ASSESSMENT OF TERRITORIAL STABILITY FROM LANDSCAPE AND ECOLOGICAL POINT OF VIEW

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Abstract
The aim of the study lies in analysing and evaluating the ecological status of the landscape with the specification of stress and anthropogenic dominant factors. The analysis was done for a case study in the upper Myjava River basin in the western part of Slovakia. To maintain the landscape's self-regulatory capabilities, it is crucial to know the historical development of the ecological stability and the stress factor influencing the current state. Ecological stability was assessed by several methodological procedures established for the conditions of the Slovak Republic, which serve to analyse landscape ecological status in the areas. Determination of ecological stability values is necessary for the comparison of development and changes of the landscape and the development of the landscape structure. The landscape ecological conditions were evaluated for the first and second military mapping, data from topographic maps of 1990, 2006, 2012, 2018 and a map of the current landscape structure. The results reflect the changes and development of the landscape structure within the individual evaluated periods and the analysis of stress factors (natural and anthropogenic). In addition, they include a proposal for measures to improve the current state of ecological conditions in the analysed area as also lift up cultural ecosystem services including recreation and ecotourism's.

Key words: ecological stability, landscape planning, stress factors, military mapping, anthropogenic activity

Introduction

In recent centuries, the country has undergone and is still undergoing significant changes, which have been caused by transformation in political, economic and property conditions. The current landscape structure is the result of gradual changes in the original natural land due to human activities. To understand the current structure of the landscape, it is necessary to pay attention to its development (Feranec, Oťaheľ, 2001), (Žigrai, 2000). Historical maps represent one of the essential materials with powerful information and interpretive ability for the needs of several scientific disciplines. In this study, maps from the first and second military mapping were used. The first military mapping called Josephine (completed during the reign of Joseph II.) was carried out in Slovakia in the years 1763 - 1785 (Boguzsak, Císař,1961). The mapping was performed without complex mathematical foundations. Second military mapping (also called Františkovo according to Emperor František I.) was mapped in 1837-1858 to eliminate the deficiency of the 1st military mapping, especially inaccuracy in the connection to the cadastre and geodetic basis. Based on the historical maps, it is possible to monitor and evaluate the landscape's development and assess the ecological stability of the landscape in particular periods. In addition, ecological stability assessment represents the fundamental base for landscape ecological planning. Nowadays, it is necessary to focus on the recreational potential of the landscape and its connection with the ecological value of the area. According to Svels, Åkerlund (2018) recreation is often considered as an important landscape element and should be included in the landscape planning in order to ensure the recreation and relaxation of its inhabitants. The assessment of ecological stability involves the application of the theoretical principles of landscape ecology. Its importance is emphasized by the growing problems that arise from the non-respect of natural laws and processes in developing the human population and civilization processes (Ferancová et al., 2010). Therefore, the paper aims to assess the landscape from an ecological and landscape point of view from the first military mapping to the present. Such a detailed landscape ecological analysis, including historical maps, provides a valuable basis for further landscape planning and improvements of management practices. A significant part of the planning includes a proposal of recreational areas as an important part of a balanced area providing possibility for recreation in correlation with the preservation of the ecological value of the landscape.

Material and methods

Description of the territory

The analyzed area is located in the western part of Slovakia close to the border with the Czech Republic (Fig. 1). The Myjava River basin is tributary of the Morava River and covers an area of more than 745 km^2. The course of the main flow of the Myjava is characterized by a multiple change of direction in its upper and middle parts of the Myjava Uplands. Among its tributaries is the Brezovský Creek, which flows from the left and is 20 km long (Hanušin et al., 2008). The dominant part of the river basin lies in a mildly warm and warm climatic zone with less than 50 summer days per year with a maximum daily temperature above 25°C. The average annual precipitation is around 660 mm, and agricultural land use is typical for this part of Slovakia.

Map inputs

Data for graphical representation of landscape ecological elements and stress factors are processed using the geographic information system ArcGIS. Map data from I. (1769-1784) and II. Military mapping (1837-1858), topographic maps (1953-1957), CORINE Land Cover maps from 1990, 2006, 2012, 2018 and ESPRIT maps of the current landscape structure are used.

Assessment of ecological stability

The methodologies developed for the territory of the Slovak Republic were chosen to calculate the ecological stability of the domain. Each method contains specific criteria for calculating ecological stability coefficients, based on which the ecological stability of the Myjava area was assessed. The following methodological procedures proposed by authors such as Míchal (1982), Miklós (1986) and Reháčková, Pauditšová (2007) were used.

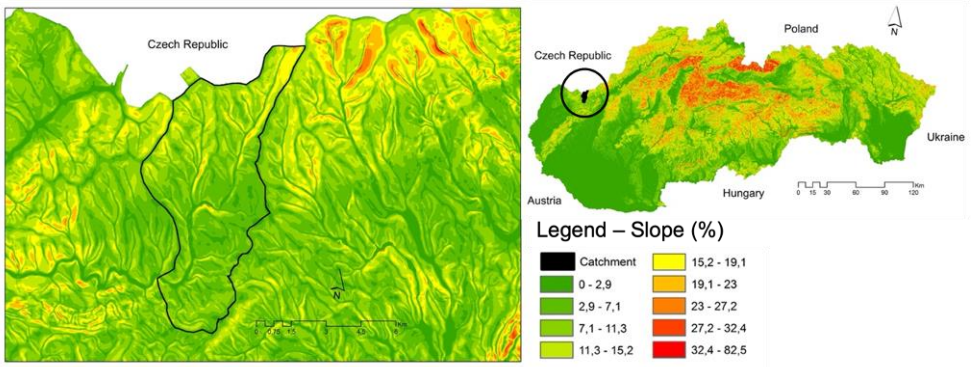

Fig. 1: Location of the mapped study area with slope representation

Results and discussion

Maps (Fig. 2) reflect the unique landscape ecological elements, their division, and subsequent changes in the spatial structure. From the first military mapping to the current territorial division, an increase in positive factors and a decrease in negative factors by 28% was observed. From 1990 to 2018, the area was mapped without significant changes. The least favourable condition of the territory is recorded during the first military mapping. After military mapping, an increase in the elements such as coniferous forests, bare soil, deciduous forests, water bodies were found. Since 1990, the values of the positive elements have started to rise again. The current territorial division clearly shows the predominance of positive elements (59%) over negative ones (41%). The positive (stable) elements include coniferous, deciduous and mixed forests, orchards and plantations and transitional forest cover, low grass, water areas. The negative (unstable) elements consist of agricultural land and urban area. The majority of the territory represents arable land (more than 30% of the total area). Areas reserved for sports and recreation are included in the current landscape structure (Fig. 2F). These zones are located within the urban area near human settlements. The location of the areas is advantageous, but it would be appropriate to complete recreational elements near forest units and thus improve the recreational potential of the area.

According to the methods of the authors Míchal (1982), Miklós (1986) and Reháčková, Pauditšová (2007) there was no change in the CES category, but the numbers improved to a better (most favourable) conditions and the overall improvement can be concluded. The consequence of the improvement to the decrease in the area of agricultural land. The presumed reason for the improvement lies in the reduction of the arable land (in the past arable land accounted for 49% and today approximately 30%).

The area was also evaluated in terms of anthropogenic and natural stress factors (Fig. 3). One of the stress factors is the pollution of the Myjava River to the extent of the entire length of the river flowing through the area. One wastewater treatment plant and three landfills have a dominant position in agricultural and industrial areas. Sources of pollution prevail in the southern part of the territory.

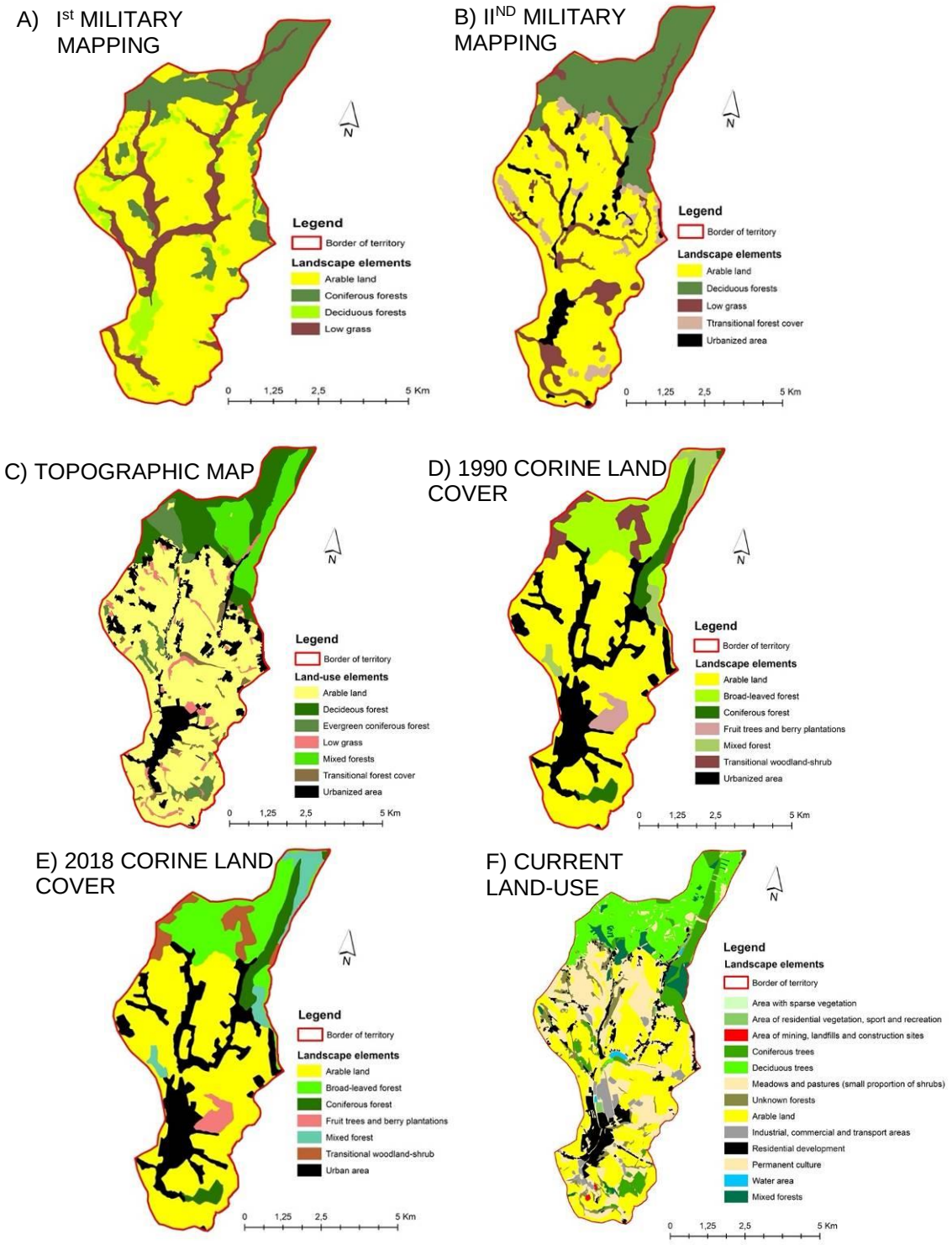

Fig. 2: Development of the landscape structure from the I^st Military mapping to the present A) I^st Military mapping, B) II^ND Military mapping, C) Topographic map, D) 1990 Corine Land Cover, E) 2018 Corine Land Cover, F) Current land-use

Tab. 1: Summary of the results of CES evaluation for the Myjava River basin; A) Míchal (Míchal, 1982), B) Miklós (Miklós, 1986), C) Reháčková, Pauditšová (Reháčková, Pauditšová, 2009)

METHODOLOGY	TIME PERIOD	CES	RESULT	
A) Míchal	IST millitary map	0.45	Intensively used area	Overall improvement of landscape
	IIND millitary map	0.65		
	Topographic map	0.52		
	Corine 1990	0.47		
	Corine 2018	0.48		
	Current land-use	1.45	Quite balanced landscape	
B) Miklós	IST millitary map	0.37	Poor quality	Overall improvement of landscape
	IIND millitary map	0.43	Low quality	
	Topographic map	0.41	Low quality	
	Corine 1990	0.37	Poor quality	
	Corine 2018	0.40	Low quality	
	Current land-use	0.55	Moderately high quality	
C) Reháčková, Pauditšová	IST millitary map	1.74	Landscape with low ecological stability	Overall improvement of landscape
	IIND millitary map	1.99		
	Topographic map	1.80		

	Corine 1990	1.63		
	Corine 2018	1.69		
	Current land-use	2.34		

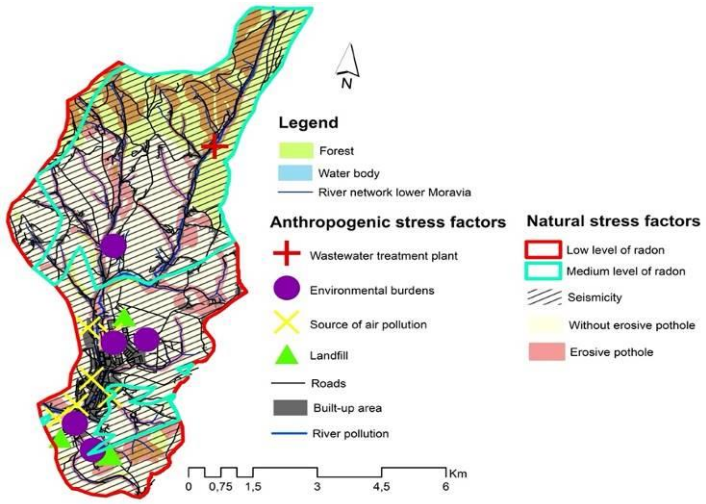

Fig. 3: Map of stress factors in the Myjava River basin (anthropogenic and natural ones)

The endogenous stress factors affecting the area are divided into a neotectonic active area (10.07 km^2) and without manifestations of neotectonic activity (32.66 km2). Other stress factors within the group of endogenous stress factors are seismicity and radon. The whole territory corresponds to the seismic risk of 0.3 m.s-^{2}, medium radon risk covering the area of 24.41 km^2, and the area with low radon risk includes 18.18 km^2. The exogenous stress factor of the mapped area is erosion deformation of slopes (erosive potholes) occurring in the southern and northern parts with a total area of 0.48 km^2.
The article deals with the evaluation of the landscape from the ecological and landscape point of view for the period from the first military mapping to the present. The largest changes in the composition of the Slovak's landscape structure are recorded since the 1950s when the intensification has become a dominant feature of agriculture. Intensification, specialization, mechanization, and chemistry have become the driving forces of agricultural production. The trend of decreasing intensification has been recorded since 1990 which has led to a decrease in the burden on the environment (Kanianska, 2006). To maintain a healthy landscape, it is necessary to incorporate an ecological element in landscape planning without disturbing and interfering with natural ecosystems (Termorshuizen et al., 2007). The balance in the landscape is important for all processes taking place in the country, including maintaining the development of water management (Kandera et al., 2021) and water resources (Keszeliová et al., 2021).

Conclusion

Knowing the state of the landscape from the ecological point of view is extremely important for maintaining the landscape's self-regulatory capabilities, thanks to which it can resist anthropogenic activities, negative consequences of human intervention and eliminate the disruption of ecosystems. The study used several methodological procedures to calculate ecological stability and assess the landscape's state in particular periods (from 1st Military mapping to the present) in the area. The results points to the changes in the landscape structure during these periods (graphic map outputs). The same results can be seen in the evaluation of cultural ecosystem services in this region, which include recreation as also tourism and we can see the importance of ecological stability of this area by proposing new measures. These can serve also as the basis for further landscape planning and proposals to improve the current situation e.g. for flood protection, erosion reduction, sustainable agricultural management etc..

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Souhrn
Cílem studie je analýza a hodnocení ekologického stavu krajiny se specifikací stresových a antropogenních dominantních faktorů. Analýza byla provedena pro případovou studii v povodí horního toku řeky Myjavy v západní části Slovenska. Pro zachování autoregulačních schopností krajiny je klíčové znát historický vývoj ekologické stability a stresový faktor ovlivňující současný stav. Ekologická stabilita byla hodnocena několika metodickými postupy stanovenými pro podmínky Slovenské republiky, které slouží k analýze ekologického stavu krajiny v daných oblastech. Stanovení hodnot ekologické stability je nezbytné pro porovnání vývoje a změn krajiny a vývoje krajinné struktury. Krajinně ekologické podmínky byly hodnoceny pro první a druhé vojenské mapování, údaje z topografických map z let 1990, 2006, 2012, 2018 a mapa současné krajinné struktury. Výsledky odrážejí změny a vývoj krajinné struktury v rámci jednotlivých hodnocených období a analýzu stresových faktorů (přírodních i antropogenních).

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