THE IMPACT OF A ROAD CONSTRUCTION ON ECOLOGICAL STABILITY OF A MODEL AREA

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ABSTRACT

Our objective was to outline the different approaches of landscape ecological stability evaluation and to emphasize its contribution in impact evaluation within the Environmental Impact Assessment process. We have chosen a road construction proposed in the northern part of the Slovakia as a model activity for this research which was assessed under Environmental Impact Assessment in the year 2003. We created a buffer around this road for precise impact prediction and evaluation and then we selected municipalities which could be possible influenced by its potential impacts. We found out the current ecological state of this model area using a calculation of different coefficients of ecological stability based on the exact areas of individual landscape structural elements. This information can be subsequently compared with available data from the Environmental Impact Assessment and other landscape plans from this area. We finally proposed the five degree scale of ecological significance of landscape elements in model area. Then we suggested some main recommendation how to preserve and increase the ecological stability of the whole area regarding its development.

Key words: ecological stability, ecological significance, road construction, impact, landscape

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INTRODUCTION

Ecological stability is an ability of any ecological system to persist even under the influence of disturbing factor and to reproduce its substantial characteristics in terms of outside interference (Míchal, 1994). Therefore the evaluation of landscape ecological stability is considered as a basis of assessing all conditions and assumptions of land use. It creates the important part of land-use planning documents such as The Conception of territorial system of ecological stability or documentations from Environmental Impact Assessment process (EIA).

More methodological tools were created to express the level of ecological stability of concrete area. The majority of these tools are based on a coefficient of ecological stability (CES) calculation. It represents a numerical value for classifying a certain level of ecological stability of studied object. We mostly set the CES based on the following two approaches in Slovak branch of landscape ecology (Rehačková, Pauditšová, 2007):

- CES as a ratio of relatively stable and unstable areas and

- CES based on the area of landscape elements with emphasis on their ecological significance.

We have chosen a two-way road construction of category C proposed as a relocation of the road I/64 in the northern part of the Slovak Republic as a model activity for this research. This action was assessed under the EIA process in the year 2003 and has been not built till today. The main reason of designing new road was bad transport situation in Rajec and Šuja municipalities. The capacity of current roads here was recovered as insufficient and therefore other problems were identified here as high transport intensity, reduced traffic safety, increased noise and increased emission production in built-up areas. This activity was proposed in four basic variants with different alternatives; in our contribution we worked with variant 1 alternative 2 as the recommended one from the EIA final statement (Luciak, Vegh, 2003). The entire length of this proposed road orbital is 5 039 km, it will begin near rail crossing in Kľače municipality and it will be joined to the current road system near the Šuja municipality. Whole road will be led outside of built-up areas on the arable land.

The aim of this contribution is to delineate methods for landscape ecological stability evaluation which are still the most used in Slovakia. The other objective is also to emphasize the importance of these methods in impact evaluation within the EIA process.

Our model area was determined on the basis of planned road construction which has been designed in this locality. We created a buffer around this road where impacts are the most significant and find out the model area which territorially belongs to 10 different municipalities.

MATERIAL AND METHODS

First steps in our research were aimed to get the available information about the proposed activity construction using the Slovak official EIA web (ME SR, 2012).We spatially reflected this road and created a 2 km buffer around it as the zone of major impacts using software ArcGIS 9.3. Subsequently we worked with some parts of municipalities Ďurčiná, Jasenové, Kamenná Poruba, Kľače, Konská, Malé Lednice, Rajec, Šuja, Rajecká Lesná and Zbyňov.

We described the model area by literature and strategic planning documents review with emphasis on its ecological values. We also created a map of current landscape structure (CLS) of our model area as a basis of our research (Map 1). The background materials were mainly aerial photos of this locality supplemented by field survey. The map was processed in ArcGIS 9.3 in the Cartesian coordinate system S-JTSK. The landscape structural elements were identified according the methodological guide (Pucherová, 2007) and ordered into 23 categories. Further it was possible to calculate the approximate size of each land structure element.

Three types of CES were used for evaluation the ecological stability of the model area in our research according to

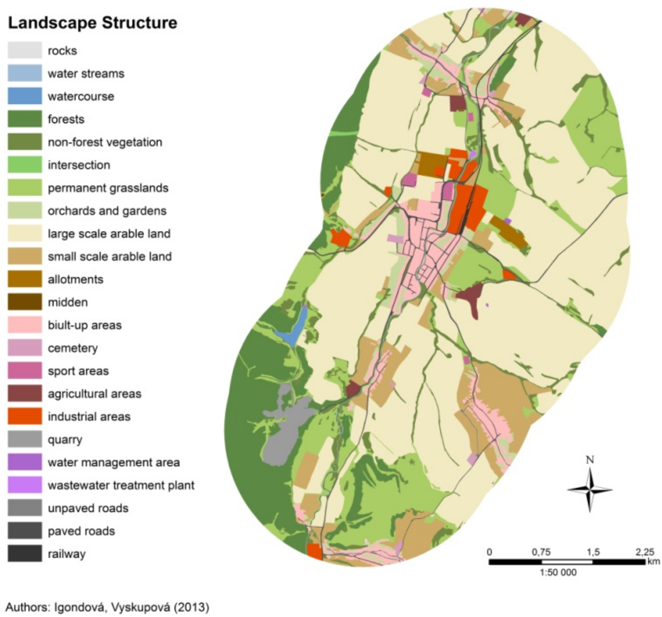
- Míchal (1982; CES_1),
- Löw et al. (1984; CES_2),
- Miklós (1986; CES_3).

We created our own scale of ecological significance using these results and knowledge about area and apply it on the model area together with emphasizing the main ecological values there (Map 3).

We worked with the final statement from the EIA process and with our knowledge about this territory to consider the effects of proposed activity on affected landscape and its ecological values and overall stability. We identified the impacts which we consider the most threatening for the local ecological stability. Finally we suggested the main mitigation measures which may be helpful in preserving local ecological stability.

RESULTS AND DISCUSSION

Our model area extends to the Alpine-Himalayan system, Carpathian basin, West Carpathians province and Fatra-Tatra region according to Mazur and Lukniš (2002). This locality belongs to the slightly warm and very wet area with rich precipitation where the average temperature is 5 – 6 °C (Lapin et al., 2002). In general, it can be considered as a narrow alluvial floodplain of river Rajčianka where the altitude ranges from 450 to 700 m. The total area of our model territory in the year 2012 was 3 276.05 ha (Map 1).



Map1 The landscape structure 2 km around planned ring road (variant 1 alternative 2) I/64 Kľače-Šuja

We figured out that more than a half of this territory has agricultural character, because the biggest part of this area was occupied by arable land with the area of 1 561.95 ha. In term of transport lines, this area is situated on the transport axis Žilina – Fačkov – Prievidza.

The ecological stability of the model area was specified using three different formulas mentioned above (Tab 1). We figured out that our model area is considered as very little ecological stable after summarizing these results. In this area is a strong linkage between the way of land use and landscape itself and it requires high deposits of additional energy. The wrong choice of human activities in this ecologically unstable area can lead to acceleration of some natural destructive processes or soil or relief degradation.

Tab. 1 The comparison of different coefficients of ecological stability of the model area

CES	The value of CES	Description of the category
CES_1	0,48	the area intensively used mainly for agricultural mass production with weakened autoregulatory mechanism
CES_2	0,98	disrupted landscape with weakened autoregulation
CES_3	0,30	highly used landscape, noticeable disrupted and weakened

Authors: Igondová, Vyskupová (2013) ** CES coefficient of ecological stability*

We created a map of ecological stability of the model area as the other step of our research. We set the five point scale of ecological significance (Tab 2) and also depictured these categories together with the most important ecological values (Map 2). All three methods of ecological stability evaluation were compared here with the ecological stability of individual landscape elements.

Tab. 2 The ecological significance of indentified landscape structure elements

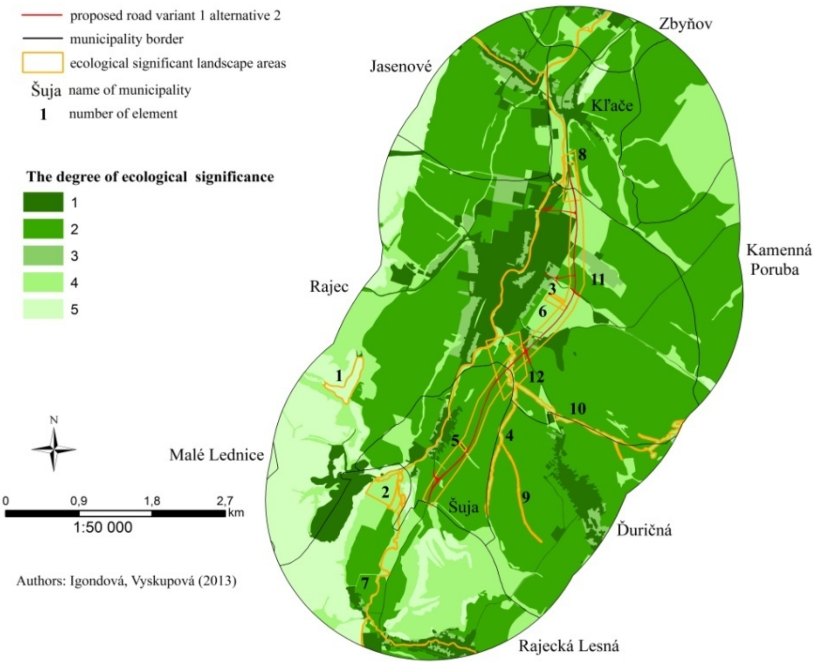
Degree of ecological significance	Description of the category	Landscape structure elements
1	very little ecological significance	roads, railway, cemetery, wastewater treatment plant, water management area, quarry, industrial and agricultural areas, sport areas, built-up areas, intersection
2	little ecological significance	midden, arable land
3	medium ecological significance	orchards, gardens, allotments
4	high ecological significance	NFV, PG
5	great ecological significance	forests, rocks, watercourse, water surface

Authors: Igondová, Vyskupová (2013) ** NFV – non-forest vegetation, PG – permanent grasslands*

We picked out the most important impacts which can affect the ecological stability of the model area according the overall impact evaluation of proposed road construction and gained information about the area. Then we divided these impacts into two groups according the time of their occurrence. We also depictured the most significant landscape elements which will be affected on the Map 2.

The most significant negative impacts during the construction phase will be more intensive traffic, effects on the water surface [no. 1 on the Map 2], effects on the ground water (the road construction area is located in a protective zone of natural and healing sources of mineral water of II. degree), effects on the Šuja wetland [2], effects on the local genofond locality Trstiny (it will cross many valuable biotopes around) and impacts on the biodiversity within the upper edge of Jewish cemetery [3] (this place contributes to local biodiversity and creates food and breading habitat). Further, this road construction will negatively affect riparian vegetation of Rybná stream [4], ravine above Šuja cemetery [5] (it is a natural residual of lime maple forest) and the site of orchid family species (*Orchideace*) in the upper part of the Jewish cemetery [6]. Also it will create a migratory barrier between regional biocoridor Rajčianka river [7] and related ecosystems (these are located at the right side of the Rajčianka river in connection with Lučanská Malá Fatra Mts.). This investment will also have adverse impacts on some parts of alluvial plains of Rajčianka river [8], on Vraninsky stream [9] and Kamenny stream [10] and it will create a migratory barrier along its whole length [11].

The most significant during the operation phase will be discharging emissions and higher noise pollution.



Map 2 The ecological significance 2 km around planned ring road (variant 1 alternative 2)

I/64 Kľače-Šuja

We have suggested some mitigation measures which could eliminate (reduce) these negative impacts and preserve (raise) its ecological stability as a result of our findings about the most important landscape structural elements, the overall ecological stability of the affected area and the main important impacts of proposed road. We mention some of them in our contribution such as fence the important habitats and genofond localities, built bridge over the road in the places where it directly crosses the valuable ecosystem mentioned above, plant new trees not only as a compensation for cutting some existing ones but also as noise barrier along the road [11], preserve migratory corridors on the local streams wide enough [12] etc. We also propose biota monitoring not only before construction but even during the construction phase and at the initial part of the operation phase as an important mitigation step.

CONCLUSIONS

We carried out that the landscape of the model area has low ecological stability with weakened autoregulation system in our research. The main reason is local human activity, mainly different agricultural actions. Therefore, any other new development activities can negatively affect the actual natural conditions of this locality. The possible solution for this situation is to increase the ecological values of current landscape structure of this area. The major beneficial actions could be preserving the existing habitats (valuable ecosystems and migratory corridors) and enlarging local biodiversity with planting new trees and protecting local biodiversity hot spots.

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