PRÍNOS CHRÁNENÝCH ÚZEMÍ K ZMIERNENIU VPLYVU FRAGMENTÁCIE KRAJINY NA SLOVENSKU

CONTRIBUTION OF PROTECTED AREAS TO MITIGATE THE EFFECT OF LANDSCAPE FRAGMENTATION IN SLOVAKIA

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Abstrakt

Hlavným cieľom výskumu je identifikovať fragmentáciu krajiny (FK) na Slovensku s osobitným dôrazom na príspevok chránených území (CHÚ) k zmierneniu vplyvu FK. Výsledky sú prezentované v rastrovom výstupe (10 m grid). Tento raster obsahuje 490 321 151 gridov, pričom priemerná hodnota FK je 59,12 % (0 predstavuje fragmentovanú krajinu, 100 predstavuje plne prepojenú krajinu prirodzenými alebo poloprirodzenými ekosystémami). Výsledkom porovnania všetkých CHÚ navzájom je 1 132 unikátnych hodnotení. Celková priemerná hodnota FK nechránených častí je stále pomerne vysoká (56,42 %) a ukazuje, že stále existujú významné plochy, ktoré sa nachádzajú v nechránených častiach krajiny.

Klíčová slova: fragmentácia krajiny, ochrana prírody, ekologická konektivita, ekosystémy, chránené územia

Abstract

The main aim of the research is to identify landscape fragmentation (LF) in Slovakia with special emphasis on the contribution of protected areas (PAs) to mitigate the effect of LF. Results are presented in the final raster output (10 m grid). The raster contains 490,321,151 individual 10 m raster grids, with the LF average value of 59.12 % (where 0 represents fragmented landscape, 100 represents fully connected landscape by natural or semi-natural ecosystems) on the national level For each category of PA, individual statistics of quality and quantity of LF are estimated and subsequently compared with unprotected parts of Slovakia. The comparison of all PAs with each other resulted in 1,132 unique assessments. The overall average value of LF of unprotected parts is still rather high (56.42 %) and it shows that there are still significant areas existing, which are situated in unprotected parts of the country.

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Keywords: landscape fragmentation, conservation, ecological connectivity, ecosystems, protected areas

INTRODUCTION

The process of habitat fragmentation affects ecological processes on several levels – functionality of habitat is limited by reducing its area, and isolation disrupts natural flow in the ecosystem. The term fragmentation (fragmentation, division) in the scientific community appears more and more often in context with the distribution and reduction of natural and semi–natural habitats and subsequently with the need for the protection of habitats, species, and communities. It is a process (or state) of a division of natural/semi-natural areas, reduction of area, and increase of their mutual isolation. Naturally isolated are e.g. areas of alpine communities. However, the species occurring in such places are adapted to these conditions, or the process of adaptation still continues.

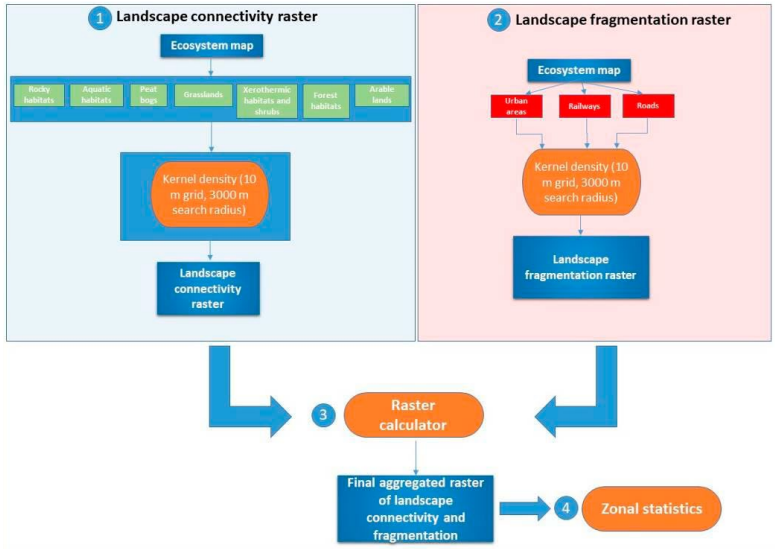
The current landscape is increasingly affected by the progressive construction of roads, highways, and high-speed railway corridors, but also by the development of industrial and residential development. Linear barriers in combination with the rapid development of buildings cause the disintegration of originally continuously inhabited natural or semi-natural units into individual mutually isolated islands, which by their size often do not meet the requirements for the long-term survival of habitats and species. The fragmentation of the environment by transport infrastructure and expanding buildings is thus becoming a major limit to the survival of several species (Romportl *et al*., 2013). In a country like Slovakia that is influenced by human activities, new obstacles or barriers are being added very quickly, which disrupt the long-term and established way of life of organisms, daily journeys for food, water, and seasonal migrations. The most serious artificial barriers include motorways, expressways, railways, built-up areas of settlements, and fenced industrial zones (Ružičková, Lehotská, 2008).

The aim of this research focuses on the assessment of LF at the national level, with special emphasis on the contribution of PAs to mitigate the effect of LF. Based on the analytical part the focus is also to assess the level of contribution of PAs to the overall landscape connectivity in comparison to the unprotected part of Slovakia. In addition, the results provide identification of important unfragmented areas, which are not presently protected, and propose adequate conservation measures. This kind of national assessment based on detailed national spatial data set analysis is actually missing and it was never performed in the past by using such detailed spatial data sets, in fact, recent and up-to-date assessments of LF on the national level based on more precise data than Corine land cover data set are completely missing. The level of precision of input data and advantageous methods used for the measurement of LF in our research is rather unique as in the past only less precise input spatial data for assessment were used, where small-scale features were barely taken into account. Results can be used not only in spatial planning but also in the field of nature conservation, preparation of national strategies for the protection of landscape connectivity, and many other practical applications.

MATERIALS AND METHODS

The preparation of the spatial analysis was based on data from the ecosystem/landscape type map (Černecký *et al.*, 2020). This data set consists of detailed data, which identifies individual landscape types in form of ecosystems and their spatial distribution. For the preparation of a landscape type map, the most precise available data from the nature protection, agricultural, and forestry sector were used. The spatial precision of the data was determined by that of the field data, which was mostly created at scales between 1:10,000 and 1:5,000. The data was stored in the form of a geodatabase containing more than 1,000,000 polygons (in the case of splitting polygons of individual buildings it is more than 2,000,000 polygons). The data in the map was streamlined and identified the ecosystem distribution in a unified ecosystem classification. EUNIS classification from the year 2017 (EEA 2017) was used for this purpose, thus the individual hierarchical habitat classes could be extracted and divided into suitability classes for the identification of landscape types. We decided to use this data instead of other data (i.e. Corine Land Cover – CLC) due to its higher precision on a national, regional, and local level. The data set was prepared in vector form and, most importantly, the polygons were not restricted to a certain size (as in the case of CLC); therefore even small and important features are present and considered in the analysis. Ecosystems, their distribution, and overall composition have a significant influence on landscape connectivity and fragmentation. Based on spatial data, ecosystems have been divided into those categories, that support landscape connectivity, and those that affect LF.

Ecosystems were transferred from vector data set to raster in the precision of a 10 m grid. The raster images were calculated by using the „Kernel density“ tool in ArcGIS 10.3. The 2 divided input data sets when processed by the Kernel density, generated clusters of landscape connectivity (ecosystems supporting the connectivity data set) and landscape fragmentation (ecosystems affecting landscape fragmentation data set). This method of measuring landscape connectivity is not very common, however, it has many advantages in comparison to other well-established methods for the measurement of landscape



1: *Flowchart of the main steps and data preparation for the analysis of LF*

fragmentation. Mainly, the tool itself has implemented spatial weighting, where the clusters of features and distance play an important role. Therefore the cumulative effect of spatial distribution is taken into account, which is not the case in many other existing methods.

The basic setup for Kernel density values was set to 10 m output cell size and 3,000 m search radius for best possible precision, but still with the relevant surrounding area for correct interpretation of broader ecosystem context. The scheme presenting the main steps in the process of analysis and data production is provided in Fig. 1.

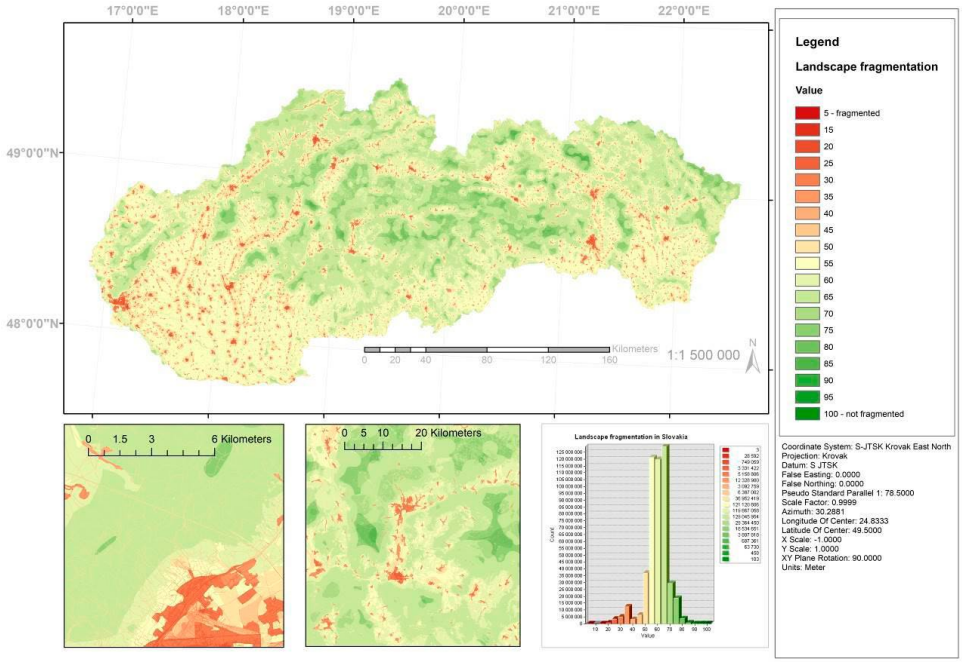
In the overall interpretation of the resulting values, the values for all categories of protected areas were compared together followed by a comparison of the individual PAs categories separately, and, above all, they were compared to the average value of LF in the unprotected part of Slovakia.

One of the final outputs is the detailed geodatabase of LF in Slovakia as well as the ranking of protected areas according to the overall LF.

RESULTS

National assessment of LF and role of the PAs in mitigating the LF in Slovakia

Results are presented in the final raster output (10 m grid). The raster contains 490,321,151 individual 10 m raster grids (Fig. 2), with the average value for landscape fragmentation of 59.12 % (where 0 represents a totally fragmented landscape, 100 represents a fully connected landscape by natural or semi-natural ecosystems) on the national level. The calculated



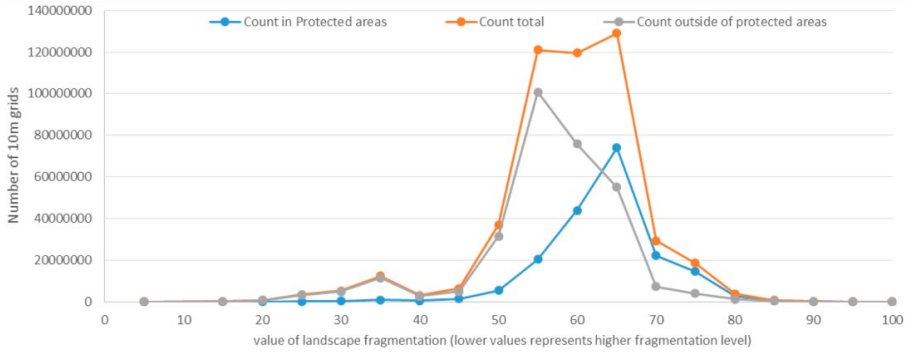
2: *Map of the LF in Slovakia, national, regional, local view, and additional statistics (count of 10 m raster grids for each value of landscape fragmentation)*

median value is 60 %. Most of the territory falls within the range of values 55–65 %, which confirms the presence of significant continuous unfragmented areas.

The comparison of all PAs with each other results in 1,132 resultant assessments. The resulting data contains an assessment of the overall LF level in %, the average, and the total assessment of each PA individually. Based on this statistic the ranking of PAs, sorted according to the overall quality is provided (Annex 1). When comparing all PAs, large-scale sites logically dominated among the others when not only quality but also the size of the PAs was taken into account. In NPs and PLAs there are 44,629,971 grids (substantial size) and high-quality of landscape connectivity (mean 61.19 %) present. The 5 best PAs providing the best overall connectivity (taking into account the total area of protected area) are SPA Volovské vrchy, SPA Nízke Tatry, SPA Laborecká vrchovina, PLA Štiavnické vrchy and buffer zone of NP Nízke Tatry. On the other hand, when purely quality was assessed the small-scale PAs dominated, especially the category of NR. Without taking the acreage of PA the best values of landscape connectivity were reached in NR Mláčik, SCI SKUEV0186, SCI SKUEV0384, NR Klenovské blatá, NR Debšín.

Generally, there is a substantially more unfragmented landscape inside of the network of PAs in comparison to the area, which is not protected (Fig. 3).

All categories of PAs scored higher than the unprotected part of Slovakia (Tab. I). The analysis also reveals that on average also unprotected part plays a significant role in maintaining the landscape connectivity, however it varies a lot in each region.



3: *Relationship of LF and PAs network*

I: *Overview of the level of LF in PAs network by PA categories*

PA category	COUNT of GRIDs	The minimum value (%)	The maximum value (%)	Mean values (%)
Biosphere reserve	3,160,283	15	75	60.83
Large-scale protected area	44,629,971	20	85	61.19
Natura 2000 – SCI	3,707,835	15	95	59.97
Natura 2000 – SPA	130,893,532	20	100	61
RAMSAR	808,641	20	70	57.21
Small-scale protected area	3,624,845	15	85	58.73
Unprotected area	303,232,907	15	95	56.42

CONCLUSIONS

This research provides an alternative overview of the value of PAs, their benefits and quality, the importance of their existence, and the need to strengthen protection in terms of landscape connectivity. It is evident that PAs are one of the most important tools for the current protection against further LF. A complementary benefit of this research is the identification of important locations of large-scale interconnected unfragmented areas of Slovakia, which are still unprotected. These areas are important for maintaining additional landscape connectivity in Slovakia. Each PA has been evaluated from a national perspective with individually calculated data. The results can be used in process of preparation of national strategies, action plans, spatial planning, environmental impact assessments, and many other purposes. Nature conservation could use this material for expert assessments and the preparation of management plans for PAs and for proposals improving/introducing protection of newly identified valuable areas of landscape connectivity. Processed data present the value and contribution of many already existing PAs, which have been recently underestimated in this field for various reasons. Despite human interventions and degradation of ecosystems, there are parts of the underrated territory, which are crucial in respect of the preservation of landscape connectivity. The added value of the research is to provide an adequate basis for the creation of a real network of interconnected natural and semi-natural large-scale areas in Slovakia. Identified degraded areas can be possibly used as a tool for defragmentation of landscape in future processes dedicated to the strengthening of ecological connectivity in Slovakia.

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