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LANDSCAPE-ECOLOGICAL APPROACH TO THE BIODIVERSITY PROTECTION

Abstract: The biodiversity is a very actual and a very hot topic. Although in the world a considerable attention is put on biodiversity protection, still many of the valuable protected areas are endangered and these sensitive areas are consequently manifested by the biodiversity loss. Besides the inefficient traditional nature protection, also there is an insufficient implementation of the management plans for biodiversity protection. The manifold conventional threats to biodiversity are aggravated by the various global change processes such as the changes of atmospheric composition, climate change and socio-economic changes. A crucial element of biodiversity conservation is the understanding of the threats to species and their habitats. If a maximum diversity of living systems is to be preserved, conservation must target a maximum possible diversity of conditions of their existence. According to the ecological principles, species or associations are endangered if conditions for their life are not satisfactory, or they are spatially (geographically) isolated. The main goal of the paper is to present new modern landscape-ecosystem concepts of the biodiversity protection (protection of maximal possible diversity of the living systems and also the maximum possible diversity of the conditions of their life). The new concept is based on the evaluation of the potential and real representative geo-ecosystems (REPGES). Geo-ecosystems are particular objects and bearing elements of geo-ecodiversity. They represent a certain landscape-ecological unit – the geo-ecosystem. The paper is presenting the methodology for specification and evaluation of the REPGES and its application in the Slovak Republic.

Key words: *ecosystems, ecosystems services, representative geo-ecosystems, biodiversity protection, green infrastructure*

INTRODUCTION

Already for a long time considerable attention is paid to the protection of biodiversity. The break in the biodiversity conservation occurred in 1992, when the Convention on biological diversity was adopted in Nairobi [1], [3]. The Convention

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was adopted during the United Nations Conference on environment and development UNCED 1992 in Rio de Janeiro. It was opened for signature from June 5th, 1992 and already on June 14th, 1992 it was signed by 157 countries the signatures of the other 11 states were added up tu June 4th, 1993. The Convention entered into force on December 29th, 1993, when the ratification of the 30th contracting countries have been stored the the UN headquarters in New York. The subject of the Convention, and the main objective of the concept contained in the protection of biodiversity is to improve the conditions for the preservation of biological diversity and the achievement of sustainable use of biological resources. The Convention commits all parties to the process and to develop a national strategy for the protection of biodiversity and take advantage of all the possibilities and methods for identification of components of biological diversity [3]. In spite of these facts of the situation in this area cannot be regarded as reasonable. In spite of irreplaceable significance of ecosystems for landscape they are continuously threatened and degraded. According to the FAO, 60% of the world's ecosystems are degraded or used unsustainably; 75% of fish stocks are over-exploited or significantly depleted and 75% of the genetic diversity of agricultural crops has been lost worldwide since 1990. Deterioration ecosystems and loss jeopardises the provision of these services: we lose species and habitats and the wealth and employment we derive from nature, and endanger our own wellbeing [4].

The factors causing of this situation is more. To the main we can include:

1. Deficient awareness of factors threatening ecosystems and causing changes in ecosystems and their services. Many human activities affect the natural ecosystems directly (changed land use causing direct destruction of these ecosystems) or indirectly (by production of foreign substances which threaten the natural development of ecosystems). From the point of view of ensuring effective protection of biodiversity, it is therefore necessary to evaluate the factors that negatively affect the ecosystems.

2. Lack of appropriate indicators – data is missing; collection of data requires a very expensive and complicated research. Specialised literature proposes processed indicators but they are often inefficient, difficult to track because there is not enough relevant data for their evaluation on regional level. Considerable differences are also in definitions of indicators in individual countries. If the representativeness of the European ecosystems is to be maintained, it is necessary to create a network of universal indicators for the European region.

3. Poor transfer scientific knowledge into real practice, in particular in the environmental policy. The problem is the fact that the scientific language is differentiated from the language of general public. Scientific language is often very difficult for the language of the public, they don't understand it.

4. The lack of environmental awareness in the area of the protection of biodiversity and preference lifestyle, which in not environmentally friendly to biodiversity protection. In many countries it is possible to meet with consumption above the limits and unthrifty utilisation of individual natural resources. The result is not only a

quantitative (the depletion of natural resources), but also qualitative deterioration of natural resources – air and water pollution, soil degradation, damage of forests etc.

5. Variability of mapping units for the assessment of natural capital and ecosystem services and their changes on regional and local levels (potential vs. real ecosystems). Objective assessment of natural capital and ecological services requires establishment of comprehensive landscape-ecological units as determined by combination of abiotic and biotic conditions. Comparison of the potential and the existing representative geo-ecosystems will help take into account the temporal aspect of ecosystem research and identify changes that affected the individual types of ecosystems.

6. The component approach to the nature conservation, which concentrates only of life particular forms. The insufficient attention is paid to the protection of the conditions of life. However, a consequence of this approach can be a neglect and omission of other – ecologically and from services point of view important ecosystems with the assertion that "there is nothing to protect". From ecological point of view such an approach is unacceptable and contradicts with the principle where life conditions and forms preservation as well as with principle that the object of nature protection should not be a randomly selected part but the landscape as a whole.

The main objective of the paper is to present a comprehensive, landscape-ecological approach to the biodiversity protection.

1. METHODOLOGY

According to ecological principles [2], [5], [9], [10], species or associations are endangered if:

- conditions for their life are not satisfactory, or
- they are spatially (geographically) isolated.

These premises are the starting points for the basic principles of modern landscape-ecological biodiversity protection formulation. If we want to preserve maximal possible diversity of living systems – biodiversity – we will have to preserve also maximum possible diversity of conditions of their life [7]. These principles have formed a base for a conception of representative geo-ecosystems [8], i. e. geo-ecosystems, which in a specific landscape, on an assumed hierarchical level are considered to be worth of preservation, and should be preserved. REPGES are landscape-ecological homogeneous units allocated on the basis of file abiotic and biotic conditions of the territory. They are an open systems of mutually interacting and each underlying (mass and energy are exchanged) components of the lithosphere, the hydrosphere, pedosphere, biosphere and atmosphere. Concept REPGES was applied on the territory of the Slovak Republic. Individual types of the REPGES in the Slovak Republic have been determined on the basis of:

- zonal (bio-climatic) conditions, most often represented by the vegetation zones in a landscape. They are characterized according to the bio-conditions, which are in their complexity expressed in 9 zones of potential vegetation.

– azonal conditions, primarily quaternary geological ground and relief, secondary soils and levels of underground water, which are divided into 37 types.

In a real landscape, these conditions are expressed in a very complex way and they cannot be separated. The zonal conditions in a region cannot be changed at all, while azonal – soils, water forms and relief – can, through investment of a certain amount of energy, be partially changed or affected.

Representative geo-ecosystems:

– are basic territorial units for assesment of ecosystem services
– represent potential for the provision of ecosystem services
– create the basis of the green infrastructure

By comparison of the representative geo-systems and current ecosystems we can assess changes in ecosystems and its ecosystem services.

2. RESULTS

Altogether 120 potential REPGES types have been determined on the territory of the Slovak Republic. The REPGES types have a character of potential geo-ecosystems, because they have been determined based on abiotic conditions which represent a certain potential for the development of geo-ecosystems, and are characterized on the basis of potential vegetation.

3. PROTECTION OF REPGES

Based on the REPGES protection assessment and analysis of the rate of NATURA 2000 components in the individual REPGES, the following general conclusions have been made:

a) Out of lowland types of REPGES, no protection is provided for some dominant types, in terms of area, ecology, production and economy, such as loess table-lands, highlands and terraces. On this types the areas protected in the degree 4 and 5 of protection can be found rarely, which is often not because of protection of some characteristic structure of the type, but more often because of different curiosities and anomalies occurrence. This is because these areas intensively used for agriculture, and therefore not interesting for the "traditional" nature protection.

b) With regard to lowland types of REPGES, the most often protected areas are wetlands, alluvial forests, sand dunes and plains, which have traditionally been attractive for nature protection.

c) The last declared Landscape Protected Area (Dunajské Luhy Floodplain Forests) is located on the lowland. This is an evidence that the former "lack of concern" for these territories is hopefully the matter of the past and suggests a shift of nature protection from the traditional cultural-natural-historical approach to the ecological one.

d) Up to now, there has not been any individual basin declared the protected territory. The Oravská kotlina Basin has only become protected thanks to the broadmindedness at the Landscape Protected Area Horná Orava planning. The other "protected" basins have become protected as a by product of national parks plan-

ning, thanks to the legislation, which gives the same degree of protection to buffer zones as to ladnscape protected area. However, the above applies only to basins in higher altitudes. Intermontane and upland basins, such as Juhoslovenské kotliny Basins are not protected. Even though, the basins are very important geographical units of Slovakia.

e) Upland and hilly types of REPGES are quite well incorporated into the network of protected areas. Traditionally, karstic types enjoy the largest and best protection. Because of the broadmindness, concerning the area of protected territories declaring, the flysch. REPGES types on the virtually whole verge of External Carpathian Arch have a very good protection, including klippen zone, where the individual klippens can be protected in the degrees 4 and 5.

f) Traditionally good protection is also typical for the REPGES types of montane and high-montane types, particularly in the degree 3 of nature protection (national parks).

g) Although the types of REPGES such as lower hills and uplands, submontane uplands and the rolling plains country have lower degrees of protection, from the ecological point of view they are very important in terms of the area and bio production.

h) The similar situation has been observed in the case of the components of NATURA 2000, where protection is also predominantly focused on attractive forms of biota – endemic, rare, endangered, and similar types, reflected in the high overlapping with the current network of the protected areas.

i) With regard to protected bird areas, the disproportions in the overlapping with the current network are more significant (the overlapping is 55.15%). That is because many protected bird areas are linked with water and wetland ecosystems, especially water reservoirs, lakes and fishponds, but also to agricultural landscape, the result of which is that several protected bird areas can be found in the regions that have not been protected so far.

4. CHANGES OF THE REPGES AND THEIR CURRENT STATUS

Many potential REPGES have been considerably changed, when their potential vegetation has been replaced by either agro-associations, urban ecosystems or eventually secondary forest. The basic drivers of these changes are the following [4]:

– ***The period of industrialization and urbanization (after the 2 nd World War, the 1950 s)*** – a period defined by a process of nationalization and industrialization of the countryside of Slovakia. A very sharp increase in industrial production gradually acquired a leading position in the structure of the economy. Approximately 300 new industrial plants were built and many increased production. Mass industrial production mainly concentrated on heavy industry was based on the unacceptable exploitation of natural resources and energy. Industrial pressures led to the increased consumption of wood. Open cast mining left large areas desolate, and the construction of industrial enterprises was aimed only at economic gains and at strengthening the economic standard of living. New employment was created, re-

sulting in a gradual migration of the rural population to urban areas and consequent unsustainable concentration of the population in cities. On the other hand, this artificial migration process caused the abandonment of rural areas, with some rural settlements coming to life only on a seasonal basis. The above-limit concentration of the population in urban areas caused many negative effects, such as increasing demands for more residential space, which in turn caused significant anthropogenic pressures on the countryside. The emergence of uniform urban settlements ignored the town's specifics, failing to respect local cultural, historical and natural-geographical particularities of the environment. The soullessness of the 'super' blocks, significant suppression of human scale, gigantism, slowness, monotony, aesthetic and visual suppression of the principles of construction, flattening out and amorphousness of the living environment are the main features of the socialist urbanization of Slovakia. Industrial development and urbanization did not respect the environment. Many industrial operations harmed the environment to a disproportionate degree, thus producing excessive emissions that contaminated various environmental media. Natural resources were depleted and there was deterioration in the overall quality of the environment. Assessing the quality of the living environment was not given sufficient attention, therefore environmental quality was not regularly monitored and evaluated. In addition, information on the status of the environment was not disclosed and remained secret.

– ***The period of collectivization*** **(1950's – 1960's)** – a period defined by the expression of power and aggression, confiscation of property of small private subsistence farmers and the setting up of cooperatives. The cooperative movement in this period became the greatest enemy of the Slovak village. People were not prepared for such changes. Collectivization was primarily considered a political issue, not subject to social, cultural or psychological questions. The traditional forms of farming were destroyed along with the traditional rural life style. With this creation of cooperatives the process of collection and consolidation of land began, gradually leading to the formation of mono-functional agricultural landscapes. Hedges and terraced fields were ploughed up, grassland and meadows were destroyed. Some private owners voluntarily entered into a cooperative, some accepted it involuntarily, and the remainder changed and went to work in industry and services in neighbouring towns. In the years 1948 – 1950, 99,000 inhabitants left agriculture and went to work in industry. During this period, 80% of Slovak agriculture was collectivized. Agriculture then gradually lost its importance and declined over time, resulting in cooperatives of only older, mostly low-skilled workers. Agricultural production was focused mainly on the cultivation of cereals and fodder. In this period, cultivation in allotments was still relatively well preserved, behind houses and also on the outskirts of municipalities, thus creating a transition zone between urban and extra-urban. Allotment growing was used only for self-supply of family food. In wine-growing areas during this period, the allotments typically produced wine mainly for private consumption, but also partly for sale. However, in the mountainous areas, private farming managed to resist collectivization and some regions were able to preserve their typical traditional forms of farming, dominated by pas-

ture meadows combined with small scale terraced fields. The remnants of these traditional farms form a valuable historical landscape structure in the countryside of Slovakia. A similar process of "nationalization" occurred in forestry, where forest land changed ownership, with a gradual increase in the area of forest owned by the state. Intensive logging began, with inappropriate forest management which threatened nature and the species composition of these forest ecosystems.

– ***Transformational changes*** (after 1989) – the transformational changes after the revolution also affected the development of agriculture and forestry. The transition from central planning to a market economy brought with it many positives, but also a number of negatives. The loss of traditional markets, the underdeveloped land market, input prices rising faster than output prices in agriculture weakened the competitiveness of Slovak farmers to succeed in the market. Even previously very successful and well performing cooperatives began to crumble. First, livestock production was closed down, as it was very labour intensive and could not compete with products imported from neighbouring countries. Finally, many agricultural cooperatives fell apart and ceased operating. As remnants of socialist intensive farming now only remain the dilapidated and abandoned buildings of the former united peasants' cooperatives and state farms. The disintegration of the farms significantly weakened the economic base of many rural settlements, as agricultural cooperatives in many settlements represented the only source of income and employment. The transformational changes gradually began sorting out ownership. Possessions were returned to the original owners, but they were often no longer interested or lacked the means, whether technical, financial or human to effectively farm returned land. The part of the land which is less fertile, or with inadequate accessibility is unmanaged, abandoned. These sites are the source and spread of synanthropic and invasive species. The socio-economic changes were also linked to changes in farming. The crop balance is diverse, with crops commanding a lucrative price preferred. Currently, in addition to cereals, mainly energy crops such as sunflower, corn, rapeseed and so on are grown. The area of energy crops has increased by nearly 200% (by 181%). The area of cereals has decreased slightly, by 5%. The largest falls were observed in forage, sugar beet and potatoes. Uncoordinated cultivation of energy crops can be a threat not only for natural ecosystems but may also threaten the individual landscape components. The multi-year management is gradually changing the balance of the original trees.

– From the spatial point of view, the montane geo-ecosystems with the high rate of natural ecosystems are the regions with the highest ecological quality and the high rate of original natural ecosystems. On the contrary, the least favourable ecological quality of spatial structures is in lowland areas, such as the Podunajská rovina Flatland, Podunajská pahorkatina Highland, Východoslovenská rovina Flatland, Juhoslovenské kotliny Basins etc., where the large–area of plough land or urbanized areas are the dominant elements of the landscape s tructure. The negative ecological quality of spatial structures is also typical for basin regions (Zvolenská, Turčianska, Žilinská, Žiarska, Pliešovská Basins, etc.), where the rate of eco-stabilizing components does not exceed 30% of the total area.

In terms of the index of originality of flora associations, some regions with the high rate of forest cover have the low rate of the index because the current forest cover is a secondary forest with considerably changed species composition – the Považské podolie Basin Basin, Turzovská vrchovina Uppland, Podbeskydská vrchovina Upland, the Borská nížina Lowland, Horehronské podolie Basin, Oravské Beskydy Mountains Mountains and Kozie chrbty Mountains, Moravsko-Sliezske Beskydy Mountains, etc.

5. PROPOSAL

From the point of view of the protection and sustainable utilisation of representative geo-ecosystems, it is necessary to realise the following actions:

- the identification of the REPGES and mapping current ecosystems – REPGES are units allocated on the basis of a synthesis of the abiotic factors of the landscape and the potential biota. The current ecosystems are units (landscape-ecological complexes) allocated on the basis of a synthesis of the abiotic factors of the landscape and the current habitats. On the basis of a comparison of the potential and current ecosystems we can assess changes in ecosystems and their environmental services
- specification of the stress factors that threaten the ecosystems and assessment of the current state of the threat and the degradation of ecosystems – the basis for this step is to mapping all the factors (in the literature called as the stress factors), both natural and anthropogenic, that negatively affect the natural evolution of ecosystems.
- assessment of the current conservation status of REPGES – this step is necessary in terms of the assessment of the adequacy of the protection of individual representative ecosystems, if all the representative ecosystems have sufficient protection. If not, it is necessary to strengthen it.
- specification of functions and ecosystem services, which provide different ecosystems – individual ecosystems provide a variety of ecosystem services, which are necessary in the light of the existence of human society [6], [11]. Features may be in a different relationship, indifferent, supporting or, conversely, may be in conflict. It is therefore in the evaluation of ecosystem services to apply the multicriterial evaluation of these services
- proposal for protection ecosystems and proposal of measures on the efficient use of individual ecosystem services – this step focuses on the selection of the most appropriate function for each ecosystem. It will set out measures for the optimal use of these features and, finally, the protection in order to ensure the sustainable use of particular ecosystems

CONCLUSIONS

The traditional nature protection in its deep nature is conservative itself. However, the result is the rather unsuitable protection of the regions and different types of geo-ecosystems. The object of the traditional nature protection are original and half-orig-

inal state, rare biotopes, rarities, endemic associations, endangered associations, the ecosystems significantly affected by man are not considered to be worth of preservation. This approach is largely based on the assessment of a real state of biota, i. e. forms of life, while the main criteria are originality and natural character, rarity, a degree of threat and other traditional nature conservation criteria. The landscape-ecological concept is based on the protection not only particular life forms but also on the protection conditions of their life. The landscape-ecological approach is based on the protection of geo-ecosystem as a whole. The criterion is the functioning of a whole system, i. e. how it is able to fulfil functions – productive, regulation, cultural functions. The modern nature protection on world scale has to become one of the tools of sustainable development and that is why it looks for ways to bring together the heritage of the traditional with modern tools, such as integrated approach with territorial planning, overall-area landscape protection, protection of functioning of all, not only traditionally selected ecosystems, emphasizing preservation of conditions not only of forms of biota, by preservation of geo-biodiversity, not only of biodiversity. To meet this objective we have elaborated out a concept of representative geo-ecosystems, i. e. geo-ecosystems, which in the specific landscape and on given hierarchical level we consider both worth and necessary to be preserved in spite of according to the traditional approaches they have not been protected so far. The key criterion for the definition of a hierarchical level of a geo-ecosystem is its spatial landscape ecological relevance, i. e. there has to be a spatial expression at least on topical level (in other words, they have to have a map scale expression). The determination of the hierarchical level is a basic step of defining the representativeness of a geo-ecosystem. It is obvious, that each part of a landscape, each natural or administrative territorial unit, each region have its representative geo-ecosystem. The concept of representative geo-ecosystems has been elaborated in a map scale 1: 500 000 although the information are derived from long-term and more detailed researches. The concept was then developed for the regional level in the map scale 1: 50 000. Maps REPGES constitute a primary landscape-ecological basis for spatial planning processes.

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