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.

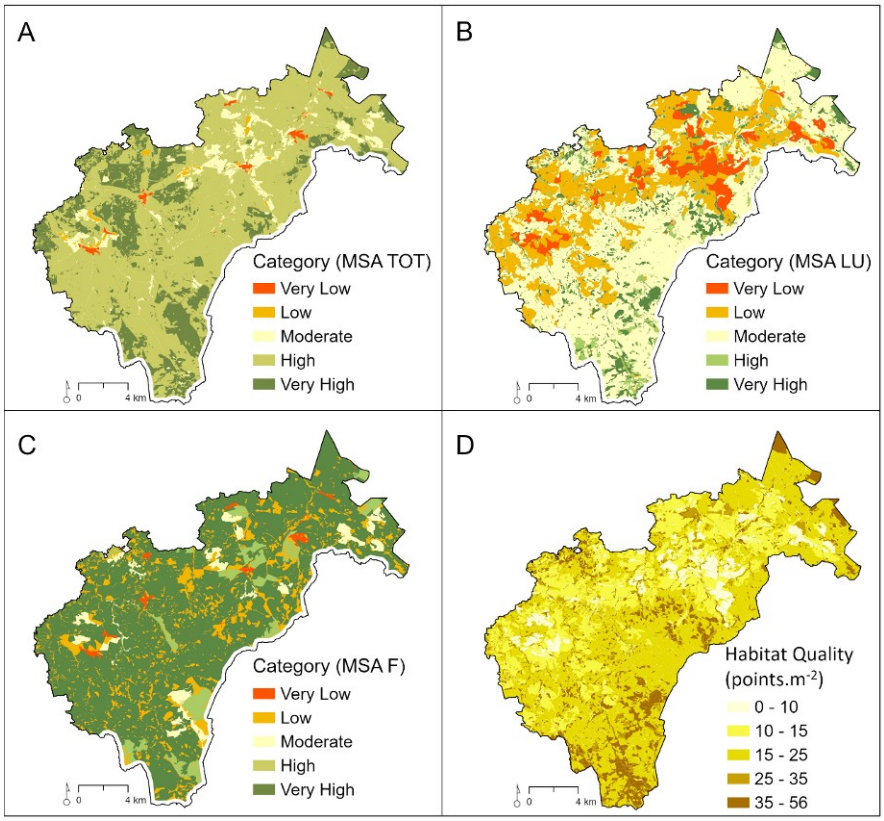

Fig. 1: Spatial distribution of Mean Species Abundance and habitat quality across the study area using HVM metod (Seják et al., 2018). (A) Total Mean Species Abundance (MSA TOT), (B) land-use related MSA (MSA LU), and (C) fragmentation-related MSA (MSA F), each classified into five ordinal categories 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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