Landscape Ecology vol. 3 no. 1 pp 43-51 (1989)
SPB Academic Publishing bv, The Hague

The general ecological model of the Slovak Socialist Republic – Methodology and contents

Ladislav Miklos
Institute of Experimental Biology and Ecology, Centre of Biological and Ecological Sciences, Slovak Academy of Sciences, Obrancov mieru 3, 814 34 Bratislava, ČSSR

Keywords: Czechoslovakia, CSSR, Slovakia, ecological model, planning, landscape management, stability, disturbance

Abstract

Development of the general ecological model (EM) of the CSSR has been included in the state program for environmental policy – the Ecoprogramme of the CSSR – at a scale of 1:1 000 000 for the entire Czechoslovak territory and at a scale of 1:500 000 for the Czech Socialist Republic (CSR) and the Slovak Socialist Republic (SSR). The objective of the first EM stage was to make a survey of spatial differentiation of the major ecological problems of the country. The EM consists of four parts, three analytical and one synthetic. These parts are:

a. The ecological state (value) of the current spatial structure of the landscape.
b. Ecological stress factors in the landscape.
c. Protection of nature and natural resources.

From the spatial synthesis of these three groups (from their spatial encounters), the following synthetic group of conditions was obtained:

d. Regional ecological problems, a system of ecologically stable areas, environmental stress factors and factors endangering the ecological stability of the landscape, the natural resources and the human environment.

Introduction

On the initiative of the central bodies of the CSSR concerned with the comprehensive protection of the landscape and natural resources, the development of a general ecological model of the Czechoslovak territory has been included in the program of the State technological policy in the sphere of the environment – the Ecoprogram of the CSSR – for the needs of land-use and regional planning authorities. The first stage of the project was designed to outline the spatial differentiation of major ecological problems in the country. The Federal Ministry for Technical and Investment Development of the CSSR entrusted the Geographical Institute of the Czechoslovak Academy of Sciences in Brno with providing theoretical and methodological guidance for synthesis of the collected data for the territory of the Czech Socialist Republic and the Institute of Experimental Biology and Ecology of the Slovak Academy of Sciences in Bratislava to do the same for the Slovak Socialist Republic. The acquisition and processing of data were entrusted to the territorial planning organizations TERPLAN in Prague and Stavoprojekt in Banska Bystrica. The work was coordinated by the Czechoslovak Centre for the Environment in Bratislava. The final cartographic processing was carried out by

'Slovenska kartografia', a national corporation, in Bratislava at a scale of 1:1 000 000 for the CSSR as a whole and at a scale of 1:500 000 for the CSR and the SSR.

The development of the ecological model (EM) included the collection of textual and map materials on the specific landscape components at a scale of 1:500 000. The most significant phenomena, or groups of phenomena, are represented on analytic, and also partly synthetic, maps (maps at the level of authorial originals). The content of the partly synthetic maps was further simplified for the final synthetic EM map. The resulting EM representation is the outcome of the superposition of background documents modified in the above way.

The present work describes the principles and content of the EM for the SSR.

General theoretical and methodological framework

The main objective of the Ecological Model of the Czechoslovak Socialist Republic is to make a substantial contribution to the process of ecologically sound landscape management, one of the principal targets of the development of our national economy both at present and in the future. The ultimate goal of this endeavor is the creation of preconditions for overall development of the society and improvement of its material standard with all of the accomplishments of the society measured by its ecological welfare.

The basic precondition for such management is the generation of ecological data for the decision-making and planning sphere, the ecological mode of management. This is also a goal of the Ecological Model of Czechoslovakia. The generation of ecological data can be assigned to two stages:

- determining what ecological conditions are necessary for managing the landscape and what are the ecological problems of current management.
- proposing an ecologically optimal method for landscape management.

The methodology of ecological landscape planning, LANDEP (Ružička and Miklos 1982), has been used in the process.

The first stage of EM development deals primarily with the first problem area. In general, ecological conditions and problems may be defined as the body of current landscape realities resulting from long-term processes of man-nature interactions affecting the management of the landscape. The philosophical and methodological premises for handling this problem area was the treatment of interrelationships between the philosophical categories, 'interests of the society' and 'natural resources', the interrelationships between the system 'Society – S_s' and the system 'landscape – G_s' (Krcho 19747.

Individual components of the landscape system and the society have been adequately considered by a variety of specialized institutions, thus, in EM development we draw on available findings and focus primarily on expressing *selected interrelationships* between activities of the society and the current state of the landscape (*i.e.*, between the S_s and G, systems), rather than on in-depth analysis of individual components. We focus on expressing individual components of the society-landscape systems in a form which allows **us** to make a synoptic and synthetic demonstration of their interfaces. This set of interfaces is referred to as the *ecological problems and management conditions* of man in the landscape. **A** spatial representation of these problems and conditions is the objective of the Ecological Model.

Methods of development of the ecological model of the Slovak Socialist Republic (EM SSR)

The ecological conditions and problems of landscape management outlined in the preceding section must be characterized both by indices related to ecological conditions of the whole territory under examination and by indices related only to specific situations in the respective portions of the territory. In adherence with this principle, it appeared to be appropriate to break down the process of EM development into the following three subject areas:

a. Ecological state (value) of the current spatial landscape structure – as a more or less stable

Table 1. Content of individual topical blocks of the EM of the SSR.

Analytical indices	Ecological interpretation of indices – a criterion for inclusion into the EM
I. Ecological state of the current landscape structure	
1. Size of built-up area and density of population in the settlements	1. Influence of the size of built-up areas with zero landscape stability of settlement structures
2. Ecological stability coefficient	2. Spatial stability of current landscape structure, stabilizing effects of landscape components
3. Global functional value of the forest stands	3. Ecological quality of internal forest structure
II. Ecological stress factors in the landscape	
a. Relative to population and urbanization	
1. Population morbidity and mortality – on special maps only	1. Threatening of manpower
2. Abortion and divorce rates – on special maps only	2. Threatening living conditions of the young generation
3. Spatial growth of municipalities	3. Use of agricultural soil for non-agricultural purposes
b. Relative to industrial and traffic growth	
4. Sources of air pollution	4. Identification of source locations
5. Emission-effected areas	5. Damage to organism, soil, water, etc.
6. Sources of water-course pollution	6. Identification of pollution sources
7. Stream purity degree	7. Necrotization of the life in water courses, contamination of the groundwater supplies
8. Traffic intensity	8. Pollution of air, noise, mechanical barriers for migration, accident etc.
c. Relative to agriculture	
9. Initial indicator: rate of agricultural production	9. Universal problems of intensive agriculture
10. Large-scale groundwater pollution	10. Contamination of groundwater resources
11. Soil erosion	11. Losses of production capacity of soil
12. Impaired ecological stability of spatial landscape structures	12. Deterioration of landscape stability, jeopardizing self-regulating mechanisms, lowering the quality of the environment
d. Relative to intensive recreation	
13. Areas with most intensive recreational activities	13. Devastation of natural environment, disturbing the life of the nature, gradual lowering of the quality of landscape.
III. Natural resources, their protection and protection of nature	
1. Mineral resources (areas with mineral deposits) – on special maps only	1. Harmonizing the exploitation with ecological conditions
2. Protected water resources (water management areas, medicinal and mineral water sources)	2. Water quality as the basic source for the life of humans and organisms
3. Forest resources (functional and protective forests)	3. Preservation of biomass playing a number of ecological functions
4. Soil resources (protected soils)	4. Preservation and improvement to production capacity of basic means of production for human nutrition purposes
5. Sources of health and recreation (the most significant recreational areas and comprehensive recreational resorts)	5. Preservation of relatively unaffected areas with sound environment or with medicinal resources for the regeneration of man
6. Protection of nature (large-scale protected areas)	6. Preservation of diversified and multifunctional natural resources for the regeneration of landscape

Table 1. Cont.

Analytical indices	Ecological interpretation of indices – a criterion for inclusion into the EM
IV. Regional ecological problems – territorial system of ecological problems. Clashes of interests	
a. Territorial system of ecological problems – basic map	
1. Territorial system of ecological stability	1. Determination of regional conditions for the preservation of ecological stability of the landscape
2. Transient territory	2. Localization of relatively problem-free areas
3. Territorial system of ecological stress factors	**3.** Identification of location and interlinkage between areas exposed to ecological stress factors
b. Characteristics of problem of encounters	
4. Endangering of ecological stability of the landscape	**4.** Endangering the interests of the protection of nature, endangering the territorial system of ecological stability
5. Endangering of natural resources (especially water resources)	**5.** Problems of the protection of quality of natural resources
6. Endangering the human environment (residential and recreational areas)	**6.** Environmental problems – health risks, risks for the mental well-being, impairment of the quality of manpower.
c. Regions of ecological problems	
7. Territorial blocks (belts) of ecological stability	**7.–9.** Regional diversification of the territory, according to ecological characteristics, supraregional relationships between ecologically problem areas.
8. Regions with unfavorable ecological situations.	
9. Ecological nodes.	

general indicator of ecological conditions and problems at each point in the territory.

b. Ecological stress factors in the landscape – local indices of adverse impacts of certain activities of man (effects of industrial, traffic, urban and agricultural growth).

c. Natural resources, their utilization while protecting nature – a local indicator for the ecological situation and an indicator of concern for the protection of nature and natural resources.

The spatial synthesis of indices of the above three groups yielded an additional, synthetic set of indices of ecological problems:

d. Ecological problems of the region – a set of common indices for the groups, a, b and c constituting a characteristic regional structure of ecological conditions and problems.

A synopsis of the above is given in Table 1 and Fig. 1.

These four areas also make up the content of the maps for the final graphic representation of the EM of the **SSR.** The legends to these four maps are the most concise textual synopsis of the EM.

The aim of both the EM of the **CSSR** and the EM of the **SSR** is to provide, in a synthetic map form, a picture of the ecological problems of the country on as wide a scale as possible. The degree of detail is given by the map scale of 1:500 000.

A brief methodological interpretation of individual subjects follows.

Current ecological state of the existing landscape structure

The basic global indicator of more or less permanent ecological conditions of the territory for the life of the population and for economic growth is the *current structure of landscape utilization.* The basic objective is to assess the ecological quality of the elements of current landscape structure, their spatial arrangement and scope. For the entire territory of **CSSR,** the 'ecological stability coefficient' (ESC) was chosen to express the ecological quality of the structure of landscape utilization (Michal and Martiš **1982).**

With regard to the complexity of the problem of ecological stability on the one hand and the aim and scale of EM on the other, within the frame of the Ecoprogram of the **CSSR** a working, practical un-

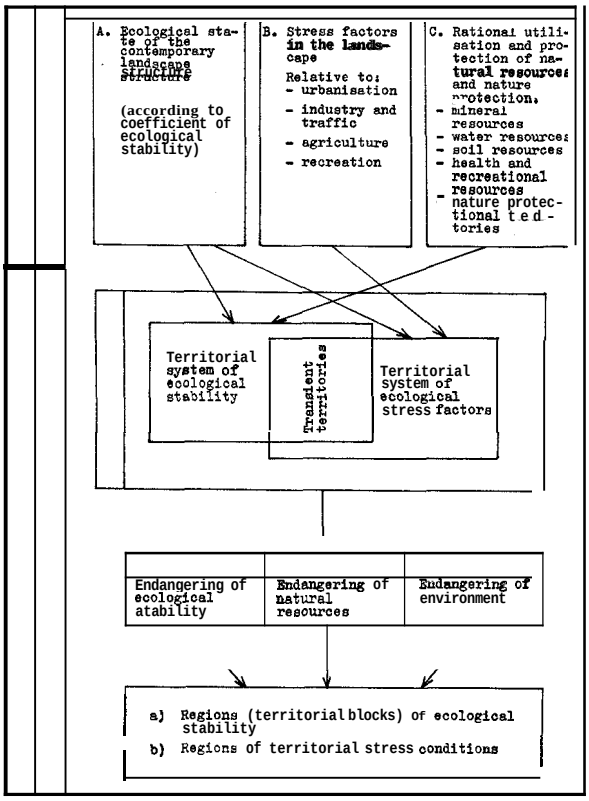

Fig. *1*. Scheme of ecological general model of **Slovak** Socialistic Republic.

derstanding of this term has been developed. In this sense, the stability is characterized according to how the autoregulative mechanisms act in the ecosystems and according to the amount of artificial energy added to keep this mechanism running. Therefore, the cultural landscape is considered stable if the permanent utilization of its functional potential (resources) is ensured without its being irreversibly endangered (Bučck and Lacina 1986). The practical application of this understanding to the ***territory*** was based on the following indices:

a. Inner 'landscape-ecological importance' (Jurko 1986) of each element of the current landscape structure. This marker is a synthetic expression of the real ecological values, such as diversity, resistence, etc. This marker well characterizes the autoregulative mechanisms that are acting (Jurko 1986). This marker is expressed by the coefficient form k_{pn}.
b. The area and spatial arrangement of single elements which have different values of k_{pn}. The theoretical thesis is: the greater the areal extent of more stable elements the higher the stability of the whole territory.

According to this principle, for all the cadaster of the territory of the **SSR,** the ESC was calculated by the formula

$$ESC = \frac{\sum_{n=1}^{12} p_n \cdot k_{pn}}{p_c}$$

p_n – area of the single elements of land utilizations (according to the geodetical data)
k_{pn} – the coefficient of the landscape-ecological importance of the single elements (according to Jurko 1986)
p_c – the whole area of the cadaster.

Continuously built-up areas displaying a virtual zero ESC value have been graphically enhanced.

The ecological quality of forest stands was assessed using the global functional value of the properties of forest stands, according to Papanek (1975), organized into three classes.

The global functional value of the properties of forest stands is a complex empirical methodic which includes a great number of different indices for forests, from timber production through the climatic function, to recreational and perceptional values. The advantage of this global value is that it is determined for each forest enterprise in the **CSSR** and is expressed uniformly in Czechoslovak currency.

Stress factors in the landscape

The elementary mode of landscape utilization includes adverse phenomena which are very dynamic and may appear or disappear rather quickly as compared to ecological conditions resulting from the current landscape structure. They are aptly referred to as stress factors, direct agents of ecological ill-effects, stresses and crises. Stress factors originate primarily in the technological processes of industrial and transport (water and air pollution, noise, etc.), intensive agriculture (water pollution, soil erosion), and intensive recreation (environmental pollution, devastation, etc.). It is necessary to note

here that from the ecological point of view areas exhibiting high stress factors due to agricultural and recreational activities also are usually characterized by the presence of important natural resources (high-quality soils, health facilities), *i.e.*, positive ecological phenomena.

Stress factors can be altered by changing the technology of production and the mode of surface exploitation. Unfavorable stress factor values give rise to environmental problems and to management problems as well, *e.g.*, the decrease of soil substance and fertility, endangered health of the population, etc.

Our aim is to pinpoint the most critical sites in the given region suffering effects from stress factors, the sources of the stresses and the extent and form of the threat to the landscape.

Natural resources, their rational utilization and protection

Society has a special interest in the utilization of available natural resources of the country in the most ecologically sound and rational manner possible. This concern has been translated into a system of legislative measures designed to protect the environment and natural resources, stating priorities and imposing a strict regime of management in the given region. These measures are positive ecological phenomena because they eliminate stress factors in the region and promote management practices which improve the ecological status of the landscape (forest and meadows, pasture farming), especially in areas with protected water resources and priorities for the protection of nature. The ecological subject area is considered by the decision-making bodies in connection with landscape utilization. The decisions for either the protection or its opposite subsequently alter the ecological status of the landscape in a positive or negative way.

Flaws in the legislative protection of natural resources may have severe ecological repercussions, such as the contamination of areas for natural water accumulation, shortage of water resources, exploitation of high-grade soil for non-agricultural purposes, lack of space for the regeneration of human potential, impairment of the genetic resources and biological productivity of the landscape, and others.

Regional ecological problems

Individual ecological factors characterized in the preceding sections occur naturally parallel to one another and in the most diverse combinations.

The territorial synthesis (superposition) of individual ecological factors results in the formation of two essentially opposing territorial systems of ecological factors, namely:

a. the territorial system of ecological stability – this system consists of the relatively more stable areas without pronounced stress factors – it could also be called the skeleton of ecological stability (see above). This system is composed of afforested areas, of land with a high coefficient of ecological stability, of areas in which the protection of nature and of natural resources is provided by legislation. The second stage of the EM is designed to enforce this type of landscape utilization through an appropriate system.

b. the territorial system involving ecological stress factors – the system consisting of impaired and/or unstable areas in a bad ecological state, with endangered natural resources and environment. The aim of the EM is to pinpoint these areas in order to eliminate the causes and to take appropriate measures for its improvement.

The division of the territory into these two systems enables decision-making bodies to take a differentiated approach and to plan the utilization of individual areas.

Between these two extremes lie areas which may be characterized as areas utilized with medium intensity, so far, without great ecological problems, the transition territory.

Understandably, the above mentioned territorial systems overlap and affect one another; clashes of interest may lead to grave ecological problems. Depending on the characteristics of these problems (encounters), they may be further subdivided into:

a. Endangering the ecological stability of the landscape

This group of ecological problems arises primarily for the territorial encounter of major stress factors, especially air pollution and large-scale agricultural production, with areas that are ecologically more

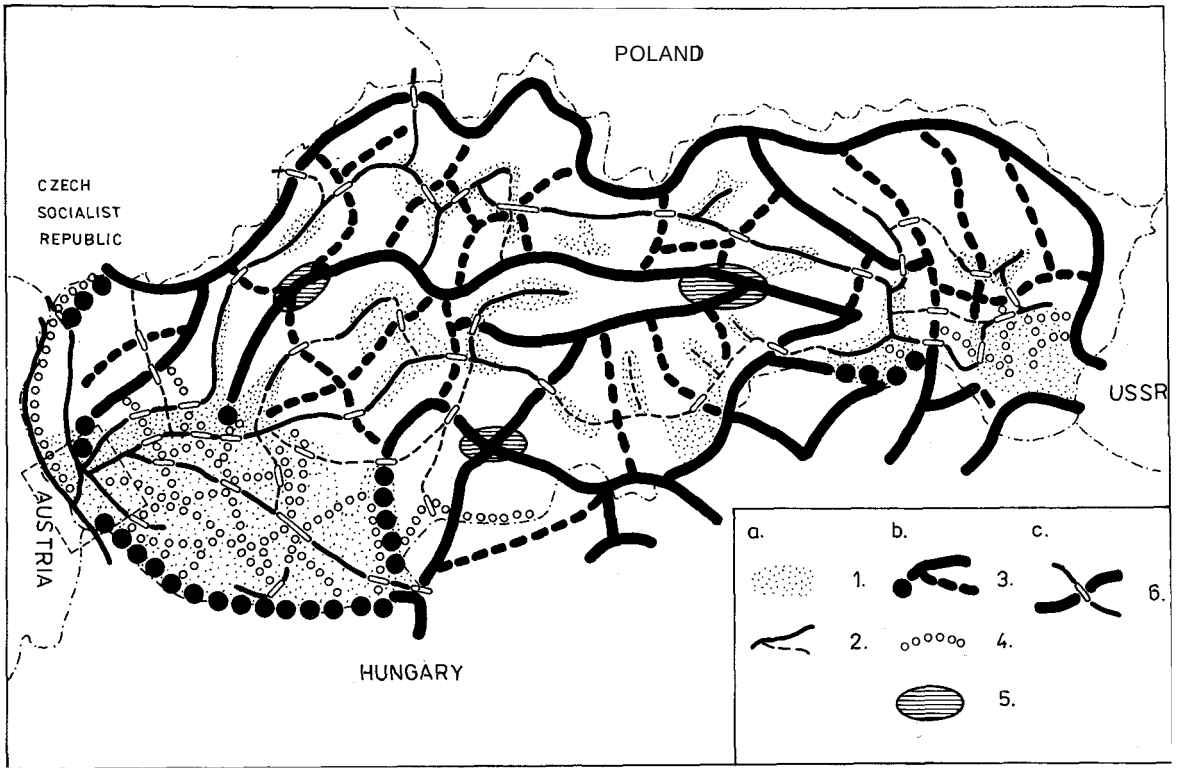

Fig. 2. Supraregional territorial system of ecological problems of the SSR.

a. Territorial system of ecological stress factors
   1. Regions of ecological problems
   2. Main and secondary corridors of stress factors – concurrently barriers of the linkage of the territorial system of ecological stability

b. Territorial system of ecological stability
   3. Main and secondary axes of ecologically more stable territorial blocks (belts)
   4. Axes of relatively isolated more stable territorial blocks (parts of blocks)
   5. Main ecological nodes

c. Encounters of the territorial systems
   6. Localisation of necessary connecting bridges for more stable territorial blocks. At the same time critical points of encounters of both systems.

stable. The problem consists essentially in the impairment of the territorial system of ecological landscape stability and disturbing the stabilizing function of individual landscape components.

b. Endangering natural resources

These problems arise from the territorial encounter of stress factors with areas which are concerned with the protection of natural resources. These include the deterioration of quality and excessive and irrational utilization. The problems of water contamination and soil erosion are of major significance.

c. Endangering the human environment

These problems arise from the territorial encounter of all types of stress factors with residential and/or recreational areas causing a reduction of 'ecological welfare' for man as a biological and social individual, *i.e.*, the deterioration of his environment. Adverse environmental impacts are assessed for communities in the Slovak Socialist Republic having

more than 10 000 inhabitants and for communities of special significance.

Regions of ecological problems of the SSR

The mapping of mutual encounters between the degree of ecological stability of the region, stress factors, natural resources and nature protection gives a picture of the spatial differentiation of afflicted territories, stable territories and transition territories which allows areas with ecological problems to be ascertained (Fig. 2).

Regions (territorial blocks, belts) of ecological stability

The territorial system of ecological stability from the aspect of supraregional considerations (mainly aspects of conjunctions and isolations) is divided by the territorial system of stress factors into major blocks of stable territories. In the SSR they are represented by the following:

a. The belt of the inner Slovakian Mountain range from Považský Inovec to the Nizke Tatry Mountains and the continuation of this belt from Pol'ana through the entire Slovak Ore Mountains down to Košice may be considered as the core area of ecological stability in the SSR. These two belts are isolated from one another by a territory with very intensive recreational activities including the resorts in the Nizke Tatry mountains.

b. The belt from the Zahorska nížina Lowland forest through the Malé Karpaty mountains to the Javorniky mountains is separated from the adjacent blocks of stable territories by the major traffic and industrial corridor Žilina – Čadca – Ostravsko.

c. The extensive belt formed by the northern frontier mountains of Slovakia from the Kysucké Beskydy mountains through the High Tatras up to the Vihorlat – Popričný mountains on the eastern frontier of Slovakia is only slightly threatened.

d. The coherence of the almost closed belt of the Inner Carpatian Volcanic Mountains in the Central Slovakian and North Hungarian Regions is disturbed by the moderately stable territory at the interface of the intramountain basins.

e. The zone of flood plain forests around the Danube from Bratislava down to Štúrovo is a relatively stable territory. However, this situation will be greatly affected with the construction of the Gabčíkovo – Nagymaros system of water structures.

f. The final SSR block includes the border zones along the frontier with Hungary around the Slovakian Karst region, the southern part of the Slanské vrchy mountains, and the area around the Bodrog and Latorica rivers in the East Slovakian lowland.

Regions with unfavorable ecological situations

These regions and locations are interlinked with territories and corridors featuring adverse ecological characteristics – transportation lines with intensive traffic and polluted water courses – adding up to a continuous territorial network with ecological problems.

Regions characterized by unfavorable ecological situations form, with their interconnecting lines, a system of barriers separating ecologically stable cores from one another. The territorial system of isolating (barrier) and isolated components, shown on the map, demonstrates the points at which ecological corridors are most needed to separate territories with adverse ecological characteristics from one another. The actual solution of this task will call for a more detailed study conducted at a larger scale.

The analysis of the maps of these regions allows us to conclude that in order to establish a relatively interconnected network of ecologically stable blocks of regions of Slovakia the role of 'ecological nodes' might be played by the regions of the Strážov mountains, the Ostrôžky mountains and the Slovak Paradise mountains which are located on the intersections of major axes of relatively ecologically stable territorial blocks connecting the central part of Slovakia with the outer Carpathian belt and with the Mátra-Slanské vrchy hills zone and the Pannonian basin (see Fig. 2).

Conclusion

The result of the above mentioned approach to solving the ecological problems on the level of **EM** is only the ***spatial differentiation*** of types of problems. This result might serve as a basic foundation for a different approach to the management of landscape in different regions. The next steps for ecologically sound landscape management must involve a deeper analysis on a more detailed scale of the inner mechanisms of these problems. The main feature of the ecologically sound landscape management according to the **LANDEP** method is the spatial, positive and chronological sequence of the ecological propositions. The recent stage of the **EM** is the first step of this procedure.

References

1. Buček, A. and Lacina, J. **1986.** Territorial systems of ecological landscape stability (in Slovak). Životné prostredie 20/2: **82–86.**
2. Jurko, A. **1986.** Landscape-ecological importance of vegetational communities (in Slovak). *In* Ecological Plan of the Utilization of East Slovakian Lowland. pp. **214–218.** Edited by L. Miklos, M. Kozova and M. Ružička. Report IEBE SAS Bratislava, Slovosivo-Michalovce.
3. Krcho, J. **1974.** The structure and spatial differentiation of the physical-geographical sphere as a cybernetic system (in Slovak). Geografický časopis 26/2: **133–162.**
4. Michal, **I.** and Martiš, M. **1982.** Czechoslovak concept of ecological stability of landscape (in Czech.) Report of TERPLAN, Prague.
5. Papanek, F. **1975.** Complex zoning of forests according to their functions (in Slovak). Report of **VULH,** Zvolen.
6. Ružička, M. and Miklos, L. **1982.** Landscape – ecological planning (LANDEP) in the process of territorial planning. Ecology (CSSR) 1/3: **297–312.**