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CHANGES IN THE AGRICULTURAL LANDSCAPE OF SLOVAKIA AND THEIR IMPACTS

MUDANÇAS NA PAISAGEM AGRÍCOLA DA ESLOVÁQUIA E SEUS IMPACTOS

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Abstract
The paper is aimed at the presentation of the evaluation of the changes slovak agricultural landscape in the process of transformation. It focuses on the assessment of the main driving forces of changes as well as on the assessment of the environmental impacts of these changes. It presents integrated approach to the evaluation of agricultural landscape. The integrated approach is based on the understanding landscape as geosystem. The basic goal of the evaluation was specification of the present problems of the agricultural landscape associated with the transformation process and proposal for their elimination.

Keywords: Slovakia. Integrated Landscape Management. Agricultural Landscape. Environmental and Socio-Economic Problems. Sustainable Development. Regulatives. Landscape as Geosystem.

Resumo
O artigo tem como objetivo apresentar a avaliação das mudanças na paisagem agrícola eslovaca no processo de transformação. Ele se concentra na avaliação das principais forças motrizes das mudanças, bem como na avaliação dos impactos ambientais dessas mudanças. Apresenta uma abordagem integrada para a avaliação da paisagem agrícola. A abordagem integrada baseia-se na compreensão da paisagem como um geossistema. O objetivo básico da avaliação foi especificar os problemas atuais da paisagem agrícola associados ao processo de transformação e propor soluções para a sua eliminação.

Palavras-chave: *Eslováquia. Gestão Integrada da Paisagem. Paisagem Agrícola. Problemas Ambientais e Socioeconómicos. Desenvolvimento Sustentável. Regulamentos. Paisagem como Geossistema.*

1 INTRODUCTION

According to international methodologies for identifying agricultural areas, the territory of Slovakia can be considered a rural agricultural landscape. This is evidenced by the character of the landscape and the settlement structure. Of the total number of 2,891 settlements in Slovakia, 141 are cities, the rest are rural settlements, which represents 95% of the settlement structure of Slovakia (Statistical Yearbook of the Slovak Republic, 2025). Agriculture and forestry are of decisive importance in terms of land use and natural resource management in rural areas. Within the framework of land use,

agricultural land dominates, occupying 2,365,715 ha, which constitutes 48.3% of the area of Slovakia. Forest land occupies 41.4% of the area of Slovakia.

Agriculture and forestry also represent the main economic base of most rural settlements. Agricultural production dominates in rural areas of lowlands and basins (western Slovakia - Danube and Záhorská lowlands; southern Slovakia - South Slovakian basins; eastern Slovakia - East Slovakian lowlands; mountain basins of central and northern Slovakia - Turčianska, Popradska, Žilina and Liptovská basins, etc.), forestry in the foothills and mountain areas of central, northern and eastern Slovakia. Almost 60% of agricultural land is arable.

During historical development, each country is subject to constant changes and each historical period leaves certain specific traces and features on its character, especially regarding the agricultural landscape (Gerard, et. all., 2010). The driving forces of these changes are diverse: socio-economic – economic development, political – legislation, adaptation and application of strategic documents, including international ones, demographic related to population change and demands, natural, especially the consequences of climate change, etc. (Jepsen, 2015; Rega, Short, Pérez-Soba, Luisa Paracchini, 2020). The agricultural landscape of the Slovak Republic, like other Eastern European countries, has recently undergone significant changes caused by the fall of communism (Creed, 1995; Janus, Bozek, 2019; Zagata, Hrabák, Lošták, 2020).

In the process of transformation, the greatest changes were recorded in the economic sphere, where there was a transition from centrally planned management to a market economy. After the advent of a market economy, business development began, the market was opened to foreign capital, ownership relations changed, restitution and privatization occurred. Land began to be returned to its original owners, which developed the land market. Land became a means of profitable earnings. Owners quickly discovered that they would gain much more by selling land than from agricultural activity, which is physically and time-consuming with an uncertain end, since the agricultural production process is largely dependent on many factors, especially the weather. Given the favorable price of land, many owners sold land to investors and so massive construction on agricultural land began, while in many cases even the best quality land was taken up.

The transformation process has led to the emergence of new problems – the disintegration of agricultural entities, changes in the structure of agriculture,

abandonment of agricultural land, a decrease in the intensity of agricultural production, increasing pressure on the take-up of agricultural land due to the strong pressure of promoting certain investment plans, but also the growth of spatial claims on land as a natural resource due to the implementation of environmental measures, etc. All these changes were subsequently reflected in the change of the traditional landscape character of a agricultural landscape (Podolák, 2008; Petrovič, Petrikovičová, 2021). Structural changes in agriculture subsequently have a negative impact on the social and environmental areas and cause a whole range of modern problems. In the environmental area, the most significant modern problems include the negative impacts of the abandonment of agricultural land on the biodiversity (Bezák,Mitchley, 2014) of the landscape, desertification of the landscape, the increase of synanthropic species, etc., collisions of the impact of the requirements of the development of individual socio-economic activities with soil protection and the protection of other natural resources, collisions between the protection of agricultural land and the creation of the Natura 2000 network, etc. These are a number of newly emerging, current, so far unresolved problems caused by societal changes implemented in our country. This is evidenced by a number of environmental problems associated with the quantitative and qualitative threat to soil resources. The aim of the contribution is to identify the problems of the agricultural landscape of Slovakia and to define the basic criteria for ensuring the sustainable use of agricultural landscape.

Similar changes were also noted in other former communist countries, but in Slovakia, these changes were most pronounced, as socialist forms of land management were very intensive applied in Slovakia (Stanis, 1976; Demo eds., 2001; Palang, Helmfrid, Antrop, Alumne, 2005; Bezák, Dobrovodská, 2019).

2 THEORETICAL AND METHODOLOGICAL BASIS

The basis for ensuring sustainable development of the agricultural landscape is ensuring such land use that will ensure not only the protection of soil resources but also the protection of other natural resources, including biotic (biodiversity) and environmental protection. To ensure this goal, it is necessary to understand the identity

and specifics of the agricultural landscape. The agricultural production process, unlike other production activities, has several peculiarities (Miklós, Izakovičová, 1977):

- it is spatially more extensive, since its basic means of production is soil,
- it is much more dependent on natural, especially climatic conditions, since it takes place in open space,
- it is under the direct negative influence of many stress factors resulting from the implementation of human activities in the landscape, since the agricultural production process takes place in open landscape,
- it is a scene of conflicts of interest, since the land, covering almost the entire economically used area, is the spatial basis for all social activities in the landscape, as well as being a living space for all elements of the natural landscape.

Therefore, proper management of land and soil is the basis for the continued existence of humanity. By ecological optimization of the agricultural landscape, we understand the harmonization of activities to ensure human requirements for sufficient production of healthy agricultural products with the natural conditions of the landscape and with the development of other social activities of the agricultural landscape. Ecological optimization will ensure the elimination of current and the prevention of the emergence of new environmental, social and economic problems and, in the long term, will ensure the sustainable development of the given territory.

The following methods were used to assess the development of the agricultural landscape of Slovakia and the resulting environmental problems:

- document analysis – which focused on the evaluation of the principles and criteria of sustainable development and their application in the assessment of agricultural landscape development
- Landscape-ecological syntheses – focused on the evaluation of environmental problems arising from the collision of positive and negative factors.
- GIS methods were used for the spatial specification of phenomena, processes and also problems
- Statistical methods – were used for the quantitative expression of phenomena, properties and current environmental problems

3 RESULTS

Despite the important function that soil plays in the country, we do not always treat it as it should be, as evidenced by a number of environmental problems associated with the quantitative and qualitative threat to soil resources. The quantitative aspect is associated with the use of land for non-agricultural activities, especially for socio-economic development, which causes irreversible loss of land, thereby also threatening the country's food security. Between 2002 and 2025, agricultural land decreased by 72,638, which means a 3% decrease, of which the use of arable land was 31,323 ha (Fig. 1). Built-up areas and other areas associated with them - courtyards, soil overburden, landfills, etc. - have increased significantly (Fig. 2.). (ÚGKaK, 2025). While the construction of industrial buildings and parks was carried out mainly on arable land, the construction of residential areas mainly involved orchards, gardens, and vineyards, as these were often the private property of the owners carrying out the construction. Compared to 2002, the area of gardens decreased by 3%, orchards by 5%, and vineyards by 4%.

Figure 1

Changes in agricultural land

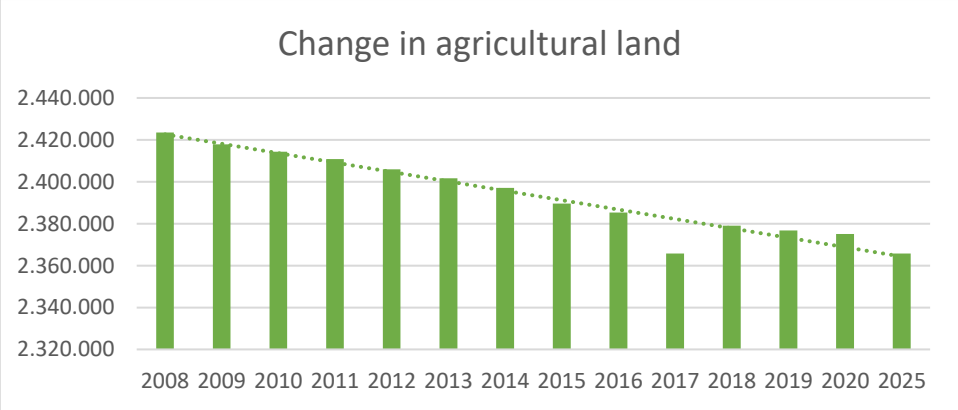
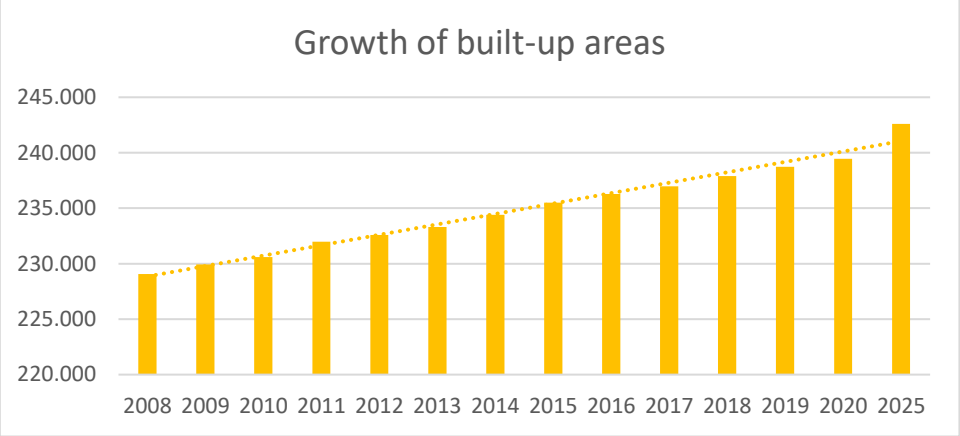


Figure 2

Growth of built-up areas



The conversion of agricultural land into building plots for various investment purposes represents activities with significant negative ecological and environmental impacts, such as the use of the best quality lands for non-agricultural activities, landscape fragmentation, increasing degree of anthropization of the territory, decreasing level of ecological stability of the territory, etc. The paradox is that the share of built-up area is increasing, but on the other hand the number of inhabitants is decreasing, similarly to the number of inhabitants per built-up area. In 2005, the area of arable land per inhabitant was 0.265 ha and in 2023 0.259 ha. This decreasing trend is a negative phenomenon from an environmental point of view, especially in the case of the removal of arable land from the agricultural land fund and subsequent reclassification into the category of built-up areas. The increasing spatial demands of the population can be attributed to the current consumer lifestyle of today's/modern man.

The qualitative aspect is associated with the threat and disruption of the physical and chemical properties of soils. The most significant physical degradation in our country is soil erosion, which is often a consequence of its inappropriate management and non-compliance with anti-erosion measures. In 2023, 219,719 ha of agricultural land in the Slovak Republic were threatened by current water erosion of varying intensity (erosion categories from medium to extreme), which represents 12.3% of the area of agricultural land in Slovakia. 150,000 (3%) hectares of agricultural land in Slovakia are threatened by wind erosion (Statistical Yearbook of the SR. 1996 and 2025). Recently, soil compaction has also become increasingly evident, mainly due to inappropriate land management,

such as the use of heavy machinery on wet soils, insufficient organic fertilization, the use of an inappropriate range of fertilizers, failure to comply with biologically balanced cropping practices, etc. In reality, about 200 thousand hectares of agricultural land are compacted, potentially another approximately 500 thousand hectares. If we want to improve the soil structure on arable lands, technologies that increase the content of organic matter in the soil must be introduced (SPU, 2024).

From the chemical aspect, the most pronounced is soil acidification, as the proportion of agricultural soils with acidic and weakly acidic soil reactions has increased in recent years. Part of the soil fund is also threatened by the presence of foreign substances in the soil. This is primarily a remnant of the pre-transformation process, where insufficient attention was paid to environmental protection issues. Contaminated soil is mainly associated with areas of industrial activity and areas of influence of so-called geochemical anomalies - mountain and foothill areas. The presence of foreign substances was also largely determined by the use of industrial fertilizers and plant protection products.

In the post-transformation process, there was a significant decrease in the consumption of industrial fertilizers in agriculture. In the period 1990–2023, the consumption of nitrogen fertilizers decreased by 29.1%, the consumption of phosphate fertilizers by 84.1% and the consumption of potassium fertilizers by 90%. In 2023, the total consumption of industrial fertilizers amounted to 83.9 kg of pure nutrients per hectare of agricultural land. In the period of intensive agriculture, high doses of pesticides were applied in the past. While in 1980 the consumption of pesticides amounted to 19,016 t, in 2022 4,725.75 t were applied in agriculture (SAŽP, MŽP SR. 2023). Excessive and incorrect application of industrial fertilizers negatively affects not only the soil, but also other components of the environment, especially water, as nutrients can be leached from the soil into groundwater and surface water. Pesticides enter the soil through direct application, washing off the leaves of treated plants, and also as a result of wind drift during application. The risk of using pesticides lies in the fact that they can also affect those organisms for which the pesticide was not originally intended. Soil and aquatic organisms are directly at risk, and through the food chain, other organisms, including humans.

After the Slovak Republic joined the EU, the Common Agricultural Policy began to be applied, which, through numerous measures within the Rural Development Programme (MPaRV SR, 2014), significantly supports agricultural production that is more environmentally friendly. Environmental awareness has also increased, which has resulted in the launch of organic farming, which is much more sensitive to the protection of nature, natural resources and environmental protection (Bezák, et. All., 2020). In 2023, a total of 1,305 entities managing organic forms on an area of 261,059.6 ha of agricultural land were registered within the agricultural production of Slovakia. One of the main objectives of the 2030 Envirostrategy for sustainable land management, to increase the share of land managed in the organic agricultural production system to at least 13.5% of the total area of agricultural land by 2030, was achieved already in 2021 (SAŽP, MŽP SR. 2023). The EU has set itself the goal of achieving the area of agricultural land in the organic agricultural production system to 15% by 2030. It can be said that Slovakia is on track to achieve this goal.

4 DISCUSSION

Land and the rural environment provides a variety of functions or goods and services, covering production, regulation, habitat and information. Their use is not always optimally coordinated, which leads to the emergence of various conflicts and the resulting landscape-ecological problems.

In summary, it can be stated that the cause of the current problems in the agricultural landscape of Slovakia is (Izakovičová, Moyzeová, Oszlányi, 2010):

1. The persistent sectoral approach to the management and use of the agricultural landscape. The development of many sectors is often carried out at the expense of the development of agriculture, because the development of these sectors is associated with certain demands on space, which also includes land, often of the highest quality.
2. Monofuntional use of agricultural landscape ignoring the nature of the landscape space as an integration of a set of natural resources of a certain creditworthiness and with certain limited reproductive capabilities. For example, agricultural production ignoring the presence of groundwater and the permeability of the

subsoil can cause their deterioration through the seepage of chemicals, excrement from animal production, etc.

3. Preference for short-term economic effects at the expense of ecological effects. For example, from an ecological point of view, it is nonsense to consider the per hectare yield of agricultural crops as the main criterion for the use of land, often achieved through the use of excessive amounts of industrial fertilizers and inappropriate mechanization, which often threatens the quality of cultivated crops, the quality of the soil, the quality of water, etc.
4. Lack of scientific landscape-ecological data on the territory of a given agricultural landscape, insufficient awareness of the impacts of individual anthropogenic activities on nature and natural resources, including soil.
5. Insufficient greening of many production technologies, as well as the agricultural production process, causing significant damage to agricultural land - contamination, soil erosion, subsidence, etc.
6. Inflexible legislative system for the protection of nature and natural resources. Legal regulations often do not respond quickly enough to the economic development of society and the associated negative impacts on soil and other natural resources.
7. Low environmental awareness of the population, low educational level of the agricultural population and low adaptability of the workforce.

Multifunctionality therefore is a key feature for implementing sustainable land utilisation (Izakovičová, Miklós, Drdoš, J997; Helming, Wiggering, (eds.), 2003; Wiggering, Dalchow, Glemnitz, Helming, Muller, Schultz, Stachow, Zander, 2007; Palang, Helmfrid, Antrop, Alumne, 2005). Individual problems of the agricultural landscape cannot be solved unilaterally, from a sectoral perspective, but solving the problems necessarily requires an integrated approach - aimed at assessing the causes and consequences in all spheres - economic, environmental and social. Therefore, solving the above problems requires the application of a new approach to the assessment of the agricultural landscape based on an integrated approach to the landscape.

The sustainable landscape management must be based on an integrated landscape research in its three basic dimensions, environmental, social and economic, analysing the connections and dependencies between the dimensions with the target to define such

landscape management, which would regulate socio-economic landscape development with its natural, human, cultural and historical potential. Is based on matching the offer, which is represented by the resources in the region, and demand which is represented by the community needs of growth and development (Miklós, Izakovičová, 1997). Integrated landscape management is based on the understanding of landscape as the integration of natural resources in a certain space. Space represents a unifying framework, a scene on which all resources occur as mutually interwoven layers (geological resources, water and soil resources, climate, biotic resources, morphometric parameters). It is a cross-sectoral understanding of space as the integrity of individual natural resources in a given territory. Each point on the earth's surface represents a specific homogeneous unit of mutual combination of the above-mentioned resources. And it is necessary to decide on the use of the landscape based on all the properties of these resources. In the use of the territory, it is necessary to respect the limits and restrictions resulting from the properties of the individual natural resources of the territory. Limits and restrictions can be divided into the following basic groups (Izakovičová, Miklós, Miklósová, Petrovič, 2019):

- Spatial-stabilization, the aim of which is to create a functional spatially stable agricultural landscape based on the functioning of all levels of territorial systems of ecological stability/Ecological networks,
- ecosozological, the aim of which is to protect nature and natural resources from their quantitative and qualitative degradation. Thus, the proposed activities in the ecological optimization process of the agricultural landscape must be in accordance with the natural potential of the landscape,
- hygienic, the aim of which is to protect human health. Therefore, the ecological optimization process of the agricultural landscape must respect the requirements for the protection of human health and the use of plots and objects of the agricultural landscape must be adapted to this purpose,
- safety, the aim of which is to protect the safety of elements of the technosphere of the agricultural landscape, such as livestock farms, transport communications, power lines, etc. These elements and their operation require certain protection zones, mostly defined as zones of sanitary protection, which must be fully respected in the ecological optimization process of the agricultural landscape,

- aesthetic, the aim of which is to create an aesthetically suitable agricultural landscape. This aspect must be intertwined with the entire decision-making process,
- compositional, the aim of which is to create a unified functional system of the agricultural landscape and preserve the characteristic character of the agricultural landscape,
- socio-economic, the aim of which is to create an economically prosperous agricultural landscape ensuring its food security and an adequate quality of life for the rural population.

5 CONCLUSION

Integrated landscape management represents a modern but very topical issue arising from the needs of landscape research as an integration of natural, cultural-historical and socio-economic resources in a given area. It results from the needs of solving not only environmental problems, but also the overall existential problems of humanity, which arise as a result of persistent sectoralism in the use and protection of the landscape.

The needs of the sustainable landscape management issue from:

- requirements to improve and ensure the spatial stabilization of the aricultural landscape. The stated criterion is here formed by the demand to achieve the biological balance in the landscape;
- needs for the nature protection and rational utilisation of the natural resources, in particular the protection of the soil, water, forests and gene pool;
- needs for the protection of cultural and historical resources in order to preserve and protect valuable historical structures of the agricultural landscape;
- needs for the regeneration of human resources and for the protection of human health;
- demands on the humanization and aesthetization of the landscape.

These requirements represent the fundamental principles of the sustainable development of the society.

Its application in practice will contribute not only to the elimination of environmental problems, but will also contribute to the overall strengthening of the socio-economic development of the given areas in accordance with the capacity possibilities of the natural resources of the territory, as well as to the improvement of the overall quality of life. The successful application of integrated territorial management also requires a number of societal measures at the level of legislation, economic instruments, as well as at the level of education and upbringing in the given area.

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Authors' Contribution

All authors contributed equally to the development of this article.

Data availability

All datasets relevant to this study's findings are fully available within the article.

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