Pauditšová E., Reháčková T., Landscape-ecological proposals for the increase of ecological stability in the contact zone between settlements and agricultural landscape.
The Problems of Landscape Ecology, Vol. XXVIII. 45–54.

Landscape-ecological proposals for the increase of ecological stability in the contact zone between settlements and agricultural landscape

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Abstract: The contact zone between settlements and landscape represents a specific type of area where a significant influence of human activities on the landscape is shown. The zone between settlements and agricultural landscape is created by natural and anthropogenic landscape components. Their relevance depends on the urban structure, settlement size, functional landscape types, topography conditions and land-use forms. Very often the contact zones face various environmental problems and low ecological stability.
The evaluation of the contact zone has been made within the model settlement of Myjava situated in the western part of the Slovak Republic. In the given contact zone the landscape structure, areas of individual types of landscape elements, vegetation components and other relevant characteristics have been evaluated. This contribution presents an approach for solving the above-mentioned problems.

Key words: *settlement, contact zone, landscape-ecological plan, ecological stability, proposals, Myjava, Slovakia*

Introduction

In Slovakia it is possible to apply to practice scientific approaches – related to the solution of ecological problems in the landscape – by way of the so-called landscape-ecological plans. These documents are a significant basis for land-use plans, the conservation of nature and landscape, and also for land arrangement projects. The landscape-ecological plan is stipulated in two Acts: Act No. 237/2000 amending Building Act (Act No. 50/1976 on Spatial Planning and Building Order in the later wordings) and Act No. 364/2004 on Water Resources in the later wordings. Within the latter, another document plays the role of the landscape-ecological plan – the so-called Basin Management Plan. Some requirements for the protection, planning and management of landscape are currently subject to further legal norms (Kozová, Pauditšová et al., 2009).

This contribution is devoted to landscape-ecological proposals that increase the ecological stability of the contact zone between settlements and agriculturally utilized landscape. This is a territory, which is

inundated several times a year. Rapid rainfalls bring about a more intensive erosion activity manifested by destructive processes, with heavy losses of human health and property. The contact zones of settlements are particularly negatively affected (due to natural conditions).

The analyzed area is represented by a specific type of the settlement system in Slovakia, so-called dispersed settlement that is typical of the given region. The region itself lies in the north-west of the Slovak Republic and its administrative center is the Myjava town (48°45 ′02.22′; 17°33′55.12′′).

Landscape-ecological plan

Documentation referring to the landscape-ecological plan represents one of the foundations to elaborate the land-use plan in Slovakia. This deals in a comprehensive way with the spatial organization and functional utilization of territory, and also suggests (in terms of subject and time) the coordination of activities influencing the environment, ecological stability, cultural-historical values of territory, territorial development as well as the process of landscape creation; all in accordance with the principles of sustainable development.

In compliance with Act No. 237/2000 the landscape-ecological plan deals with:

- the ecologically optimal spatial arrangement and functional utilization of territory; the ensuring of sustainable development of territory
- the territorial system of ecological stability and the utilization of protected parts of landscape
- the spatial-functional arrangement of landscape maintaining the harmony of all activities in the territory
- the protection of natural resources
- the creation of landscape; restoration and recultivation interventions in the landscape
- the delimitation of sites for public good constructions and protected parts of landscape
- the principles of rational utilization of natural resources in order not to exceed the carrying capacity of territory
- the satisfying of basic human necessities for life.

The landscape-ecological plan is thus a fundamental material for proposing the ecologically optimal spatial arrangement and functional utilization of territory. It is a result of harmonization between economic requirements of man and landscape-ecological conditions of a certain territory.

Characterization of the studied territory

The analyzed territory (Figure 1) is formed by the cadastral area of the Myjava town (town parts Myjava a Turá Lúka), which was established in 1586. Currently, the town constitutes the center of dispersed settlement in the Trenčín Region and its population is almost 15 thousand.

The territory of the town has a hilly topography with an elevation range of 370–400 meters. The core of the territory represents a shallow denudation basin in the wider neighborhood of the Myjava River; the basin is bounded by flat ridges.

From a geological viewpoint, the studied area is created by the klippen belt, flysh belt, Neogene sediments and Quaternary (Began et al. 1984). Main soil units in the territory (see Hraško et al. 1991) occur very unevenly as a consequence of geological and geomorphological conditions. The largest part of territory (20.55%) is covered by rendzinas but also fluvisols and cambisols may be found here.

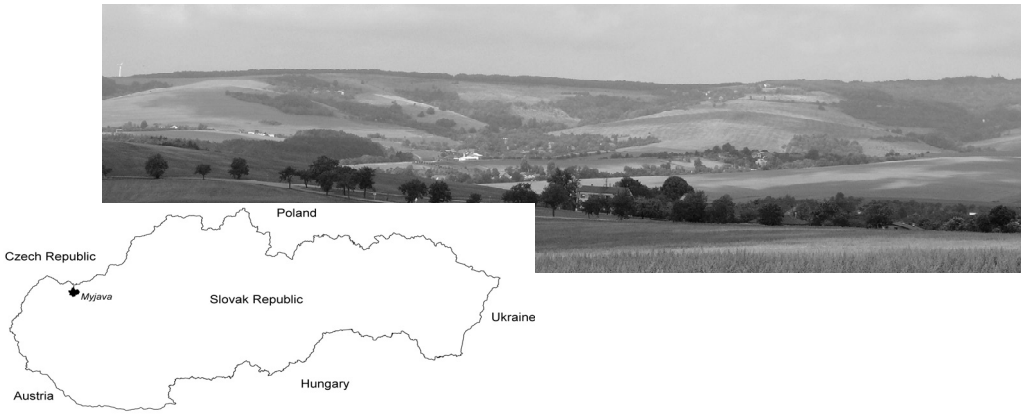

Fig. 1. A view of the studied territory – dispersed settlement of Myjava and its position within the Slovak Republic

The analyzed territory is divided by the Myjava River into the southern and northern parts. The river is an axis of its basin and has several minor tributaries that form a relatively dense network. Besides, three water surfaces are situated in the territory (reservoirs of Myjava and Brestovec, and one water surface in a garden colony).

Dispersed settlement, made of groups of dwellings and farm buildings, may be found in all the studied territory. The built-up areas consist primarily of: areas with smaller blocks of flats and single-family houses with gardens, areas of public service, sport and infrastructure. Cemeteries, manufacturing and agricultural areas are located in peripheral settlement parts.

Forests are (as for their surface area) the second most represented landscape element in the studied territory. They are mostly situated in its western to south-western parts. Orchards and gardens, in which fruit tree species dominate, are an important and characteristic element of the local landscape structure too. From the viewpoint of land utilization, the territory is agriculturally quite intensely utilized. Arable land and meadows comprise almost 70% of the overall area of the territory. Large blocks of arable land – somewhere split up by stands of linear vegetation and roads – are in direct contact with settlements.

The current landscape structure of the analyzed territory is completed by the elements that are not positively perceived from a landscape-ecological aspect. These are especially waste sites, mining areas, devastated areas and the like. The contact zone between dispersed settlement and agricultural landscape is very specific. Due to dispersed dwelling units, the extent of this contact zone is much greater in comparison with other types of settlement (rural, urban). For this reason, landscape-ecological measures to increase ecological stability were proposed for the studied territory as a whole.

Methods

The contribution deals with selected key problems associated primarily with the stability of landscape and the protection of territory against threats resulting from existing natural as well as anthropogenic processes. In principle, the elaboration of landscape-ecological proposals for the studied territory was largely inspired by the Methodological procedure for the ecologically optimal utilization of territory used within surveys and analyses for the land-use plan of a commune (Hrnčiarová et al. 2000). The methodol-

ogy of landscape-ecological planning LANDEP (LANDscape-Ecological Planning) served as a theoretical-methodological basis to develop the above mentioned methodological procedure. LANDEP represents a special-purpose complex of applied landscape-ecological methods and techniques, which is arranged in a system way. Its cardinal aim is a proposal for the ecologically optimal spatial organization of territory, utilization and protection of landscape. This issues in a proposal of subsequent measures to ensure the working of landscape-ecological relations and processes (Ružička, Miklós 1982; Ružička 2000).

The methodological procedure consists of the following steps (Hrnčiarová et al. 2000):

1. Landscape-ecological analysis – directed towards the obtaining and reassessment of input information on the properties of single landscape components (abiotic, biotic and socio-economic ones).
2. Landscape-ecological synthesis – the creation, characterization and classification of quasi-homogeneous spatial areas (landscape-ecological complexes) with approximately the same properties of indicators concerned.
3. Landscape-ecological interpretation – the determination of functional properties of landscape.
4. Landscape-ecological evaluation – the process of determining the suitability of landscape properties for the localization of selected social activities.
5. Landscape-ecological proposition – the transfer of outcomes from the decision-making process to maps:
   a) alternative ecological selection;
   b) ecologically optimal utilization of territory;
   c) landscape-ecological measures.

The result of the procedure is a proposal for the spatial and functional optimization of the given area and the determination of measures ensuring the appropriate utilization of territory from a landscape-ecological viewpoint.

Within the landscape-ecological plan, part of the landscape-ecological study of territory is formed by the determination of ecological stability. In order to express it, several methodological tools are used in practice (e.g. Löw et al. 1995; Míchal 1992). Most of these tools are based on calculating the coefficient of ecological stability (CES) as a numerical indicator. According to it, the landscape is classified into a certain degree of ecological stability (most often 5 degrees are used). In Slovakia, within landscape-ecological research, CES is most often determined by two ways:

1) as a ratio of relatively stable to relatively unstable areas
2) on the basis of surface area of landscape elements with regard to their landscape-ecological significance.

The following formula was applied in the analyzed territory to calculate the coefficient of ecological stability (Reháčková, Pauditšová 2007):

$$CES = \sum_{1}^{n} \frac{p_i \cdot S_i}{p}$$

where: CES – coefficient of ecological stability for the studied territory
p_i – area of individual types of elements of the landscape structure (in hectares)
S_i – degree of ecological stability
p – total area of the studied territory (in hectares)
n – number of elements of the landscape structure in the studied territory.

The presented relation reflects the degrees of ecological stability for individual elements of the landscape structure, their proportion in the analyzed territory (as to surface area) as well as the state of cur-

rent vegetation and degree of hemeroby (the extent of anthropogenic transformation of vegetation cover in relation to soil properties – e.g. Jalas 1955, Sukopp 1976, Kowarik 1988, Wittig 1998).

With the help of the given formula one may obtain the numerical values of CES between 1 to 5; they express the ecological stability of landscape. When we attribute the respective degree of ecological stability to individual elements of the current landscape structure, it is always necessary to allow for the present species composition of vegetation, especially the shares of neophytes and terophytes. For this reason, the same elements of the landscape structure do not need to have the identical degree of ecological stability. On the basis of calculated CES, we classify the landscape into 5 degrees of ecological stability, with a scale ranging from "landscape with very low ecological stability" up to "landscape with very high ecological stability" (Table 1). Then, a proposal of general measures to increase or maintain the ecological stability of landscape has been submitted for each degree of ecological stability.

Table 1. Interpretation of the coefficient and degrees of ecological stability

Landscape evaluation	CES	Degree of ecological stability	Measures
landscape with very low ecological stability	1,0–1,49	1	high need to implement new ecostabilizing elements and ecostabilizing management measures
landscape with low ecological stability	1,50–2,49	2	need to implement new ecostabilizing elements and ecostabilizing management measures
landscape with medium ecological stability	2,50–3,49	3	conditional need to implement new ecostabilizing elements or application of suitable management measures
landscape with high ecological stability	3,50–4,49	4	implementation of suitable management measures
landscape with very high ecological stability	4,50–5,0	5	implementation of maintaining management

Results

On the basis of the comprehensive landscape-ecological evaluation of the studied territory it was found that the most grave problems have been there manifestations of erosion-accumulation activities and the low ecological stability of landscape. These two problems are very closely connected with each other. Therefore, such proposals and measures have been recommended for the analyzed territory, which have a positive influence on the mitigation of erosion processes and, at the same time, they can contribute to the increase of ecological stability of territory.

The calculated coefficient of ecological stability for the cadastral area of the Myjava town has the value of 1.72. This means that its landscape has low ecological stability (Reháčková, Pauditšová 2007). The given value of CES is a reflection of the real situation in the utilization of territory – here large blocks of agriculturally utilized land dominate. From an ecological viewpoint, this land is an unstable element of the landscape structure. Though forest stands constitute almost 20% of the territory, their ecological quality is decreased by the presence of allochthonous species, especially conifers. Various other elements such as built-up, industrial and warehouse areas etc. – without significance for ecological stability – are well repre-

sented (as for their surface area) in the studied territory too. The degree of ecological stability of some elements is decreased also by neophytes that widely occur, for example, in riparian stands.

The storage capacity of landscape in the analyzed territory is reduced due to changes in the way of management; this happened during the transformation of the structure of arable land from a small-block one into a large-block one. Owing to land collectivization in the 1950s, those landscape elements that ensured natural protection against rapid water run-off and soil removal ceased to exist in the territory. From a regional viewpoint, deforestation in the studied territory is a problem as well. It started long ago and culminated in the development of dispersed settlement. The outlined processes were simultaneously manifested also in the decrease of ecological stability of territory. At present, the landscape structure is negatively affected by intensive agricultural activities with all resultant consequences (Collective of authors 2007).

At proposing anti-erosion and ecostabilizing measures many analytical and synthetic maps (for example, those of the current landscape structure, slope steepness, river microbasin, slope length, water erosion danger – see Figure 2) were used as a basis.

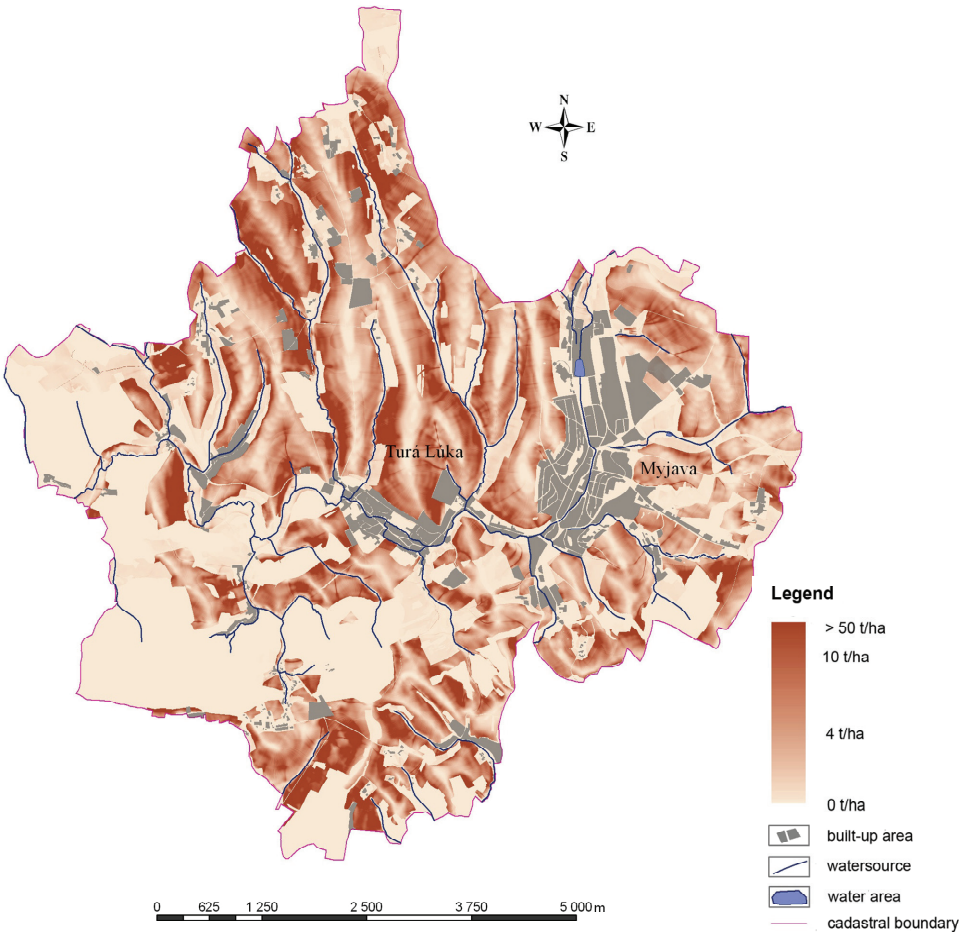

Fig. 2. Illustration of the map of water erosion danger in the model territory

Solutions to both identified problems are well known among the experts. However, these solutions often meet with misunderstanding or the lack of financial means necessary to improve the situation. A principal shift at solving the given problems may be achieved through land arrangements. Their goal is – besides putting land property rights in order – also the management of problems connected with erosion, ecological stability and the like.

Landscape-ecological measures

Within the landscape-ecological evaluation of the analyzed territory, the following measures have been proposed (Figure 3):

- the transformation of arable land into permanent grasslands – there were delimited the sites with slope steepness > 12°, which are simultaneously agriculturally utilized. These places are proposed to be changed from arable land into permanent grasslands
- the grassing of valley flowlines – with the aim to increase the storage capacity of problem sites in the territory as well as to slow down water run-off
- the planting of new elements of greenery having the anti-erosion function – the planting of greenery is most often understood only as an ecological measure but it is possible to combine in practice its ecological function with the anti-erosion function. Therefore, the planting of a linear character is proposed in the studied territory. Its aim is to brake long slopes into shorter segments, since the former are one of the risk factors for the removal of material from the area. This proposed measure relates also to recommended sizes of tracts of land, used for projects of land arrangements. For the analyzed territory, linear planting located in the direction of contour lines are proposed. Planting is always proposed with various spatial parameters
- the extension of existing greenery elements, the completion and creation of new elements of accompanying greenery along road communications. The species composition of newly planted stands (as well as that of just extended stands) should be close to natural vegetation. Such an approach increases the possibility of a suitable incorporation of stands into the landscape. Vegetation elements are thus predestined to long-term existence and are able to respect habitat conditions. When selecting the suitable species it is needed to start solely from potential natural vegetation ones. In the model territory, they are represented by species of Carpathian oak-hornbeam forests; in the case of planting in riparian stands they are represented by species of Floodplain submontane-montane forests according to Michalko et al. (1986).

Technical measures

Technical measures to mitigate erosion-accumulation activities are represented, as a rule, by drainage ditches and the like. In the studied territory, we proposed to construct 5 dry polders that should considerably help in the catchment of rapid rainfalls during an increased rainfall activity.

The function of drainage ditches is to catch, drain or accumulate surface water run-off (rapid rainfalls or thawing snow). Within the contact zone of settlements, ditches are situated in front of the delineated border of the built-up areas or along roads communications. Drainage ditches have to be inclined towards the sediment basin and from there water may be conducted away through the outlet trough.

Another way of dealing with the mitigation of surface run-off is the construction of the so-called evaporation ditches of a trapezoid shape. In order to increase their infiltration capacity, it is recommended to fill the bottom of the ditch with porous material (e.g. gravel) and it is also possible to grass the lateral profile of the ditch up to a slope steepness of 1 : 2.

The recommended proposals for measures reflect the level of hitherto theoretical and practical knowledge. However, it is necessary to remind that these measures are primarily based on the planting of greenery. Any planting of greenery – with regard to its substance – represents a process during which the conditions are gradually changed in dependence on the development of vegetation cover. Simultaneously, they are directed to an optimal state that is at equilibrium with its surroundings. The comprehensive evaluation of success/failure of this process is thus possible only in a longer time horizon.

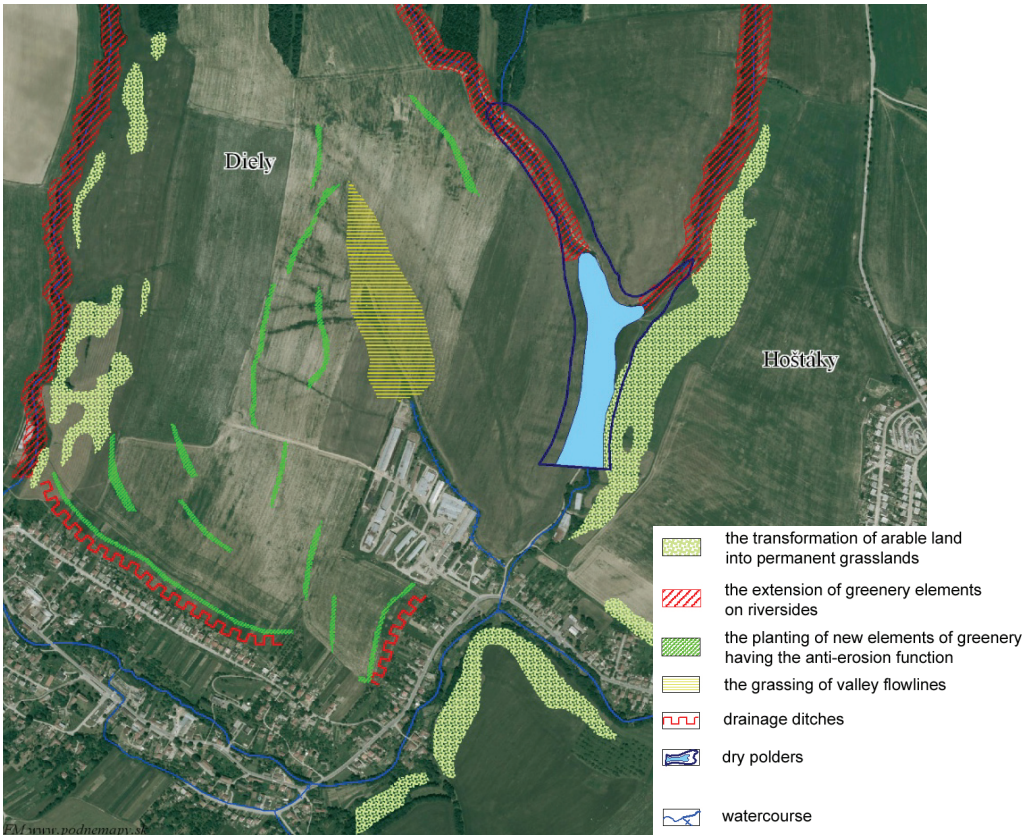

Fig. 3. Illustration from the map of proposals for landscape-ecological measures in the cadastral area of the Myjava town

Discussion

Within land-use planning processes, landscape-ecological plans are worked out as a compulsory part of land-use plans. It is done so according to a methodological procedure recommended by the Ministry of the Environment of the Slovak Republic. This procedure is, however, time-consuming and requires an expert

background. We meet in practice with the misunderstanding of significance of the landscape-ecological plan in the framework of elaborating land-use planning documentation. The landscape-ecological plan is an important tool for the optimal utilization of the territory's potential. The realization of proposals resulting from the landscape-ecological plan – besides the elimination of specified environmental problems – ensures also the prevention of generating new ecological problems. At the same time, the landscape-ecological plan may become an appropriate instrument for the prevention and mitigation of manifestations of natural risks and hazards (floods, erosion-accumulation processes, landslides etc.). A well-elaborated document is suitable for the evaluation of ecological stability and for a proposal of the territorial system of ecological stability.

A certain problem of this type of documentation is not rarely the fact that the studied territory is analyzed much in detail. Through the gradual synthesis of information we then make evaluations, on the basis of which it is very difficult to prepare such proposals that can be feasible in practice. There are several reasons for the non-implementation of proposals. Most often they are as follows: economic reasons, the unwillingness of land tenants to accept recommendations, unclear land property rights and the like.

A serious shortcoming in the process of elaborating the landscape-ecological plan is that no professional qualification is required for that. Another negative factor seems also to be the missing price list for expert works.

Despite the mentioned shortcomings it is possible to consider the landscape-ecological plan and proposals resulting from it to be the fundamental tool for the implementation of principles of sustainable development of territory into real life as well as the tool that enables to enforce scientific knowledge into practice.

Acknowledgements

This contribution is the result of the project VEGA No. 1/0653/08 and the project VEGA No. 1/0558/10.

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