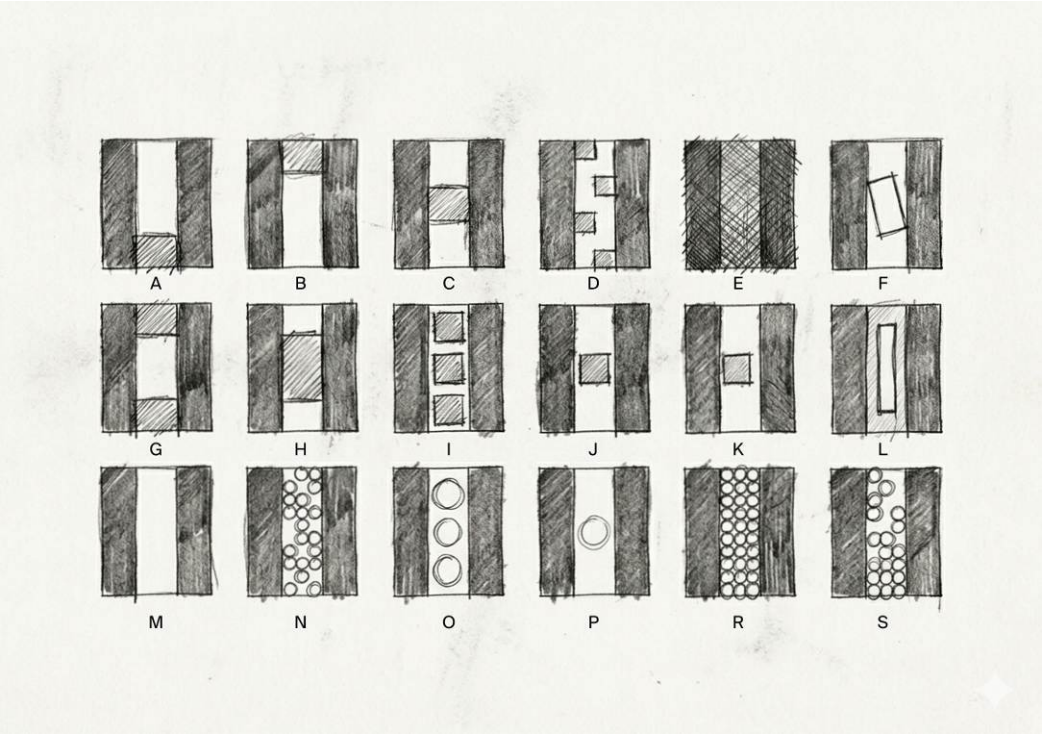

Fig. 1: Matrix of student-generated intervention scenarios (A–S) illustrating object-based (A–L) and vegetation-based (M–S) approaches to urban void transformation. Source: author.

To enable comparative analysis, the proposals were synthesized into a unified matrix of intervention scenarios (Fig. 1), labeled A–S. The matrix is structured according to the type of spatial intervention, distinguishing between object-based (built) and vegetation-based strategies. The first two rows (A–L) represent interventions based on the insertion of built elements, while the third row (M–S) focuses on vegetation-driven approaches. Within the object-based scenarios (A–L), several sub-categories can be identified. Scenarios A–D explore compact and centralized insertions, while E–H introduce larger or more dominant spatial elements. Scenarios I–L focus on linear or vertical structuring, organizing the space through directional elements and spatial sequencing. These approaches demonstrate varying degrees of spatial definition and functional specificity. The vegetation-based scenarios (M–S) represent a contrasting set of strategies, emphasizing ecological processes and spatial softening. Scenarios M–P illustrate dispersed or singular planting elements, while N, R, and S explore densification through clustered vegetation systems. These approaches highlight the potential of planting strategies to redefine spatial boundaries, enhance biodiversity, and improve microclimatic conditions.

The results demonstrate that even within a constrained urban void, a wide spectrum of spatial possibilities can be generated. The matrix reveals different relationships between built structure and natural processes, ranging from minimal intervention to more intensive spatial transformation. The analysis confirms that the value of the design process lies not in producing a single optimal solution, but in generating a range of alternative scenarios. This approach enables a deeper understanding of the spatial potential of urban voids and supports the development of adaptable and context-responsive regeneration strategies.

Discussion and Conclusion

The results of the workshop demonstrate that urban voids can function as effective platforms for research-based education and experimental design. The use of a real site within a compact urban structure allowed students to engage directly with spatial constraints, ecological processes, and user perceptions, reinforcing the value of site-specific learning. The matrix of scenarios reveals that even small and constrained urban spaces can accommodate a wide range of spatial strategies. The distinction between object-based and vegetation-based interventions highlights two fundamentally different approaches to regeneration: one focused on spatial definition and functional structuring, and the other on ecological processes and gradual transformation. These approaches are not mutually exclusive but can be combined to create hybrid systems that respond to both environmental and social needs. From an educational perspective, the research-through-design approach proved to be an effective tool for generating diverse and comparable outputs. The structured process enabled students to move from observation and analysis to conceptual design, while the synthesis of individual proposals into a unified matrix provided a higher level of abstraction and interpretation. This step was crucial in transforming individual design solutions into a transferable analytical framework.

The findings suggest that the value of urban voids lies not only in their physical characteristics, but also in their capacity to act as experimental environments. When approached as living laboratories, these spaces support the exploration of alternative design strategies, encourage critical thinking, and facilitate the integration of ecological and social aspects of urban development.

In conclusion, the proposed educational framework contributes to the broader discourse on sustainable urban regeneration by demonstrating how small-scale interventions and research-based teaching methods can be combined. The resulting matrix of scenarios offers a transferable tool for understanding and designing urban voids, while also highlighting the importance of flexibility, adaptability, and context-responsive design in contemporary landscape architecture.

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Souhrn
Městské prázdnoty mohou sloužit jako experimentální prostředí pro výuku a výzkum v oblasti krajinářské architektury. Studie představuje edukační rámec založený na přístupu research through design, aplikovaný formou workshopu na reálném území v Nitře. Výsledkem je matice scénářů, která ukazuje různé přístupy k transformaci těchto prostorů a jejich potenciál pro ekologickou i sociální regeneraci.

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USE OF MEDICINAL PLANTS AS A PART OF CULTURAL INTERPRETATION AND ENVIRONMENTAL EDUCATION

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Abstract

The paper focuses on the possibilities of using medicinal, aromatic and spice plants (MAPs) in environmental education and in the interpretation of cultural and natural heritage within recreational and tourism activities.

Based on the study of selected historical herbaria, the identification and quantification of recorded plant species are carried out. The findings are further applied in the development of a methodology for establishing exhibition plantings of MAPs inspired by historical sources, which can serve as components of educational gardens, botanical displays or interpretive trails.

The research also includes an analysis of methods for preparing durable plant exhibits for exhibition and educational purposes, for example through freeze-drying and other preparation techniques. These exhibits represent a sustainable alternative to living plants, as they enable long-term presentation of plant material without the limitations of seasonality and high maintenance requirements.

The result is a set of practical approaches and recommendations that link the study of historical sources with modern forms of plant presentation and contribute to the development of environmental education, the interpretation of cultural landscapes, and the sustainable recreational use of natural and cultural heritage.

Key words: herbarium, plant preservation, exhibition planting, education, garden tourism

Introduction

Medicinal plants represent an important link between cultural heritage and environmental education, as they enable the interpretation of historical knowledge while simultaneously supporting contemporary approaches to their conservation and presentation.

The origins of herbaria date back to the 16th century, when the spread of paper following the invention of the printing press enabled the effective drying and preservation of plants. The first herbaria were created around 1540, most likely in Italy, and rapidly spread across Europe, where they became a key tool for botanical research and systematics (Thijsse, 2025). An important role was played by the order of the Brothers Hospitallers, within which herbaria served both practical and educational purposes. Notable examples include the herbaria of Joachim Ramschissl, Norbert Boccius (1766), and Menander Fekete (1841) (Surá et al., 2023). The Broumov Herbarium from 1595 represents the oldest known herbarium in the territory of the Czech Republic and constitutes a valuable source for understanding the history of botany in Central Europe (Skružná et al., 2024). At present, emphasis has shifted towards the conservation, research, and accessibility of herbarium collections, reflected in methodological approaches to the care of *hortus siccus* collections (Novák et al., 2025).

Drying is one of the oldest methods of plant preservation, enabling long-term stability of material, although this results in the loss of spatial structure. The effects of various drying agents on the quality of plant material, including colour and inflorescence shape, have been described, for example, in *Bellis perennis* and *Malva sylvestris* (Jezdinský et al., 2024, 2025). Other methods include glycerine preservation, which maintains tissue flexibility (White et al., 2007), and encapsulation in epoxy resin, which allows long-term preservation of shape and structure (Pratheeksha & Tanuja, 2024). Additional

approaches include liquid preservation, staining, and freeze-drying (lyophilisation), which, according to Antal et al. (2011), preserves aromatic compounds more effectively than hot-air drying, although optimal conditions for plant materials cannot be universally defined (Chen et al., 2000).
An alternative to these methods is the preservation of plants *in situ* through exhibition plantings, which allow the presentation of living plants in their natural context and fulfil an important educational function (Smékalová et al., 2025). These plantings also enable direct interaction between visitors and plants, supporting a better understanding of their biological characteristics and historical uses.
The aim of this paper is to present the outputs of the project "History of the Use and Cultivation of Medicinal Plants as Part of National and Cultural Identity", which focuses on the analysis of historical sources, the development of the use of medicinal, aromatic, and spice plants, and the creation of tools for their presentation. The study is conceived as an integrated approach combining historical analysis of herbarium collections, the establishment of exhibition plantings, and experimental verification of plant preservation methods.

Material and methods
The research was designed as a combination of historical-analytical study, field implementation, and experimental work, forming three interrelated pillars.
Within the first pillar, a floristic revision of selected herbarium specimens from the digitised historical herbarium of Norbert Boccius (1766) was carried out. Individual specimens were taxonomically identified and the representation of species was quantified. The following sources were used for identification: Key to the Flora of the Czech Republic, Flora of the Czech Republic (Vols. 1–8), the Pladias database, Plants of the World Online (POWO), and the Global Biodiversity Information Facility (GBIF). The obtained data served as a basis for further applications in the interpretation of historical sources.
The second pillar focused on the design and implementation of an exhibition planting of useful plants in the grounds of Kačina Castle. The planting design was based on historical sources and the results of the floristic analysis of the Boccius and Broumov herbaria. Species requirements, as well as aesthetic and educational aspects, were considered during planning. The implementation included site preparation and planting of selected species.
The third pillar consisted of experimental verification of freeze-drying methods for flowers intended for exhibition and educational purposes. Due to the problematic structure of flowers (high water content and low tissue permeability), a modified approach was applied in addition to the standard procedure. Freeze-drying was performed using a Lyotrade Amaru device. Flowers were immediately frozen after collection at −75 °C, subsequently tempered in a pre-cooled freeze-dryer (−35 °C, 50 kPa, 8 h), and then dried at a pressure of 40 Pa and a shelf temperature of 35 °C for 36 h. In the modified procedure, flowers were immersed in deionised water (7 °C) prior to freezing, fixed to prevent floating, and after 24 h of freezing (−75 °C) freeze-dried under identical conditions.

Results
1) Survey of selected herbarium specimens
The Boccius herbarium was found to contain a total of 1,136 specimens across three volumes, of which 885 have been reliably identified to date. The ten most represented plant families account for approximately 60% of all identified species. The family Asteraceae predominates, followed by Lamiaceae, Fabaceae, and Apiaceae among native species and archaeophytes. In contrast, Poaceae—one of the most species-rich families in the Czech flora—is only the sixth most represented in the Boccius herbarium.
Comparison with the Czech Pharmacopoeia (2023) revealed 74 unique species corresponding to 98 herbarium records, representing approximately 8% of the total number of specimens.
2) Establishment of an exhibition planting
An exhibition bed measuring 24.5 × 2 m was established in the grounds of Kačina Castle, situated in front of the former carriage house. The planting was based on historically documented medicinal and useful plants recorded in both the Boccius and Broumov herbaria and includes approximately 40 species, predominantly perennials.
The first phase (14 October 2025) involved the planting of perennial species, with annuals to be added in spring 2026. The species composition includes, for example, *Achillea pannonica*, *Antennaria dioica*, *Anthemis tinctoria*, *Aquilegia vulgaris*, *Foeniculum vulgare*, *Fragaria vesca*, *Hypericum perforatum*, *Malva sylvestris*, *Nepeta cataria*, *Salvia pratensis*, *Thymus pulegioides*, and *Veronica spicata*.
The planting forms a coherent functional and visual unit corresponding to the intended historical-educational concept and will serve as an outdoor component of the exhibition *"Gardens Bound in Books"* at Kačina Castle in 2026.

3) Optimisation of freeze-drying methods
Under standard freeze-drying conditions, significant deformation or “inflation” of petals was observed across all analysed samples (*Ficaria verna*, *Viola odorata*, *Bellis perennis*, *Geranium sanguineum*).
In contrast, the method involving freezing in an ice matrix resulted in markedly better preservation of both shape and colour.

Discussion
The species composition of the Boccius herbarium indicates a dominance of families such as Asteraceae, Lamiaceae, and Apiaceae, differing from their representation in the flora of the Czech Republic (Slavík, 1997; 2000; Slavík & Štěpánková, 2004). This can be explained by the higher proportion of medicinal and otherwise useful species within these groups. Conversely, the lower representation of Poaceae is likely related to its more limited practical use. The relatively low overlap with the Czech Pharmacopoeia (2023) reflects differences between historical and contemporary concepts of medicinal plants.
Further findings demonstrate the potential of historical herbarium data as a basis for the design of educational plantings that connect cultural heritage with environmental education and landscape interpretation. The Kačina planting exemplifies the practical translation of such historical botanical data into a contemporary interpretive context. Species selection considered not only historical relevance but also ecological adaptability and functionality in public spaces. The resulting concept therefore represents not merely a reconstruction, but a purposeful interpretation adapted to current educational and presentation needs.
The observed deformation of petals during freeze-drying can be attributed to tissue expansion caused by water vapour accumulation combined with structural collapse when critical temperature thresholds are exceeded. Imbalances between heat input and sublimation rate likely resulted in increased internal pressure and tissue expansion. Simultaneously, local exceeding of the glass transition temperature (Tg) may have reduced viscosity and mechanical stability (Karathanos et al., 1996). Freezing in an ice matrix mitigated overheating and enabled more uniform vapour removal, resulting in improved preservation of both morphology and colour.

Conclusion
The study of the Boccius herbarium revealed differences between historical and contemporary concepts of medicinal plants. These findings were successfully applied in the design of an exhibition planting representing a practical interpretation of historical sources within a modern educational context. Furthermore, optimisation of freeze-drying methods demonstrated the potential to produce higher-quality plant specimens with preserved structure, suitable for long-term use in environmental education and the presentation of cultural and natural heritage. This integrated approach—combining historical research, practical implementation, and innovative preservation techniques—represents a valuable model for the application of botanical knowledge.

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Souhrn
Tato studie představuje integrovaný přístup k využití léčivých, aromatických a kořenících rostlin v environmentální výchově a zprostředkování kulturního dědictví. Analýza historického herbáře Norberta Bocciuse odhalila rozdíly mezi historickým a současným pojetím léčivých rostlin, které byly následně uplatněny při návrhu výstavní výsadby. Současně se ukázalo, že upravené metody lyofilizace zlepšují zachování struktury rostlin. Výsledky potvrzují přínos propojení historického výzkumu, praktické realizace a inovativních technik prezentace rostlin.

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VOLEC II – "THE FOREST ROAD NETWORK INFLUENCE ON RUNOFF FROM FORESTS IN CHANGING CLIMATIC CONDITIONS"

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Abstract
The VOLEC II project, supported by the NAZV agency of the Czech Ministry of Agriculture, is primarily focused on water management on forest roads, or rather on influencing the hydric regime of forests through the forest road network. It provides outputs that can be used not only for technical practice, but also for the practice of ecology and forest protection and their stabilization, and also for the area of the social functions of forests. In this area, it is possible to speak in particular about the specific microclimate in the vicinity of forest roads, which forest roads determine, among other things, by adjusting the visual regime in their surroundings. The purpose of the project and the submitted contribution is to propose technical measures to minimize the negative effects of forest roads on the runoff regime in forests in a technical sense, but secondarily to propose measures to improve the microclimate in the vicinity of forest roads and thus strengthen their explicit recreational function.

Key words: humidity regime of forest roads surrounding, microclimate modification, water on forest roads, fecreational role of forest roads

Introduction

In the Czech legislative environment (Decree No. 239/2017 Coll.), a forest road is a purpose-built road for making forests accessible to traffic and connecting them with roads, local or purpose-built roads, which serves for forest management, and in particular for carrying out rescue and liquidation work by components of the integrated rescue system of the Czech Republic and for recreation. The cited decree further defines other technical aspects of forest roads, including measures that address their drainage or water traffic in their surroundings in general. Technically, the forest road network is dealt with in ČSN 73 6108, and recommendations for designing a forest transport network are given in great detail in Zlatuška et al., (2020).

It is generally known that LCS significantly affects runoff processes. Older works, for example, Herynek, (1999) notes the intensification of this influence, especially in areas of spring micro-basins with increasing road network density and the number of drainage elements. The influence of LCS density on the runoff process in the basin was investigated using the DHSVM model by Dymond et al. (2014).

In our conditions, the influence of LCS on the elements of the emergence, recurrence, intensity and peaks of flow waves has been studied for a long time in the Beskydy Mountains in the Červík and Malá Ráztoka basins. However, Chlebek (1987) did not obtain a sufficient set of data for statistical calculations in his research here. Vícha et al. (2009) or Bíba et al. (2006) (in their publications they repeatedly draw attention to this issue and point out the need to pay attention to this topic. In their articles they also mention that forest roads, compared to soil in a forest environment, reduce the possibility of water infiltration and have a higher runoff coefficient. They also summarize the findings of other authors in terms of increasing the culmination of flood flows in the range of 12.5 - 90%. The same conclusions were reached by groups of authors from Oregon, USA and Queensland, Australia, e.g. Wemple et al. (2000) and Forsyth et al. (2006). Lane et al. (2006) in their research on the dispersion of concentrated runoff state that the possibility of dispersion or retention significantly reduces the increase in runoff and the culmination of flood waves from the catchment area. This topic was addressed, among others, by the NAZV project, QK22020146: Technical recommendations for water management within the forest transport network led by doc. Ing. Karel Zlatuška, CSc. solved in cooperation with ČZU in Prague and MENDELU in Brno.

Perhaps the only comprehensive overview of the topic can be provided by a review by Kastridis (2020). In his work, he discusses currently used procedures, emphasizes the importance of already acquired knowledge and suggests measures to mitigate the impact on runoff processes. Like other authors, he points out the need for further research in this area. Among the measures he suggests are, for example, minimizing the creation of incisions when building LCS and within the framework of routing, avoiding source micro-catchments. He also recommends abandoning the idea of modeling

these effects and focusing on direct field measurements, e.g. within the framework of a paired catchment model.

Material and methods

The research project QL25020051 follows on from the research project QK22020146 "Technical recommendations for water management within the forest transport network" (2022-2024) and uses the original locations and their instrumentation. At the Lesy ČZU V Kostelec nad Černými lesy enterprise, this is the JEVANY research object (49.957N, 14.807E); at the ML Křtiny School Forest Enterprise, this is the HABRŮVKA object (49.308N, 16.699E). A total of 90 TOMST point dendrometers with increment measurements in 15-minute intervals and a total of 12 sap flow sensors (EMS Brno, CR) are installed on these areas on the same trees on which dendrometric measurements are performed; with values measured in 10-minute intervals.

At both locations, the flow is continuously measured through pipe culverts equipped with sharp-edged Thomson overflows with US1200 ultrasonic sensors and H7-G-TA4-SZ data loggers (both devices Fiedler AMS, České Budějovice). In the infiltration pits and in the connecting transects related to the infiltration pits, pipe shafts with a perforated lower part are set up, which are equipped with submersible pressure level gauges (TSH37, Fiedler AMS, České Budějovice) continuously monitoring the height of the free water surface; there are a total of 32 measuring points at both locations. Climatic data are obtained from the network of local meteorological stations of the company Amet (Velké Bílovice). For the Kostelec SLP, data from the Tuchorazy station was used, and for the Křtiny SLP, data from the Útok 6 station were used. SMT100 pedological sensors for measuring bulk moisture and soil temperature are installed near the pipe shafts in the walls of the soil excavations (pedological probes); they are placed to a depth of 10 cm, 30 cm and 60 cm. A total of 66 soil profiles were opened and described and 198 soil sensors were installed at both locations. Continuous measurement was set to 10 min. intervals with cloud storage and data management.

Two new research objects were newly established for the research project QL25020051. At the ML Křtiny School Forest Enterprise, this is the ÚTĚCHOV object, cadastral register Bílovice nad Svitavou, South Moravian Region (49.280N, 16.646E); at the Lesy ČZU enterprise in Kostelec nad Černými lesy, this is the DÍLNA research facility, cadastral area Stříbrná Skalice, Central Bohemian Region (49.904N, 14.863E). The location of the existing and newly established research facilities is schematically shown in Figure 1.

Fig. 1: Project localities

Results

Although the project results are still only in the phase of primary collection and evaluation of the first synergies between the individual determined parameters, everything indicates that shallow subsurface runoff is currently a crucial factor in the water balance in the forest stands of the lower hills in the changing climate. At the same time, it is evident that forest drainage routes traced in contour directions interrupt its paths and thus disrupt its natural hydrological influence both in the system of the catchment-runoff process and the soil-wood system, and in its role in providing other forest functions, including the recreational function.

The following graph (Figure 2) demonstrates how significant the influence of the forest drainage road on shallow slope subsurface runoff is. This graph describes the course of the so-called rain experiment at the Habrůvka site. Using this experiment, we create precipitation of the required intensity. We carry out rain experiments because we do not normally achieve the required precipitation

naturally at the project sites. The blue columns in the graph show natural precipitation amounts, the orange column shows the total artificial experimental precipitation, the red line shows the water level in the borehole in the forest road and the gray level in the infiltration pit.

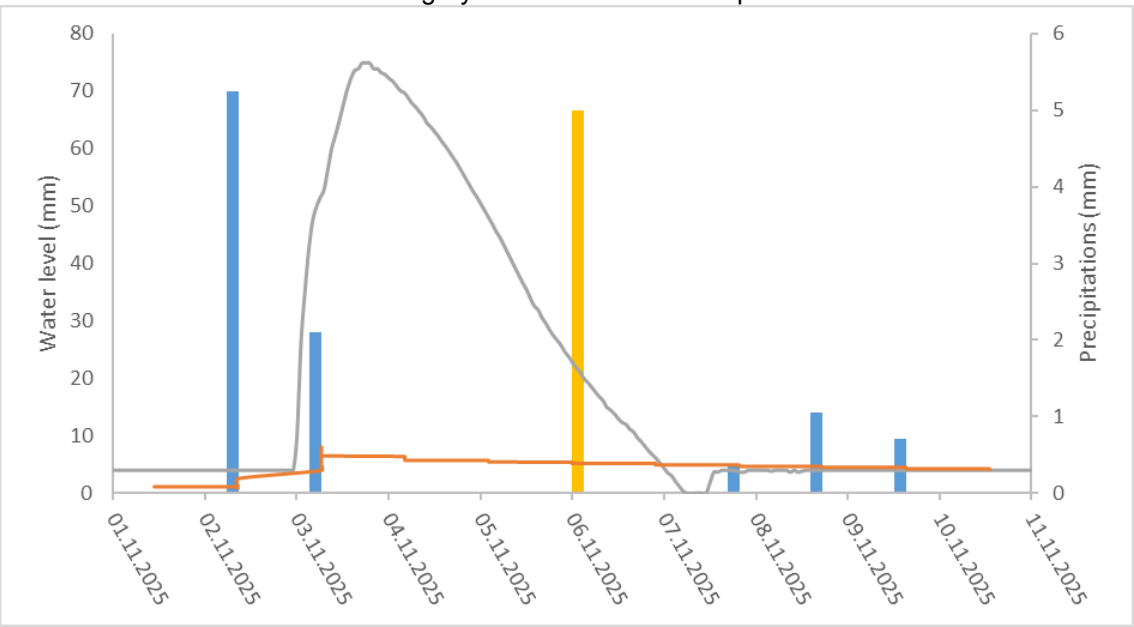

Fig. 2: Results of the rain experiment at the Habrůvka site 6.11.2025

It is clear from the graph that water, the source of which is rain, whether natural or artificial, passes under the road body by means of a pipe culvert, however, a shallow slope drain does not pass under the road.

Discussion

Although the importance of forest roads for recreation in forests is obvious and is also enshrined in some legislative regulations, in the Czech Republic, for example, Decree No. 239/2017 Coll., there are relatively few scientific works that deal with the technical aspects of the effects of forest roads as such on recreation in forests. Most published works understand forest roads more as a means of achieving recreational satisfaction through the forest or natural environment and its effect in general. There are works that address the limits for the use of forest roads for various groups of recreationists in a more technical way (e.g. Lepoglavec et all, 2023).

In this context, we expect that the results of our project will bring, in addition to improving knowledge about the influence of forest roads on shallow slope subsurface runoff, the possibility of using this knowledge not only in the practice of designing forest haul roads, but also in the practice of optimizing their multifunctional use, especially in the field of recreation in forests.

Conclusion

The article presents the VOLEC II project, supported by the NAZV agency of the Ministry of Agriculture of the Czech Republic, and its first results. The project is primarily focused on water management on forest roads, or rather on influencing the hydric regime of forests through a network of forest roads. It is intended to bring outputs that can be used not only for technical practice, but also for the practice of ecology and forest protection and their stabilization, and also for the area of social functions of forests. In this area, we can speak in particular of the specific microclimate in the vicinity of forest roads, which forest roads determine, among other things, by modifying the visual regime in their surroundings. It turns out that the knowledge of the parameters that influence the recreational understanding of forest roads other than just as a means of achieving other recreational connections is relatively low. In addition to the specific limits resulting for vacationers, e.g. from restrictions on their movement, it is clear that the character of the forest road and its technical facilities can be one of the fundamental factors of its recreational use. The project is currently in the phase of data collection and testing of the first implemented measures. Current data indicates that the project's objectives and planned results will be achieved without any problems.

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Souhrn
Projekt VOLEC II, podporovaný agenturou NAZV Ministerstva zemědělství ČR, je primárně zaměřen na hospodaření s vodou na lesních cestách, respektive na ovlivňování hydrického režimu lesů prostřednictvím sítě lesních cest. Poskytuje výstupy, které lze využít nejen pro technickou praxi, ale i pro praxi ekologie a ochrany lesů a jejich stabilizace, a také pro oblast sociálních funkcí lesů. V této oblasti lze hovořit zejména o specifickém mikroklimatu v okolí lesních cest, které lesní cesty určují mimo jiné úpravou vizuálního režimu v jejich okolí. Účelem projektu i předkládaného příspěvku je navrhnout technická opatření k minimalizaci negativních vlivů lesních cest na odtokový režim v lesích v technickém smyslu, ale sekundárně navrhnout opatření ke zlepšení mikroklimatu v okolí lesních cest a tím posílit jejich explicitní rekreační funkci. V současné době je projekt ve fázi sběru dat a testování prvních zrealizovaných opatření. Aktuální data naznačují, že cíle i plánované výsledky projektu budou bez problémů dosaženy.

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WASTEWATER MANAGEMENT AND RECREATIONAL TOURISM IN DAR ES SALAAM: A REVIEW OF CURRENT CHALLENGES

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Abstract
As the primary gateway for tourists in Tanzania, Dar es Salaam faces critical wastewater management challenges that directly threaten the integrity of its tourism industry. The majority of the city's wastewater is discharged untreated into the Indian Ocean. For sustainable tourism, this translates into beach pollution, health risks for visitors, and a loss of aesthetic appeal. Sustainable tourism requires a safe and hygienic environment; however, odors and visible pollution in tourist areas are in direct conflict with the concept of 'ecotourism.' This study aims to identify key practices, successes, and failures, and to explore future prospects for wastewater management in relation to recreational tourism in Dar es Salaam, Tanzania. A systematic search and review of peer-reviewed and grey literature were conducted using electronic databases such as ScienceDirect, Jstor, Scopus, PubMed, and Web of Science. To ensure the stability of the tourism sector, we recommend the implementation of small-scale treatment plants directly within hotel complexes and tourist resorts, along with the construction of artificial wetlands to naturally filter wastewater. Furthermore, essential collaboration between municipal authorities and tourism operators is required, focusing on financing the modernization of the sewerage network in key locations.

Key words: ecotourism, sustainable tourism, tourism infrastructure development, recreational water quality, Tanzania

Introduction

The current era of rapid population growth and industrialization presents a critical challenge in the form of increasing waste, which in developing countries such as Tanzania poses an existential threat to sustainable tourism and the well-being of residents (Yao et al., 2023; Nayeri et al., 2024). Although modern wastewater treatment plants utilize complex physical and biological processes, untreated sewage sludge remains a problematic residue in cities such as Dar es Salaam, which, if not properly managed, causes odor, greenhouse gas emissions, and the spread of diseases, which is in direct contradiction to the vision of ecotourism (Singh et al., 2014; Hreiz et al., 2015). The alarming situation, with only 10 % of the population connected to sewage, is leading to a phenomenon of "vomiting" and massive pollution of the Indian Ocean, which, due to institutional inefficiency and corruption, is devastating coral reefs and biodiversity crucial to international visitors (Wilson, 2015; The Nature Conservancy, 2021). The future stability of the sector therefore depends on overcoming the financial deficit of water authorities and implementing resilient decentralized systems, such as small-scale treatment plants and artificial wetlands directly in hotel complexes, which will transform Dar es Salaam into a clean and competitive gateway to East Africa (Sweya et al., 2018; Wawa, 2020).

Material and methods

A systematic search and review of peer-reviewed and grey literature from electronic databases such as ScienceDirect, Jstor, Scopus, PubMed, and Web of Science was thoroughly utilized to identify articles related to the issue.

Results

The issue of wastewater management in Dar es Salaam is the subject of intensive research, especially in connection with rapid urbanization and the protection of marine ecosystems, which are crucial for tourism. Below we present a synthesis of available scientific papers and reports, classified into categories according to their focus (Table 1).

The critical state of sanitation in Dar es Salaam, where only 25 % of wastewater is adequately treated (EWURA, 2020), directly discredits Tanzania's reputation as a safe and sustainable destination. This infrastructure deficit is causing a demonstrable 22 % drop in hotel occupancy in tourist-attractive areas such as Kigamboni Beach (Waycott et al., 2025). Massive microbial contamination in the Msimbazi

River estuary, exceeding standards by 800 %, combined with the incidence of cholera, seriously threatens the health of visitors and destroys coral reefs crucial for ecotourism (WHO, 2018; The nature Conservancy, 2021). The future stability of the sector therefore depends on the implementation of decentralized technologies (DEWATS), which, according to the World Bank (2024), could increase annual tourism revenues by US$7.1 million and restore the city's status as a competitive gateway to East Africa.

Tab. 1: The summary of the key articles and themes collected and analyzed.

Themes Studied	**Citations**
Current wastewater treatment status in in Dar es salaam	Singh et al., 2014; Hreiz et al., 2015; Wilson, 2015; Worrall et al., 2017 Sweya et al., 2018; Todd et al., 2019; EWURA, 2020; Wawa, 2020; The Nature Conservancy, 2021; UN-Habitat, 2021; Catherine, Augustina, 2022; Yao et al., 2023; Nayeri et al., 2024
Technologies applied in wastewater treatment	Chaggu et al., 2002; NEMC, 2007; BioInnovate Africa, 2014; Kasala et al., 2016; Sinharoy et al., 2019; Wawa, 2020; Catherine, Augustina, 2022; Datola, 2023
Socioeconomic Impact and Tourism	Lau et al., 2020; Mohammed, 2020; Said, Msuya, 2020; World Bank, 2024; Mollel, Mwendapole, 2025
Environmental Degradation	Waycott et al., 2005; Yao et al., 2023; Bakari et al., 2025
Infrastructure and Demographics	Sinharoy et al., 2019; EWURA, 2020; Selemani Msuya, 2025
Public Health	WHO, 2018; Kitole et al., 2024
Technological Solutions (DEWATS)	McFarlane et al., 2014; UNEP / BORDA, UN-Habitat, 2018

Discussion

A closer look at the issue of wastewater management in Dar es Salaam reveals a critical disconnect between Tanzania’s ambitions for sustainable tourism and the reality of its sanitation infrastructure, where uncontrolled sewage discharges directly detract from the coastal recreational potential and threaten public health (Wawa, 2020).

According to published studies, anaerobic digestion (AD) is an innovative solution for tourism resorts and urban centers, which can effectively stabilize sludge, eliminate pathogens and reduce waste volume (Siddiqui et al., 2023). Implementing AD within the framework of a circular economy allows for the production of biogas for energy independence of facilities and the extraction of nutrients for sustainable agriculture, which increases the ecological credit of the destination (Alengebawy et al., 2024). This technological approach not only protects water resources from contaminants such as pharmaceuticals, but also significantly reduces greenhouse gas emissions, thereby supporting the global goals of sustainable tourism (Huang, 2024; Kegl et al., 2025).

Conclusion

A comprehensive analysis of the available literature (EWURA, 2020; World Bank, 2024) clearly demonstrates that the current critical state of sanitation infrastructure in Dar es Salaam is in direct conflict with the principles of sustainable tourism, with uncontrolled discharge of untreated sewage irreversibly degrading coral ecosystems and mangroves crucial to Tanzanian ecotourism (The Nature Conservancy, 2021). Effective management of urban infrastructure and modernization of sanitation systems, including the use of physical, chemical and biological processes in wastewater treatment plants (Hreiz et al., 2015), appear to be priority steps for the long-term sustainability of this East African metropolis.

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The paper was supported by project VEGA 2/0031/23 Analysis and evaluations of the environmental history of selected types of Slovak landscape from the early prehistory to the present.

Souhrn
Kritický stav sanitace v Dáresalámu, kde se čistí pouze 25 % odpadních vod, přímo brzdí udržitelný turismus a devastuje korálové ekosystémy (EWURA, 2020). Pokles hotelové obsazenosti o 22 % v oblasti Kigamboni potvrzuje, že znečištění a zdravotní rizika (cholera) podkopávají konkurenceschopnost destinace (WHO, 2018). Řešením je implementace decentralizovaných technologií (DEWATS, anaerobní digese), které v rámci cirkulární ekonomiky mění odpad na bioplyn a živiny. Podle Světové banky (2024) by tato transformace mohla zvýšit příjmy z turismu o 7,1 mil. USD a vytvořit z města bezpečnou, ekologickou bránu do východní Afriky (Sweya et al., 2018).

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WEEDS IN THE CONTEXT OF EXPERIENTIAL EDUCATION: SUPPORTING THE EDUCATION AND RECREATION OF SENIORS

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Abstract

Weed vegetation represents a specific group of plants that has long accompanied human civilization and evokes numerous memories associated with past activities. Weeds are a common component of gardens, agricultural land, and urban environments, and most older adults have encountered them repeatedly throughout their lives. The aim of this study was to evaluate the potential of using the topic of weeds in senior education within the framework of experiential pedagogy. A specialized course was implemented at the University of the Third Age of Mendel University in Brno in the form of traditional lectures supplemented with extensive demonstrations of individual weed species. The results of a questionnaire survey indicated that older adults recall 26 weed species from childhood, while an additional 7 species are recognized but their names cannot be retrieved now. The most frequently reported species include *Convolvulus arvensis*, *Elymus repens*, *Taraxacum* sect. *Taraxacum*, *Matricaria chamomilla*, *Aegopodium podagraria*, *Urtica dioica*, and *Papaver rhoeas*. The findings further demonstrate that older adults best remember those weed species associated with specific personal experiences. The topic of weeds therefore appears to be suitable for recreational use of leisure time combined with the education of older adults.

Key words: ethnobotany, University of the Third Age, vegetation, older adults

Introduction

Humans and nature are closely interconnected, which is reflected in the affective and emotional responses of individuals and ultimately in the way the environment is perceived (Speake et al., 2013). Traditional knowledge associated with cultural context and plant heritage forms the basis of ethnobotany, a branch of botany focused on the study of interactions between humans and plant biodiversity (Morales et al., 2011). Research to date shows that ethnobotany is a highly motivating tool for students with the potential to promote sustainability while enriching the scientific dimension of education (Gutiérrez-García et al., 2020). Vegetation thus not only fulfills key ecosystem functions, but also provides important cultural services (Fagerholm et al., 2016).

Weeds are one of the most common and well-known plant groups. Their importance and role in agroecosystems can be viewed from different perspectives. On the one hand, weeds are traditionally perceived negatively, as they compete with cultivated crops for nutrients, water and light (Oerke, 2006). However, weed science also includes fundamental questions of plant ecology and evolution within agroecosystems (Neve et al., 2018). Therefore, a deeper understanding of the relationships between changes in weed properties, climate change, the development of cultivation technologies and changes in the agricultural landscape at both global and local levels is crucial (Gaba et al., 2017). In the field of education of older adults, various teaching formats can be used, but they must respect the specific limitations of this target group (Schirmer et al., 2023). Ferreira et al. (2016) point out that seniors require different inclusion strategies than younger learners. According to Gutiérrez-García et al. (2020) informal educational activities implemented within a standard academic environment have a positive effect on the acquisition of botanical and ethnobotanical knowledge. The aim of this work was to verify the possibilities of using the topic of weeds in the education of seniors.

Materials and methods

The course entitled "Weeds and their secrets" was implemented within the Institute of Lifelong Learning MENDELU in the winter semester 2024/2025. The course focused on the most important types of weeds. The students were introduced to their ecosystem functions and negative impacts, and attention was also paid to the possibilities of weed control.

In the last lesson, the participants were presented with a questionnaire to fill out. Based on the answers, information was obtained about the students' education, specifically about its level and focus. The answers to open-ended questions, in which the students gave the names of the weed species, served to verify the knowledge gained from the course. A total of 30 completed questionnaires were submitted.

Results

The answers to the question “Which types of weeds do you remember from childhood” in the course “Weeds and their secrets” show that the students recall a total of 26 types of weeds from the lesson, while in 7 cases they remember the species but cannot recall its name.

The most frequently mentioned species *include field bindweed (Convolvulus arvensis), creeping fescue (Elymus repens*), dandelion (*Taraxacum* sect. *Taraxacum*), common chamomile (*Matricaria chamomilla*), goitre (*Aegopodium podagraria*), stinging nettle (*Urtica dioica*) and poppy (*Papaver rhoeas*). The number of answers for each species is shown in Figure 1.

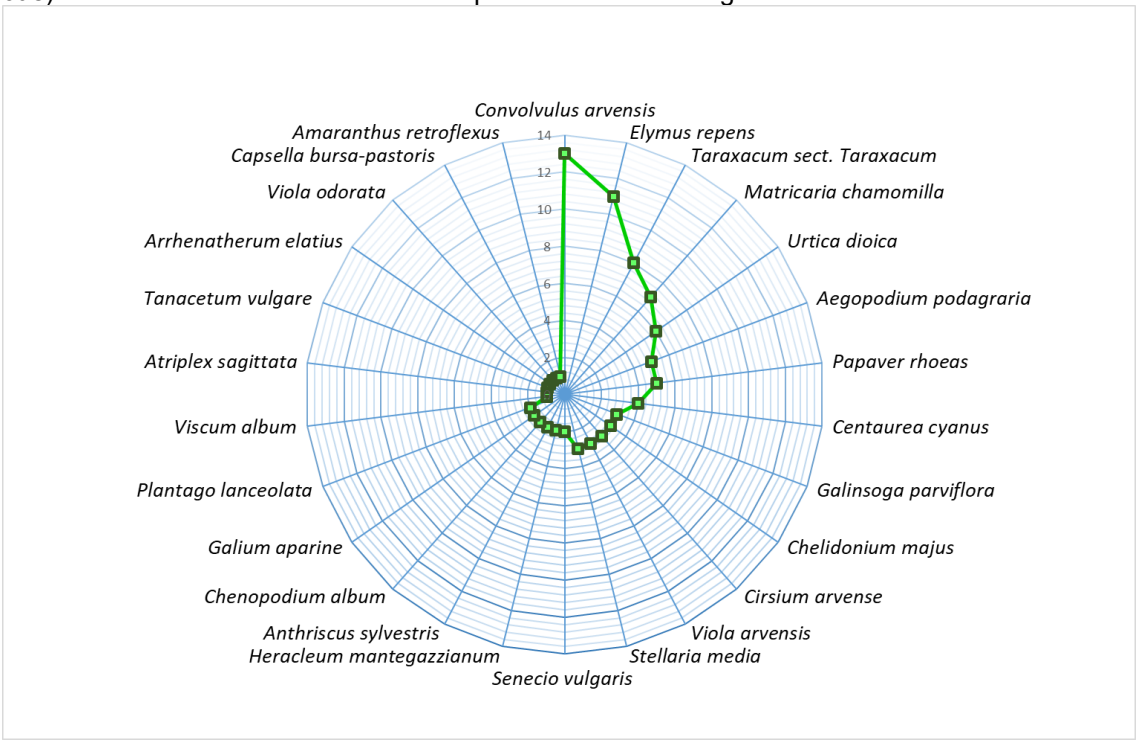

Fig. 1: Number of responses that mention specific weed species.

Discussion

Education in the field of plant species identification requires time, patience and also professional guidance that ensures adequate feedback (Pearson et al., 2011). The acquisition of knowledge about plants should have a higher priority, especially in the context of global biodiversity loss (Pernat et al., 2023). This also places increased demands on educators providing education on ethnobotanical topics.

From the perspective of seniors, physical activity, sensory perception and personal experience play an important role in learning, which together support memory and evoke memories. Multifaceted stimulation – including sight, touch and smell – contributes to better memorization of new information. Learning about plant species, including weeds, can thus lead to diverse interactions that are very beneficial for the education of seniors.

At the same time, this topic has significant recreational potential. Activities related to learning about plants in their natural environment combine education with exercise in the fresh air, thereby contributing to the overall mental and physical well-being of seniors. The combination of low-intensity

physical activity, cognitive stimulation, and social interaction represents a suitable form of leisure time that supports active aging and increases the quality of life of older adults.

Conclusion

The course "Weeds and Their Secrets" is an example of a successful connection of university experts from various fields, especially agronomy and pedagogy. An interesting benefit is also the feedback from seniors, which lecturers can use when teaching university students.

The findings also show that older adults remember best those types of weeds that are associated with specific personal experience. The topic of weeds therefore seems to be suitable not only for education, but also for meaningful recreational spending of seniors' free time, which naturally connects learning, movement and sharing of experiences.

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Souhrn

Vegetace plevelů představuje specifickou skupinu rostlin, která dlouhodobě provází lidskou civilizaci a vyvolává četné vzpomínky spojené s minulými aktivitami. Plevele jsou běžnou součástí zahrad, zemědělské půdy i městského prostředí a většina starších dospělých se s nimi během života opakovaně setkala. Cílem této studie bylo zhodnotit potenciál využití tématu plevelů ve vzdělávání seniorů v rámci zážitkové pedagogiky. Specializovaný kurz byl realizován na Univerzitě třetího věku Mendelovy univerzity v Brně formou tradičních přednášek doplněných rozsáhlými ukázkami jednotlivých druhů plevelů. Výsledky dotazníkového šetření ukázaly, že starší dospělí si z dětství vybavují 26 druhů plevelů, zatímco dalších 7 druhů sice poznají, ale jejich názvy si již nedokážou vybavit. Mezi nejčastěji uváděné druhy patří svlačec rolní (*Convolvulus arvensis*), pýr plazivý (*Elymus repens*), pampeliška (*Taraxacum* sect. *Taraxacum*), heřmánek pravý (*Matricaria chamomilla*), bršlice kozí noha (*Aegopodium podagraria*), kopřiva dvoudomá (*Urtica dioica*) a vlčí mák (*Papaver rhoeas*). Zjištění dále ukazují, že starší dospělí si nejlépe pamatují ty druhy plevelů, které jsou spojeny s

konkrétní osobní zkušeností. Téma plevelů se proto jeví jako vhodné pro rekreační využití volného času spojené se vzděláváním starších dospělých.

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WHY IS GLASS DANGEROUS FOR BIRDS

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Abstract
Thanks to technological advances, glass is now used more extensively in the construction industry. Large glazed surfaces are being incorporated into the building envelopes of structures such as recreational facilities and private vacation homes. Glass is also used for noise barriers, bus shelters, and bike racks, as well as for auxiliary structures such as balcony railings. Virtually all glass surfaces can be dangerous to birds; it depends greatly on their surface treatment and, above all, their location. Glass also reflects its immediate surroundings, including trees, thereby creating a fictional environment that birds attempt to enter. The aim of this article is to provide a basic introduction to the issue of bird collisions with glass surfaces. The article will focus on identifying the locations and structures where collisions most frequently occur. Subsequently, options for prevention or additional measures will be presented.

Key words: bird collisions with glass surfaces, glass surface planning, glass reflectivity, transparency.

Introduction

Nature is home to birds. Birds in the wild face a wide range of dangers. Some are natural, while others are caused by humans. Often, it is a combination of several factors at once. Humans frequently destroy the natural habitats that are so vital to birds; they also endanger birds through traffic and by constructing large glass surfaces, not only on buildings.

In many ways, birds see better and more clearly than humans. Their vision is among the most highly developed in the animal kingdom. Many birds have eyes on the sides of their heads, allowing them to see almost all around (up to nearly 360°), giving them a wide field of vision.

Most diurnal birds have tetrachromatic vision. In addition to the three types of cones found in humans, they possess a fourth receptor sensitive to ultraviolet light. This allows them to distinguish color combinations that do not exist for humans and to perceive a much broader spectrum of hues. In connection with sensitivity to UV radiation, it is important to note that many objects in nature that play an important role in birds' lives (e.g., insects, fruits, feathers, or eggs) reflect this radiation. (Šulc, 2014) As a result, the world is far more colorful to them than it is to us, and they perceive color patterns and markings in their feathers that remain hidden from us.

We also know that, for example, the hunting of birds of prey is primarily guided by visual acuity. They can spot prey from a great distance. Although birds have excellent vision, glass surfaces are invisible to them. The reflection of their natural surroundings in large windows is confusing to birds, causing them to injure themselves as they attempt to fly through the glass. Smaller songbirds, such as titmice, finches, blackbirds, thrushes, swallows, and sparrows, as well as some larger bird species, such as woodpeckers and doves, are particularly at risk from glass surfaces. Why do birds collide with glass if they have such good eyesight? First and foremost, it is important to realize that birds move significantly faster on average than mammals. Even small songbirds the size of a tit fly at a minimum speed of 30 km/h when flying short distances, and pigeons, for example, commonly fly at speeds of around 70 km/h.

Material and methods

The most common cause of bird collisions with glass is its transparency. Birds do not perceive glass as an obstacle. They see the sky, trees, or other attractive features in nature through it, try to fly toward them, and collide. Furthermore, the risk of collision increases with the size of the glass surface and its transparency. However, clear (transparent) glass can act as a mirror at certain angles of light incidence; in such situations, clear glass can behave as a reflective surface (Viktora, L., Dolejský, V. 2015).

Reflective glazing is generally considered the most dangerous. In addition to their aesthetic function, their reflective coating also serves a thermoregulatory purpose—it reflects solar radiation and most of the heat energy, preventing a sharp rise in indoor temperature during sunny weather. They are often used for the exterior cladding of entire buildings or parts thereof, and south-facing windows also frequently feature a reflective coating. At the same time, they faithfully reflect their surroundings,

thereby creating a fictional environment that birds attempt to penetrate. For example, mirrored trees appear as a distant target, and birds then collide with the glazing at full speed. These collisions are very often fatal. (Viktora, L., Dolejský, V. 2015)
It doesn't always have to be buildings. Reflective surfaces in the landscape have the same effect.
So which specific locations are dangerous?
First, noise barriers (see Fig. 1) or windbreaks made of transparent materials—such as glass—are most commonly found along major roads and railway lines. These barriers are also frequently installed on bridges that span natural obstacles such as river valleys, bodies of water, or similar areas. It is precisely these areas that serve as natural corridors for birds.

Glass and related materials are becoming increasingly popular building materials in construction. Demand for glass is growing as processing technologies improve its physical properties. For example, the use of glass for cladding entire buildings or parts of them (large glass surfaces, entrance portals, atria, connecting passages, etc.) is very popular, especially where greenery is incorporated. Sometimes it is precisely the architect's intention to reflect the interesting immediate surroundings on the facade (see Fig. 2) or even on a building such as a mountain cable car station or a mountain hotel. Views into the interiors of buildings or through the entire structure may be designed. The danger also increases in confined spaces (e.g., a glass wall between two large buildings).

Fig. 1: Noise and wind barriers along roads
Fig. 2: Mirroring trees is aesthetically pleasing, but not at all suitable for birds

Small structures in open landscapes, such as bus, train, or public transit stops, may also consist solely of clear or reflective glass panels mounted on metal frames. Similarly, clear panels are used to enclose playgrounds (see Fig. 3), certain sports facilities, seating areas in restaurant gardens, and even animal enclosures in zoos. There are, therefore, many places that offer views of the surrounding area, but they also pose a danger to birds. Glass railings on balconies or green roofs with vegetation planted behind them can also become hazardous areas.

Results
If transparent surfaces in exposed areas cannot be avoided, it is essential to reduce their transparency. The most effective method is to use semi-transparent materials or materials with a pattern covering the entire surface. It has been shown that silhouettes of birds of prey do not serve the intended purpose. Stickers featuring bird silhouettes are not a sufficient protective measure to make the infill visible (see Fig. 4).
To effectively prevent bird collisions, transparent surfaces must be modified so that they are visible to birds. While reduced transparency may limit our view, it will prevent further bird collisions. There are two options to choose from: patterns covering the entire surface (such as stripes or dots), see Fig. 5, or alternative materials, such as matte, light-transmitting materials like patterned, textured, or frosted glass. Glass manufacturers offer a wide range of standard patterns.

Fig. 3: Glass screens at the playground prevent flying objects from passing through

Fig. 4: It is found that silhouettes of predators do not have the desired effect

Fig. 5: Transparent glass at stops can be made visible with stickers according to recommendations

Clear outlines and high-contrast lines are the most effective patterns. Tests have shown that red and orange patterns are significantly more effective than the same patterns in shades of blue, green, or yellow. Vertical lines perform slightly better than horizontal lines. Markings placed on exterior surfaces are even more effective, as they break up reflections. It is generally recommended to use proven patterns, as even small changes in the pattern can result in significant changes in effectiveness. Rules for additional printing—linear patterns:

- Lines must always be at least 3 mm thick with a maximum spacing of 25 mm (horizontal lines) or 5 mm thick with a maximum spacing of 100 mm (vertical lines).
- Dotted patterns should cover at least 15% of the surface area. Coverage may be reduced to 4% only if the diameter of the dots exceeds 30 mm. Dots should have a diameter of at least 5 mm. The dotted pattern should contrast sharply with the background; otherwise, the lines must be thicker.

(Schmid et al., 2021)

Guidelines for the design of bird collision protection elements for new noise barriers (TP 104, 2024)

- Use panels with integrated vertical or horizontal black lines, typically 2 mm wide with a spacing of 30 mm;
- Alternatively, the following may be used: • panels with sandblasted stripes 20–30 mm wide, spaced at a maximum of 100 mm for vertical stripes and a maximum of 50 mm for horizontal stripes

- integrated wire mesh with 20 × 20 mm mesh openings,
- Screen-printed black lines, typically 2 mm wide with a spacing of 30 mm;
- As a supplementary measure to the above, subtle color shading of transparent fill areas may be used.

Semi-transparent glass surfaces, walls, and blocks are building elements that pose no danger to birds. Depending on the material used, sufficient natural light can be achieved.
Adjustable and fixed shading elements on the exterior of a building's glazed surfaces serve not only to protect against overheating. Depending on their type and method of installation, they can also help reduce the risk of bird collisions. For example, double-pane windows with integrated vertical blinds allow diffused light into the interior while simultaneously increasing bird safety. Horizontal blinds also help make the glass more visible to birds (see Fig. 6).

Fig. 6: External shading elements provide sufficient protection for birds

Additionally, colored surfaces with low reflectivity and rich colors can be safe for birds.
To reduce the risk associated with reflectivity, it is recommended to install glass with an external reflectance coefficient of 15% or lower (Schmid et al., 2021).

Conclusion

Glass surfaces can be very dangerous for birds. Collisions occur due to the transparency and reflectivity of the glass. If it is not possible to modify the glass so that it is not invisible to birds, the immediate surroundings of a building with glass surfaces must be modified so that they are not attractive to birds. This primarily means planting trees and shrubs at a distance of approximately 30 meters from the facade, avoiding the placement of bird feeders, and refraining from designing water features. Trees should only be placed in front of non-reflective parts of buildings. This must be addressed during the design phase to avoid the need for additional measures later. A simple measure can be applying additional window decals or installing blinds. Previous window decals featuring silhouettes of birds of prey on bus stops and noise barriers are being replaced with more effective decals in the form of stripes or dots of recommended dimensions.

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Souhrn

Prosklené plochy pro ptáky mohou být velice nebezpečné. Dochází ke kolizím v důsledku průhlednosti a odrazivosti. Jestliže nemáme možnost sklo upravit tak, aby nebylo pro ptáky neviditelné, je třeba prostředí v nejbližším okolí budovy s prosklenými plochami upravit tak, aby nebylo pro ptáky atraktivní. Znamená to zejména vysazovat stromy a keře ve velké vzdálenosti od fasády, neumisťovat krmítka pro ptáky nebo ani nenavrhovat vodní plochy. Stromy mohou být jen před neodrazivými částmi budov.

To je třeba řešit již v projektu, aby nebylo nutné provádět dodatečná opatření. Jednoduchým opatřením pak mohou být dodatečné polepy skel nebo instalace žaluzií. Dřívější polepy skel siluetami dravců na zastávkách a protihlukových clonách se nahrazují účinnějšími polepy ve formě pruhů nebo teček doporučených rozměrů.

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ZERO-EMISSION SPORT AND RECREATIONAL FLYING?

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Abstract
This article provides a comprehensive overview of gliding as a form of sport and recreational aviation, emphasizing its close relationship with natural atmospheric phenomena and its minimal environmental impact. It introduces the broader context of sustainability in aviation and outlines relevant European, international, and Czech regulations that influence gliding activities. The text traces the historical development of gliding from early 19th-century experimental gliders to the emergence of organized sport gliding in the 1920s and its continued evolution into a modern competitive discipline. Detailed explanations are provided on launch methods, soaring techniques using ridge lift, thermals, and wave lift, as well as principles of cross-country flying. The article also describes the FAI performance badge system, including Silver, Gold, and Diamond levels, and outlines the structure and demands of national and international gliding competitions. Emphasis is placed on the importance of meteorological knowledge, terrain awareness, and pilot skill for safe and effective soaring. Finally, the article highlights gliding as an accessible and environmentally friendly way to experience flight, connect with nature, and explore landscapes from a unique aerial perspective.

Key words: Gliding, Sailplane / Glider, Sport aviation, Recreational flying, Environmental impact of aviation

Introduction

Gliding represents one of the most environmentally sustainable forms of aviation, as it relies predominantly on naturally occurring atmospheric phenomena and produces virtually no emissions during flight, with the exception of the launch phase. In the context of increasing global emphasis on climate change mitigation and the reduction of aviation-related environmental impacts—such as noise, air quality degradation, and greenhouse-gas emissions—gliding occupies a unique position within the aviation sector. These concerns are further underscored by international assessments from organizations including the IPCC, WMO, and Copernicus Climate Change Service, which highlight the rapid and unprecedented climatic changes affecting Europe.

The regulatory framework governing aviation in the Czech Republic and the European Union reflects these environmental priorities, integrating both national legislation and EU-level rules aimed at balancing aviation development with the protection of sensitive natural areas. Within this highly regulated environment, gliding constitutes a distinct category of sport and recreational flying that, unlike powered aviation, relies on the pilot's capacity to exploit atmospheric processes such as ridge lift, thermal convection, and mountain waves for sustained flight. This unique reliance on meteorology and terrain interaction requires glider pilots to possess extensive knowledge of atmospheric physics, geographical patterns, and local weather dynamics, making gliding both a technical and environmental discipline

The development of gliding has deep historical roots, with verifiable glider flights dating back to the early 19th century and systematic sport gliding emerging in the 1920s, particularly in Germany, which continues to hold a leading role in the field. Contemporary gliding is supported by structured organizations such as the Aeroclub of the Czech Republic and the Fédération Aéronautique Internationale (FAI), which provide standardized rules, performance classifications, and international competition formats.

As both a scientific and sporting activity, gliding integrates aerodynamics, meteorology, environmental science, and human performance. Its study therefore contributes to broader discussions on sustainable aviation, atmospheric dynamics, and applied aeronautical training. This article examines the environmental, technical, historical, and organizational dimensions of gliding, with particular attention to the interaction between pilot expertise, landscape characteristics, and atmospheric conditions that shape the practice and safety of soaring flight.

Materials and methods

This study is based on a comprehensive descriptive document about gliding, which includes: the legislative and environmental framework of aviation (e.g., European climate strategies, national laws, international aviation regulations) the characteristics of sport and recreational flying and its dependence on natural processes the historical development of gliding and organizational structures administered by the FAI and the Aeroclub of the Czech Republic launch techniques and principles of unpowered flight methodology of cross-country flights and out-landing procedures the FAI performance badge system the structure of gliding competitions

The analysis draws on text segments referencing: international institutions (IPCC, WMO) EU and national legislation (e.g., Regulation (EU) 923/2012, Act No. 49/1997 Coll.).These sources provided the foundation for evaluating environmental and regulatory aspects of gliding.

A thematic and content analysis of the document was performed, focusing on: identifying major thematic areas (regulation, history, technique, sport performance) mapping all described technical processes, particularly launch methods (aerotow, winch, bungee, car tow, self-launch) classifying described atmospheric lift sources: ridge lift, thermal convection, wave lift .

These components were systematically coded and categorized according to glider-flight dynamics. Analytical segments related to cross-country flying and out-landing procedures were synthesized to form a unified methodological framework for modern soaring: procedures for planning and executing cross-country flights, methodological approach to selecting suitable out-landing fields, procedures for using auxiliary propulsion units.

For the analysis of FAI performance classes, an interpretative method was applied to the description of qualification criteria for: Silver Badge, Gold Badge, Diamond achievements. The required performance parameters (flight duration, altitude gain, distance) were taken directly from the text. To describe the competitive aspects of gliding, the study compared text segments concerning: competition difficulty, typical course lengths and glider speeds.

These data were used to establish a coherent analytical framework for assessing competitive performance.

The Materials and Methods section is grounded in: documented textual analysis, technical-operational classification, systemic synthesis of described flight techniques, comparison of performance standards, all strictly supported by corresponding sections of the original text.

Results

The text confirms that gliding represents a largely emission-free form of aviation, producing no harmful emissions during the majority of the flight, with environmental impact limited primarily to the launch phase. In contrast to powered aviation, which is characterized as a significant contributor to emissions, gliding aligns with modern sustainability requirements emphasized by international bodies such as the IPCC and WMO, which report rapid climatic changes and increased environmental risks in Europe

The analysis shows that Czech aviation is regulated through a combination of national laws and EU legislation, including the Civil Aviation Act and EU Regulation 923/2012, which define operational and environmental constraints. These findings demonstrate that gliding takes place within a structured regulatory environment designed to balance aviation activity with environmental protection.

The document provides clear evidence of the long historical evolution of gliding. Early experimental gliders of the 19th century, including those of Sir George Cayley, Otto Lilienthal, and Percy Pilcher, represent foundational developments in aerodynamic research. Sport gliding emerged in the 1920s, particularly in Germany, where key performance breakthroughs—including the exploitation of ridge lift, thermals, and wave lift—were achieved before World War II.

Organizationally, modern gliding is structured under the Aeroclub of the Czech Republic and internationally under the Fédération Aéronautique Internationale (FAI), both of which standardize rules, performance metrics, and competition frameworks. Competitions, including national championships and the Gliding Grand Prix format, reflect the institutionalization and global reach of the sport.

Fig. 1: Preparing for takeoff using an aerotow

Analysis of the technical content shows that gliding flight relies on multiple launch methods: aerotow, winch launch, bungee launch, car tow, and self-launch using an onboard engine. These methods differ in cost, altitude gain, training suitability, and environmental impact.
Three primary atmospheric lift mechanisms were identified: Ridge lift, produced when wind is forced upward along slopes .
Thermal lift, arising from rising pockets of warm air, often indicated by cumulus clouds.
Wave lift, generated by standing waves in the lee of mountain ranges and capable of producing extreme altitudes and long-distance flights.
These results confirm that soaring is a meteorologically dependent discipline requiring pilots to understand and adapt to atmospheric dynamics, terrain interaction, and weather evolution.
Cross-country flight performance is shown to depend on identifying rising air, managing altitude, and conducting safe out-landings when lift is insufficient. The text identifies out-landings as routine, facilitated by the modular construction of gliders and the use of transport trailers.
The document outlines the FAI system of performance badges—Silver, Gold, and Diamond—each defined by standardized requirements for flight duration, altitude gain, and distance. The analysis indicates that these badges establish global benchmarks for pilot competence and achievement.
Competitive results reported in the source text show that gliding championships typically last two weeks, include daily tasks when weather allows, and require pilots to complete predefined courses at the highest possible average speed. Elite gliders routinely achieve average speeds around 130 km/h on distances of 200–800 km, demonstrating the high performance potential of modern sailplanes.

Discussion

The results of this analysis demonstrate that gliding occupies a unique position within the wider aviation sector due to its minimal environmental impact, strong dependence on natural atmospheric processes, and the high level of pilot expertise required for safe and effective operation. The document consistently highlights that gliding, unlike powered aviation, produces virtually no emissions during flight, with environmental impact limited almost exclusively to launch procedures. This finding aligns directly with the broader environmental imperatives described in the text, in which international bodies such as the IPCC and WMO report accelerated climatic changes in Europe and increased environmental risks requiring mitigation measures in aviation activities. Within this context, gliding can be considered a model for sustainable aeronautical practices.
The regulatory framework described in the document further reinforces the importance of environmental compliance. Czech and EU aviation legislation incorporates extensive environmental considerations and operational restrictions, especially in relation to specially protected areas. These constraints shape how pilots plan and execute flights, emphasizing that environmental stewardship is not only inherent to gliding's physical characteristics but also embedded in its operational context. The coexistence of technical flight requirements with legal and environmental obligations highlights gliding as an interdisciplinary activity at the intersection of aeronautics, environmental science, and regulation.
From a historical and developmental perspective, the findings reveal that gliding evolved from early aerodynamic experiments in the 19th century toward a structured international sport in the 20th century, with Germany remaining a key center of innovation and performance development. The continuity between early experimental objectives and modern performance-oriented gliding is evident in the persistent focus on exploiting atmospheric energy—ridge lift, thermals, and wave lift—which

remains fundamental to the discipline today. This continuity suggests that gliding has maintained a scientific core centered on aerodynamics and meteorology throughout its history.
The technical aspects also carry important implications for pilot training and operational safety. The document illustrates that gliding demands a high degree of environmental awareness, particularly in the recognition and use of lift sources, prediction of meteorological developments, and interpretation of landscape features that affect atmospheric behavior. Furthermore, the routine nature of out-landings, combined with procedures for safe retrieval and aircraft disassembly, demonstrates that gliding incorporates inherent operational risks that must be mitigated through pilot proficiency and procedural discipline. These characteristics differentiate gliding from other forms of aviation and indicate that technical skill alone is insufficient without comprehensive environmental literacy.
The performance badge system described by the FAI provides a structured framework for assessing pilot competence, endurance, and navigation skills. The requirements for Silver, Gold, and Diamond badges—which include significant altitude gains, long-duration flights, and extended cross-country distances—illustrate the progressive nature of skill acquisition and performance in gliding. The inclusion of internationally standardized criteria supports a comparative evaluation of gliding performance across different geographical and meteorological environments.
Finally, the discussion of competitions indicates that gliding has developed into an internationally recognized sport with complex performance metrics, standardized tasks, and high-level athletic demands. The reported average speeds of approximately 130 km/h over distances up to 800 km reflect the high aerodynamic efficiency of modern sailplanes and the advanced skills of competitive pilots. These findings confirm that contemporary gliding is both a scientific and athletic endeavor, combining environmental understanding, aeronautical engineering, and competitive strategy.
Overall, the analysis underscores that gliding is not merely a recreational activity but a sophisticated form of aviation deeply integrated with meteorology, environmental management, regulatory frameworks, and sport performance. Its reliance on natural energy sources positions it as an important example of sustainable aviation, while its technical and organizational complexity situates it firmly within the domain of advanced aeronautical disciplines.

Conclusion

The analysis of the document demonstrates that gliding represents a distinctive and environmentally sustainable form of aviation, relying largely on natural atmospheric processes rather than mechanical propulsion. Its ecological advantage is evident in the fact that no emissions are produced during the majority of the flight, with environmental impact limited primarily to the launch phase. This positions gliding as a relevant model within broader efforts to reduce the environmental footprint of aviation, especially in light of documented climate changes and environmental pressures reported by international organizations such as the IPCC and WMO.

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Special thanks go to the glider pilots, instructors, and technical specialists whose expertise, field experience, and dedication to the safe practice of soaring significantly contribute to the advancement of this aviation discipline. The author also acknowledges the contributions of institutions and researchers involved in environmental and aviation studies, whose publicly available reports and analyses offer valuable insights into the broader regulatory and ecological context in which gliding operates.

Souhrn
Plachtění je ekologická forma leteckého sportu, která během letu neprodukuje žádné emise a spoléhá výhradně na přírodní zdroje stoupavého vzduchu. Článek představuje historický vývoj kluzáků, legislativní rámec ovlivňující provoz, i hlavní techniky vzletu a letu bez motoru. Popisuje tři klíčové druhy stoupavých proudů – svahové, termické a vlnové – které umožňují provádět dlouhé přelety. Dále vysvětluje výkonnostní třídy FAI, jejichž splnění je podmínkou pro získání sportovních odznaků. Text uzavírá charakteristika plachtařských soutěží a zdůrazňuje, že úspěšné plachtění vyžaduje hluboké porozumění meteorologii, krajině a technickým aspektům letu.

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Z-GENERATION AND THOSE BEYOND. HOW SHOULD THEY PERCEIVE DROUGHT ADAPTATION OPTIONS WITHIN ENVIRONMENTAL AND RECREATIONAL EDUCATION?

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Abstract

Z-generation as a first generation of people growing completely in a digital era. Are present climate topics sufficiently attractive to young people? Climate change is one of the major environmental challenges of our time, increasingly visible also in Central Europe. Alongside mitigation and adaptation options to ongoing changes is becoming essential. Environmental education within the Czech EVVO program (Environmental education, upbringing and awareness program) plays a crucial role by building knowledge, attitudes, and skills for responsible action of our society. This paper is trying to analyze how climate change adaptation is reflected in environmental education in Czechia and suggests ways to strengthen its role within the national approach. It focuses on topics such as water management, biodiversity protection, and the adaptation of landscapes and settlements to extreme weather/climate. The study highlights the importance of interdisciplinary cooperation between schools, NGOs, and public administration, as well as the environmental and recreational potential of adaptation measures.

Key words: climate change literacy, remote sensing, adaptation potential, educational programmes, environmental education policy

Introduction

Climate change represents one of the most important environmental challenges of our time, which is increasingly evident also in the conditions of Central Europe. In this context, except mitigation measures, the potential for adaptation measures to already ongoing climate change is also gaining its importance. Environmental education, upbringing and awareness-raising within the framework of the EVVO program play a key role in this process, as it contributes to the development of knowledge, attitudes and skills necessary for responsible action by individuals and society as a whole.

The aim of the contribution is to analyze how the topics of adaptation to climate change are reflected and integrated into environmental education in Czechia and to propose options for strengthening their role within the framework educational program. Attention is paid in particular to the topics of water management, biodiversity protection, the adaptation potential of landscapes and settlements to extreme climate features. The study also points to the importance of an interdisciplinary approach and cooperation between educational institutions, the non-profit sector and public administration in developing the adaptation potential of landscapes in the context of ongoing climate change. The important focus was paid to the environmental and recreational potential of chosen adaptation measures.

The contribution also draws attention to the potential of remote sensing methods in teaching geography through the topic of water on Earth from a global, but also a Czech perspective. It deals with the theoretical support of the topic and the setting of the topic in the context of textbooks, selected geoportals and web map services with the possibility of use in teaching geography at both levels of primary school, as well as current approaches within the revised Framework Educational Program from the perspective of geographical objectives and skills or abilities to analyze and interpret geographical data and remote sensing images. The purpose is to point out the interconnectedness of human management in the landscape with natural risks and various geographical phenomena and processes through monitoring changes in water in the landscape.

Adaptation measures in Czechia

In recent years, the Czechia has been systematically developing adaptation measures to respond to the manifestations of climate change, especially the increasing risk of drought. The main goal of these steps is to increase water retention in the landscape, slow down the runoff of rainwater and strengthen the country's overall water security. Coordination is ensured by the Ministry of Agriculture (MZe) and the Ministry of the Environment (MŽP) through the Interdepartmental Commission WATER-DROUGHT

and professional institutions, such as the T. G. Masaryk Water Research Institute in Prague. At the political level, the National Drought Panel operates, which serves as an advisory body to ministers.

Strategic framework of the concept

The basic strategic framework is the Concept of Protection against the Consequences of Drought in the Czech Republic, which is based on five pillars and a set of specific measures. The comprehensive approach is applied primarily in individual river basins, where environmental and technical elements are interconnected so that the measures complement each other. The key objective is to retain as much water as possible in the landscape and slow down its outflow. This is the goal of projects for the construction and reconstruction of water reservoirs, the restoration of extinct ponds and historical waterworks, as well as pilot projects for the artificial infiltration of surface water into rock structures. An important role is also played by the prepared amendment to the Water Act, allowing the declaration of a state of water shortage, and considerations on the constitutional enshrining of the principle that water is the most valuable raw material and a public good. The new anti-erosion decree also introduces the obligation to protect soil on land at risk of erosion and strengthens control of subsidies provided to farmers.

Concept pillars

The first pillar of the concept is the creation of a high-quality information platform for drought monitoring. This is provided primarily by the portals of the Czech Hydrometeorological Institute (CHMI), the „InterSucho“ system, the websites „suchovkrajine.cz“ and „stavsucha.cz“. These information sources serve both experts and the public and help increase society's preparedness for drought.

The second pillar, technical measures, focuses on connecting water supply systems, ensuring a reliable supply of drinking water in dry areas, reducing water losses in pipeline systems and building new dam reservoirs connected to water management systems. Furthermore, the modernization of agricultural irrigation (drip irrigation), the construction of irrigation and fire reservoirs and the use of modern technologies in raw water treatment are supported.

The basis of the third pillar lies in the agricultural sector, where measures focus on increasing soil protection against erosion, using deeper ploughing and breaking up compacted subsoil, as well as supporting crop rotation and growing more resistant varieties. Increasing the content of organic matter in the soil, which binds water better, is also important. Agricultural policy also focuses on returning to sustainable farming, including supporting livestock farming and an ecological approach to the use of biomass.

However, increasing the retention capacity of the landscape (4th pillar) has played a key role in the long term. This includes revitalising watercourses, using the retention potential of river floodplains, building polders and restoring wetlands. Historical ponds and mountain reservoirs (Fig. 1) which were used to retain water in the past, are also somewhere gradually being restored. Modern forestry supports the species diversity of stands and the natural renewal of forests, thereby increasing their resistance to drought. In 2024, as a result of these steps, the retention capacity of the Czech landscape increased by more than 1.8 million cubic meters of water.

The fifth pillar aims at sustainable water management across all sectors. In industry and energy, water recycling and reuse technologies are being introduced, and in households and municipalities, the use of rainwater is being expanded, for example through the “Dešťovka” program. The issue of drought is also reflected in spatial planning — new developments must take into account the water balance of the area. In cities, the emphasis is placed on blue-green infrastructure, i.e. greenery, permeable surfaces, water features and green roofs, which help cool the microclimate.

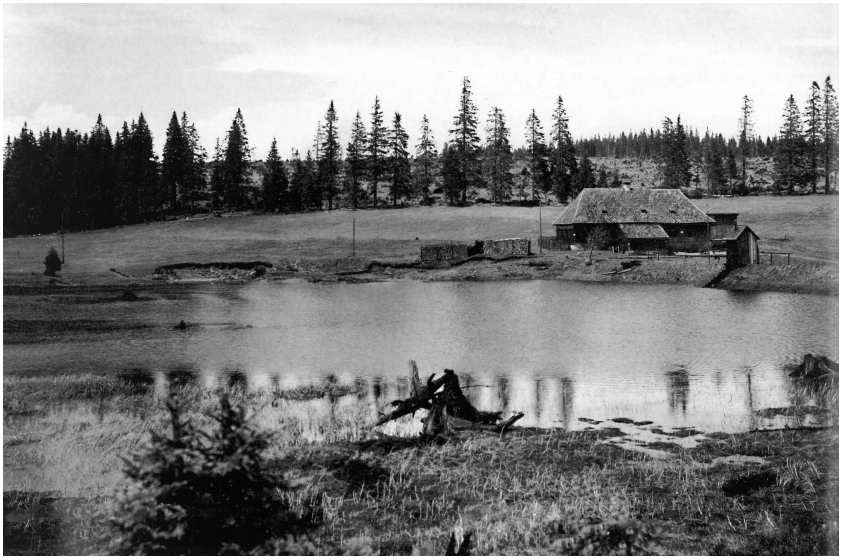

Fig. 1: Historical photo of one of former accumulation reservoirs used for wood floating from the turn of the 18th and 19th centuries (author unknown).

Educational and recreational potential of measures

Recent outcomes have brought about the urgent need to maintain and strengthen the complexity of the proposed measures. The key outcome for the younger generations, however, is primarily the assurance that current modern technologies, including remote sensing methods, open up significant space for self-realization.

Our research can become one of the possibilities to grasp the issue of landscape transformation from different perspectives through a diverse form of images. It can help grasp the transformation not only of water resources, but also the observation of changes in the landscape in a comprehensive way - using the interpretation and comparison of individual images. Through the search for causes and consequences of processes and phenomena in the landscape, by building a sensitive perception of students. Both hypotheses were confirmed. Most students were not still aware of the issue of remote sensing methods and developed their perspective on this topic through joint teaching. The use of interpretation of images and text, as well as work with a map, contributed to the development of a more sensitive perception of the transformation of the landscape around us in most students and the building of a relationship to the Czech landscape, i.e. the landscape of "home". The students were able to work critically with the map and use it to search for archive images of the selected location.

Conclusion

Tens of billions of crowns are spent on the implementation of adaptation measures in Czechia every year. More than three quarters came from European Union funds. The funding is provided by programs such as the Landscape Care Program, Support for the Restoration of Natural Landscape Functions, the Operational Program Environment, the Rural Development Program, and also the national initiative “We Return Water to the Forest”.

The potential of adaptation measures not only against dry periods, but also against frequent flood episodes, can be increased in various ways. One of them is the restoration of former accumulation reservoirs historically used in our border areas for floating wood, or ponds, which were the pride of our country for centuries.

The current strategy of the Czech Republic therefore connects technical, nature-friendly and legislative solutions, which are to be implemented simultaneously and complement each other. The emphasis is placed primarily on long-term adaptation of the landscape, effective management of water resources, and a responsible approach of society to water as a vital and strategically irreplaceable raw material.

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Souhrn
Generace Z jako první generace lidí, kteří kompletně vyrůstají v digitální éře. Jsou současná klimatická témata dostatečně atraktivní pro mladé lidi? Změna klimatu je jednou z hlavních environmentálních výzev naší doby, která je stále více viditelná i ve střední Evropě. Spolu s možnostmi zmírňování a adaptace na probíhající změny se stává nezbytnou. Environmentální vzdělávání v rámci českého programu EVVO (Program environmentální výchovy, vzdělávání a osvěty) hraje klíčovou roli při budování znalostí, postojů a dovedností pro zodpovědné jednání naší společnosti. Tato práce se pokouší analyzovat, jak se adaptace na změnu klimatu odráží v environmentálním vzdělávání v Česku, a navrhuje způsoby, jak posílit její roli v rámci národního přístupu. Zaměřuje se na témata, jako je vodní hospodářství, ochrana biodiverzity a adaptace krajiny a sídel na extrémní počasí/klima. Studie zdůrazňuje význam interdisciplinární spolupráce mezi školami, nevládními organizacemi a veřejnou správou, jakož i environmentální a rekreační potenciál adaptačních opatření.

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