

Article

Integration of Landscape Ecological Data in Spatial Planning in Slovakia

Zita Izakovičová ¹  and František Petrovič ^{2,*} 

¹ Department of Geography and Geology, Faculty of Natural Sciences, Matej Bel University, Tajovského 40, 974 01 Banská Bystrica, Slovakia; zita.izakovicova@savba.sk

² Department of Ecology and Environmental Sciences, Faculty of Natural Sciences and Informatics, Constantine the Philosopher University in Nitra, 949 01 Nitra, Slovakia

* Correspondence: fpetrovic@ukf.sk

Abstract

This paper is focused on the evaluation of the implementation of landscape ecological documents in spatial planning processes in Slovakia. The implementation of landscape ecological regulations in spatial planning is a necessary condition for ensuring sustainable land use. The basic tools in Slovakia can be considered the landscape ecological plan and the territorial system of ecological stability, which are also enshrined in legislation. The landscape ecological plan is more complex. It represents a complex process of mutual coordination of the spatial requirements of human activities with the landscape ecological conditions of the territory. This paper presents the position of landscape ecological planning in legislation, presents basic theoretical and methodological approaches to the processing of landscape ecological documentation, barriers to the successful implementation in real practice, and also defines basic measures to improve the situation. Slovakia has a good theoretical and methodological basis for processing landscape ecological studies and also legislative support, but its implementation in real practice in spatial development is weaker. The specifics and strength of landscape ecological planning in Slovakia are the bridging of the sectoral approach to landscape management and its replacement with an integrated approach.

Keywords: spatial planning; sustainable land use; landscape ecological plan; territorial system of ecological stability; landscape ecological regulations



Academic Editors: Xi Li, Kai Li, Yuejing Rong, Hao Xia and Ruhong Xin

Received: 21 January 2026

Revised: 12 March 2026

Accepted: 16 March 2026

Published: 27 March 2026

Copyright: © 2026 by the authors.

Licensee MDPI, Basel, Switzerland.

This article is an open access article distributed under the terms and conditions of the [Creative Commons Attribution \(CC BY\)](https://creativecommons.org/licenses/by/4.0/) license.

1. Introduction

Spatial planning is a fundamental tool that regulates the spatial arrangement and functional use of the territory. Economic and social development should be ensured through the spatial organisation and functional use of the territory, while simultaneously ensuring national defence and security, the protection of nature and the landscape, and the preservation of historical and cultural heritage. It should reasonably balance the economic, social, and also environmental aspects of territorial development. Growing environmental problems such as the degradation of natural resources, loss of biodiversity, and deterioration of environmental quality are evidence that environmental aspects are not always sufficiently considered in spatial planning. Economic aspects dominate, and in many cases the interests of individual lobby groups are preferred, as evidenced by current landscape and ecological problems [1–4]. Up to 60% of the world's ecosystems are degraded and used unsustainably, and only 17% of habitats and species and 11% of

key ecosystems protected under European legislation are in good condition. The situation is also unfavourable in Slovakia. Threatened embryophyte species represent 42.6% of all assessed categories, or 30.3% within the CR, EN, and VU categories. The threat to invertebrates in Slovakia is currently around 8.4% (or 5.4% only within the CR, EN, and VU categories). As for vertebrates, up to 59% are endangered [5]. If we want to stop these negative trends, we must urgently move towards effective biodiversity protection and natural resource conservation, not only in research but especially in real practice. Landscape ecological planning is an effective tool for this process [6–8]. From the point of view of ensuring sustainable development of the territory, it is necessary to integrate landscape ecological regulations into spatial planning processes, especially into spatial planning. This aspect is also emphasised in the European Landscape Convention, where participating countries undertake to introduce and implement landscape concepts aimed at the protection, management, and planning of the landscape and to implement landscape concepts aimed at the protection, management, and planning of the landscape.

In many EU countries, spatial planning is legislatively linked to ecological and environmental regulations, but the degree of integration varies. The Strategic Environmental Assessment (SEA) Directive (2001/42/EC) [9] requires the assessment of the environmental effects of plans and programmes in sectors including spatial planning and land use. It aims to integrate environmental considerations directly into the preparation of plans [eur-lex.europa.eu]. Each EU member state is required to have a mechanism in place to ensure that spatial planning incorporates environmental considerations (SEA), although the specific method of implementation differs among countries. The form and depth of the process depend on capacity, policy, and practice (ScienceDirect+1).

In principle, two basic models of implementing landscape ecological and environmental regulations into spatial planning processes (SPP) can be distinguished:

- Model A—creation of separate landscape ecological/planning documentation (e.g., German Landschaftsplanung; Czech and Slovak Territorial System of Ecological Stability (TSES), or landscape ecological studies). These documents form a professional basis and are subsequently transferred in the form of regulations to territorial plans and spatial planning [10–12].
- Model B—integrating regulations directly into the “environmental/territorial law” in unified plans (e.g., Dutch Omgevingswet, English Biodiversity Net Gain + Landscape Character Assessment, French Trame verte et bleue in SRADDET). These countries codify green infrastructure and ecological objectives as a mandatory part of spatial planning [13–15].

Each of these models has its advantages and disadvantages. Based on the evaluation of the literature search, the countries with the best integration can be classified as countries in western and northern Europe, such as Germany, the Netherlands, Norway, Sweden, Finland, and England, where they have strong environmental policies with the integration of environmental principles into spatial planning. The most unfavourable situation in Europe is found in eastern and southeastern European countries such as Hungary, Albania, and Bosnia and Herzegovina, where landscape ecological data are often insufficiently anchored in spatial planning legislation. These are mostly former post-communist countries that joined the EU later, and countries outside the EU. In these countries, environmental issues have not been given sufficient attention. The Czech Republic and Slovakia have a special position among Eastern European countries. Their landscape planning methods are generally well-developed theoretically, but their application in real practice is weak.

The aim of this paper is to present the Slovak model of implementing landscape ecological knowledge into spatial planning, to establish the strengths of this process, but

also to specify the basic barriers to the success of this process and to bring suggestions for improving the situation.

Study Area

Slovakia is a small but very diverse landscape. Its area reaches 49,034 km² with 5,428,792 inhabitants (Figure 1). Slovakia is a post-communist country. In 1989, after the gentle revolution, it switched from a centrally planned economy to a market economy. Economic development began to accelerate, and investor pressure to change the use of the land increased. In 2004, Slovakia joined the EU, which obliged it to devote more intensive attention to the protection and creation of the environment.

Regions of Slovakia



Figure 1. Regions of Slovakia.

The landscape structure is dominated by agricultural land, which occupies 48.4% of the total area of the landscape. Forests occupy 41.4% of the area. The extent of built-up areas has increased significantly in recent years, now reaching almost 5% of Slovakia's total territory. Natural resources are not always used efficiently, as evidenced by the degree of their threat and degradation. The territory of the Slovak Republic is divided into three levels of environmental quality. Almost half of the territory of the Slovak Republic (49.2%) falls into the first level of environmental quality (high-quality environment)—23 regions. The territory with the second level of quality (regions with moderate environmental disturbance) occupies 39.8%, which represents 29 regions of Slovakia that fall into this category. The remaining part of the territory of Slovakia—8.8% (7 regions)—falls into the third level of quality (regions with severe environmental disturbance) [16]. Deteriorated levels of quality of life are a consequence of the failure to apply landscape ecological regulations in spatial planning.

2. Materials and Methods

The methodological procedure consisted of document analysis, both legislation and theoretical–methodological procedures for the creation of landscape ecological documentation. Within the framework of legislation, all legislative instruments that define landscape ecological documentation (territorial systems of ecological stability, landscape ecological plans, and landscape studies) and requirements for their processing were analysed. The following acts were analysed:

- (a) Act on Nature and Landscape Protection 284/1994 and 543/2002 Z.z.: there is the basic definition of TSES, the European network NATURA 2000, and its determination as a basic document for different planning.

- (b) Act on Territorial Planning and Construction Order, amendments 262/1992 Zb. and 237/2000 Z.z., defines that the elements of TSES are obligatory regulations on all levels of territorial plans. It states that the basic landscape ecological input for spatial planning is the landscape ecological plan.
- (c) Act on Land Arrangement and Land Ownership 331/1991 Zb. and its amendment 549/2004 Z.z. define that the TSES is an obligatory basis and part of each Land Arrangement Project; moreover, the need for improving the TSES function might be accepted as a legal cause for enacting the land arrangement procedure. In the land arrangement project, the elements of the territorial system of ecological stability and important landscape elements are considered as a common arrangement.
- (d) Act on Environmental Impact Assessment 127/1994 Z.z. and 24/2006 Z.z.: defines that elements of TSES are an obligatory object of impact assessment.

Among the methodologies analysed were methodological procedures for processing territorial systems of ecological stability [17–21] and methodology for processing landscape ecological plans [17].

At the same time, the personal, long-term experience of this paper's authors was also used, whether with the preparation of methodological procedures or with the creation of specific landscape ecological documentation. To specify the basic strengths and weaknesses, a sociological survey and a semi-structured interview were carried out. We had prepared questions in advance, but the method and form of answering the questions remained free. Respondents could choose the style of their answer. The interview was conducted at two levels:

- (a) with the mayors of the municipalities falling within the urban functional area of Trnava (15 mayors). The interview with local government representatives was conducted in the form of open interviews, where the questions focused on assessing the significance of landscape ecological documentation in the spatial development of the municipality and the application of landscape ecological regulatory measures in spatial plans. The last question was aimed at specifying the main problems related to the processing of landscape ecological studies.
- (b) with the designers of landscape ecological studies (10 experts).

The sociological survey was carried out in the form of personal interviews. Of the experts, six were authors of landscape ecological methodologies, two were authors of both the landscape ecological plan and the territorial system of ecological stability methodologies, four were authors of the territorial system of ecological stability methodologies, two were authors of the landscape ecological plan methodologies, and three were designers who processed documentation for municipalities according to the given methodological instructions. The interview questions were focused on three basic areas: assessing the quality of processing landscape ecological documentation, assessing the complexity of the methodological procedure, and specifying the problems associated with the realisation and implementation of landscape ecological studies.

3. Results

3.1. Legislation

The position of landscape ecological documents in the legislation of the Slovak Republic was most comprehensively elaborated by the amendment to Act No. 237/2000 Coll. of the National Council of the Slovak Republic, amending and supplementing Act No. 50/1976 Coll. on spatial planning and building regulations (Building Act), as amended, which considers the optimal spatial arrangement and functional use of the territory to be an integral part of surveys and analyses, taking into account landscape ecological, cultural-

historical, and socio-economic conditions (landscape ecological plan). The aforementioned amendment defined ecologically optimal spatial arrangement and functional use of the territory as a complex process of mutual harmonisation of spatial requirements of economic and other human activities with landscape ecological conditions of the territory, which result from the structure of the landscape. The results of the landscape ecological plan are part of the analysis surveys within the spatial planning documentation, and the basis of the landscape ecological plan must be formed into the form of landscape ecological regulations, which should be implemented in the proposals for spatial and functional use of the territory within the spatial planning documentation.

The amendment defines the territorial system of ecological stability (TSES) as the starting point for the landscape ecological plan. The elaboration of the TSES is based on the concept of understanding the spatial ecological stability of the landscape as the dynamic ability of the landscape structure to maintain spatial ecological relationships between individual ecosystems due to the dynamic variability of conditions and forms of life, even assuming that the landscape is locally formed by ecosystems with different (even low) degrees of ecological stability. Such a state of the landscape can be ensured both by preserving the “internal” ecological stability of the key stabilising elements of the landscape and by preserving the spatial system of mutually non-isolated ecosystems [22,23].

The concept of a territorial system of ecological stability focuses on a gradual transition from a black-and-white division of the landscape into protected and unprotected to a comprehensive differentiated system of preserving an ecologically suitable landscape structure carried out through a differentiated method of use. The territorial system of ecological stability consists of two basic parts: 1/the skeleton of the territorial system of ecological stability (biocenters, biocorridors, and interaction elements, etc.) and 2/ecostabilisation measures (a set of measures to strengthen spatial stability). The elements of the TSES skeleton should have the status of protected territories in spatial planning processes, and ecostabilisation measures should be applied as landscape ecological regulations.

Last year, a new Building Act 25/2025 Coll. was adopted, which considers a landscape study to be the basic landscape ecological basis instead of a landscape ecological plan. The processing of a landscape study is much broader than a landscape ecological plan, which can further complicate the process of implementing landscape ecological regulations into spatial planning processes. The landscape study can be considered a kind of synthesis of the landscape plan and the territorial system of ecological stability. A landscape study is currently being prepared at the national level, which will be the basis for the new Concept of Territorial Development of Slovakia. Subsequently, these documents will be implemented at the regional level.

The basic methodological principles of creating a landscape ecological plan were summarised from the analysis of documents (Figure 2).

The basic methodological principles of creating a landscape ecological plan were summarised from the analysis of documents. The basis for creating a landscape ecological plan is a decision-making process, which consists of the following two basic steps [2,17,24,25].

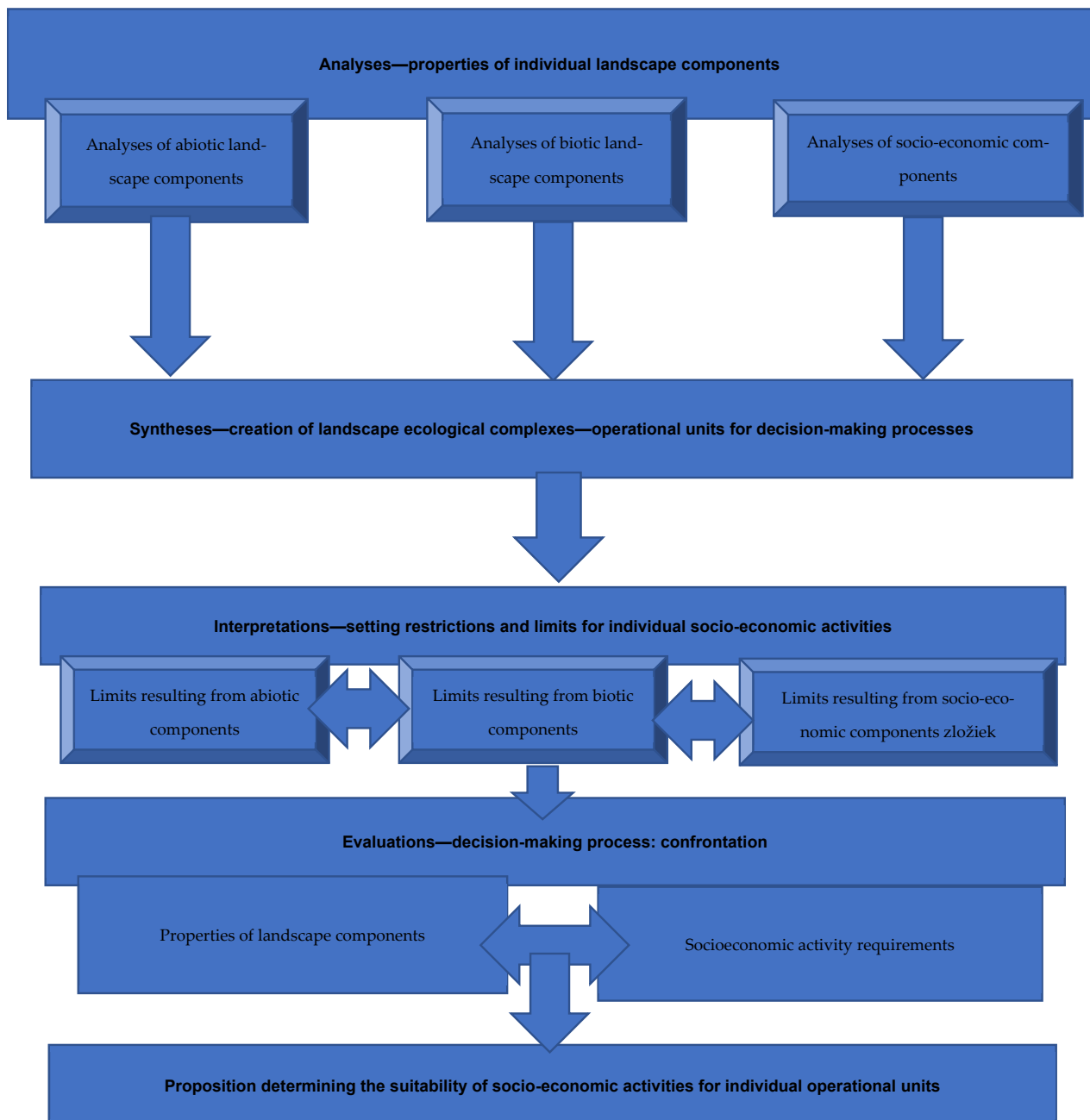


Figure 2. The basic methodological principles of creating a landscape ecological documentation.

A/Landscape ecological evaluation—the process of determining the suitability of landscape features for the location of selected social activities. Evaluation is the core of the entire decision-making process, in which the requirements of individual activities for landscape ecological conditions are confronted with the existing values of the landscape using limits. They enter the evaluation process [17,18,26,27]:

- landscape ecological documents—a set of clearly defined landscape ecological documents, which are represented by synthetic units—LEC (Landscape Ecological Complex) types. Types have their real spatial expression on maps with different combinations of natural and socioeconomic indicators of the landscape. LECs are homogeneous complex landscape units differentiated due to the different combinations of properties of individual landscape-forming components occurring in the given area;
- proposed activities for the land use reflect the requirements of the territorial community for its development and land use of the given territorial unit.

The process of determining the suitability of the features of the landscape for the location of selected social activities is carried out in the form of determining the limiting and restricting factors for the implementation of individual human activities. The basic principles of limitation are as follows [18]:

- Abiotic conditions represent the determining factors conditioning the diversity of the conditions of the given territory. This differentiation also determines different forms of land use. Due to the permanent, unchangeable nature of these elements, the properties of the abiotic elements of the landscape must be considered as determining factors of socio-economic development;
- In locations sensitive and susceptible to the manifestations of degradation processes (locations prone to erosion-accumulation processes, landslides, earthquakes, etc.) because of the implementation of socio-economic activities, it is necessary to implement such land use that mitigates the negative manifestations of the mentioned risk factors;
- In protected territories, ecologically valuable and stable territories (locations of the territorial system of ecological stability), it is necessary to prioritise development that does not threaten the natural values of landscape units; it is primarily about the development of scientific research, nature conservation, or medical and recreational activities, etc.;
- Similarly, in areas with legislatively defined protection of natural resources, it is necessary to exclude the development of those human activities that could negatively affect individual natural resources and to prioritise the development of activities aimed at supporting the protective functions of individual natural resources;
- In areas characterised by a high level of stress factors, such as polluted air, soil and water contamination, and excessive noise pollution, activities sensitive to environmental hygiene parameters are excluded;
- Areas without stress factors are not suitable for locating operations that could endanger the current satisfactory hygienic quality. They are particularly suitable for the development of activities with high demands on hygienic parameters. The development of housing, recreation, civic amenities, cultivation of agricultural crops for direct consumption, and viticulture, etc., is suitable here.

B/Landscape ecological proposition—proposal for the optimal landscape ecological use of the territory consisting of:

- determination of alternative ecological choices: for each area, a set of activities is defined that can be implemented in the given area, i.e., they are not limited by any property of the landscape-forming components.

Thus, the landscape ecological plan establishes: Maps of alternative and optimal ecological choices can be considered basic landscape-ecological regulations for territorial development, as they stipulate: Those activities that cannot be localised in a given area from a landscape ecological perspective.

- Those activities that can be localised, but under certain limited conditions, with a strict management regime.
- The hierarchy of those activities that are most suitable for implementation on a given plot from a landscape ecological perspective.
- Determination of landscape ecological measures—this involves defining a set of measures aimed at *improving the ecological stability and biodiversity of the area, protecting natural and cultural–historical resources, and measures to improve the quality and aesthetics of the environment.*

Subsequently, in cooperation with the main stakeholders, a compromise selection of the most optimal socio-economic activity in each area is made according to the needs of the given territorial community.

The main cartographic outputs of the landscape ecological plan are:

- Map of current land use shows the current land use.
- Map of landscape ecological complexes as basic operational units for decision-making processes.
- A map of landscape ecological problems resulting from the current inappropriate use of the landscape, i.e., from the specification of problem areas where the current state of land use is not in accordance with the landscape ecological conditions of the area.
- A map of the proposal for landscape ecological optimal use, including a proposal for a territorial system of ecological stability, which should be implemented into spatial planning processes in the form of landscape ecological regulations.

3.2. Practical Implementation Barriers

Despite the undisputedly important role of landscape ecological regulations in spatial planning processes, their implementation in concrete practice has been met with great reluctance. Stakeholders in the sociological survey identified the following as the main reasons for the unsuccessful application process:

- Lack of understanding of the significance of landscape ecological documents within spatial planning documentation by the contracting authority (primarily the local government). As half of the mayors said, *landscape and ecological documentation complicates the processing of spatial planning documentation*—contracting authorities have not sufficiently understood the significance of documentation as a tool for optimal use of the potential of the territory, which, in addition to eliminating specified environmental problems, will also ensure the prevention of the emergence of new landscape ecological problems. At the same time, they can be a suitable tool for preventing the impacts of climate change, mitigating the manifestation of natural risks and hazards—floods, erosion-accumulation processes, and landslides, etc. [3,28].
- Complexity of the methodological procedure for processing landscape ecological documentation and TSES—the methodologies recommended by the Ministry of the Environment of the Slovak Republic [17,18] are based on the LANDEP landscape ecological planning methodology [2]. This is an open system of a set of subsequent steps, modifiable based on the specifics of the territory, the scale of processing, and the time horizon of processing the task, etc. It should be noted that the modification of individual steps requires certain professional experience and cannot be performed by a worker who does not know the basic principles of the landscape ecological planning methodology or has no experience with similar landscape ecological planning methodologies. The methodology is based on an integrated approach, the essence of which is the knowledge of space as an integration of diverse properties and specificities of individual landscape-forming components—abiotic, biotic, and socio-economic. At the same time, a necessary condition is also the knowledge of the relationships between the above-mentioned resources. Such an approach is demanding for designers. In practice, the sectoral approach still dominates [6,27].
- Lack of experts for processing documentation—processing of landscape ecological studies requires some experience with methods of landscape ecological planning, and it is obvious that this documentation cannot be processed by urban planners, architects, or other professions. It is necessary to have some knowledge of the relationships and processes taking place in the landscape. Otherwise, the processing of documentation is limited only to mapping the current landscape structure and marking “green areas”

as elements of the ecological network. The processing of high-quality documentation requires an interdisciplinary team, of which there is currently a limited number in the Slovak Republic [18].

- Low promotion and awareness of the above-mentioned issue—insufficient information is also a problem, especially among contracting authorities, about the requirements for processing high-quality landscape ecological documentation. Due to the lack of “positive” examples, there is no possibility of comparison. Similarly, competent authorities (the Ministry of Environment of the Slovak Republic, the Ministry of Construction and Regional Development of the Slovak Republic, and the Ministry of Agriculture) pay little attention to the promotion of landscape ecological documentation. Another mistake is that professional competence is not required for the processing of the landscape ecological plan (LEP), which often leads to the fact that the landscape plan is not processed by experts in the given issue. The situation is slightly better within the framework of the processing of the TSES, where professional competence is required for the processing of the documentation [29].
- Inappropriate inclusion of landscape ecological data in surveys and analyses in the processing of the SPP. This fact is reflected in the fact that landscape ecological studies are processed as separate, necessary parts of surveys and analyses, and are subsequently not reflected in landscape ecological regulations. Processing a landscape ecological study as a separate document is self-serving and meaningless. From the point of view of landscape ecological optimisation, it is necessary to reflect and respect the regulations resulting from landscape ecological studies in spatial and functional use proposals within the framework of territorial planning. Otherwise, the processing of these studies becomes pointless [2,30].
- Failure to approve methodological procedures for processing landscape ecological studies by binding legislation in the form of methodological guidelines for processing the landscape ecological documents. This situation creates a certain freedom in processing documentation, which causes diversity in the processing of documentation.
- Rejection and underestimation of landscape ecological documents by the processors of the territorial plans—the processing of landscape ecological studies is not supported by the processors of the territorial plans, as this fact increases the difficulty of solving the spatial and functional arrangement of the territory compared to the classic processing of the territorial plans. The processing of the territorial plans has a long-standing tradition in the Slovak Republic. From the point of view of the processors, there is not much willingness to change the already “established” procedures. The processors of the territorial plans consider the processing of landscape ecological studies to be an “indispensable obligation”.
- Limited financial resources for processing documentation—individual contracting authorities often do not have enough financial resources to process landscape ecological documentation. For processing of territorial plans and land adjustments, there are tables for calculating prices based on the number of inhabitants, houses, size, and complexity of the cadastre. For processing landscape ecological documents, such schemes for calculating prices are not available, which leaves a minimum of financial resources for processing landscape ecological documentation. In practice, one can often encounter the fact that the price for processing landscape ecological documents reaches a maximum of 5% of the total price of processing territorial plans or land adjustments. However, it should be noted that reasonable processing of landscape ecological documentation does not have to contribute to a significant increase in the price of documentation, since much of the information for processing landscape ecological documentation, spatial planning documentation, and land adjustments is identical,

especially information on the properties of individual components of the environment. Currently, it is also possible to draw funds from EU funds for these purposes [2,31].

4. Discussion

As outlined in Section 3, landscape ecological planning serves as a core instrument for safeguarding the sustainable development of territories. Approaches to the creation and especially the application of landscape ecological plans in real practice differ from country to country. In most countries, the main landscape ecological regulations for spatial planning are considered to be elements of the ecological network—biocentres and biocorridors (Netherlands, Norway, France, Czech Republic, Spain, Estonia, Poland, and Slovakia, etc.). These countries codify green infrastructure and ecological objectives as a mandatory part of spatial planning [13,14,32–39]. Some Central and Eastern European countries have legal instruments but limited practical integration due to capacity and data barriers.

Landscape ecological regulations are understood more broadly in German planning, where landscape ecological planning (Landschaftsplanung) is legislatively enshrined in the Federal Nature Conservation Act (BNatSchG); there are hierarchical documents (Landschaftsprogramm, Landschaftsrahmenplan, Landschaftsplan, and Grünordnungsplan), which are linked to spatial planning (Bauleitplanung) [11,40,41]. In England, in addition to green infrastructure, landscape character is also considered the basis of landscape ecological regulations [42].

The planning practice in the Czech Republic and Slovakia also stems from the German environment, where significant similarities can be seen, as these countries formed a common state until 1992. Together, in 1984, the concept of ecological networks, known as the territorial system of ecological stability, was created. After the division of the common state, the development of the TSES concept in the Slovak Republic began to develop independently.

Slovakia has ratified all environmental strategies and environmental laws and has developed national strategies based on them. The constant creation of new concepts or their modification (concept of sustainable development, ecological networks, green infrastructure, and ecosystem services, etc.) leads to a certain chaos and the representatives responsible for the management of the territory do not always have enough information about the significance and importance of the needs of individual documentation and it is not entirely clear to them how to incorporate them into spatial planning documentation and which documentation should have a higher priority. As a result, many documents are processed formally and are little or not applied in practice. A similar situation is declared by several countries—France, the Czech Republic, and Netherlands [19,43–46].

The processing of quality documentation is relatively complex and requires capacity and financial demands on local and regional authorities [14]. The application in practice is also significantly complicated by the stakeholders' interest in territorial development. In practice, economic interests are usually promoted over environmental ones, as economic development brings the prospect of faster profits for given territorial communities [38]. Pressure from investors and various lobby groups also plays a key role in decision-making processes on land use. In practice, we can see the varying quality of these studies, which depends not only on the focus of the study developers but also on regional and national politicians [19,43,46]. The problem is not only in Slovakia but also in, for example, Spain, Germany, Poland, and the UK, where there is regionally uneven implementation and different quality [8,11–14,43] and incompatibility between municipalities and regions. In terms of success, planning studies need to be processed for compact natural units, as individual natural phenomena and processes do not know administrative borders. For

example, the movement of biota or the spread of foreign substances does not stop at the state border. In practice, this means there is a requirement that environmental aspects be considered, but the form and depth of processing depend on the capacities, policies, and practices of individual countries [39].

Slovak landscape ecological planning is much more complex. It not only focuses on ensuring and protecting green infrastructure but also takes into account the overall spatial ecological stability of the territory, as well as the protection and effective use of the overall potential of the landscape. It focuses not only on the protection of life forms—delineation of main TNES elements: biocentres, biocorridors, and interactive elements that compose the framework of an ecological network—but also on the protection of the conditions of individual life forms, including human life. It also defines a set of eco-stabilising measures to address practical ecological functions such as soil and water protection, microclimatic, hygienic, aesthetic, and more. Based on these measures, it sets landscape ecological restrictions and limits for land use. The main strengths of planning practice are listed in Table 1.

Table 1. Strengths of landscape ecological planning in Slovakia.

Strength	Description
Long-standing tradition	Landscape ecological research in Slovakia began to develop more intensively in the 1970s. In 1982, the methodology of landscape ecological planning—LANDEP—was created, which was applied in eight countries around the world. It was also enshrined in Agenda 2020, in Chapter 10, as one of the recommended methodologies for integrated protection of natural resources.
Good legislative support	After Slovakia joined the EU, it ratified all important conventions and strategies—the Convention on Biological Diversity, the European Landscape Convention, the Water Convention, the Green Deal, and Green Infrastructure, etc.—and implemented them at the national level. Landscape planning is enshrined in the Building Act, and the creation of ecological networks in the Act on Spatial Planning and Land Adjustment is the basic landscape ecological document.
A comprehensive, holistic approach to the landscape	Landscape ecological planning is built on the concept of the landscape as a geosystem. Landscape as a geosystem is a complex of space, location, relief, and all other functionally interconnected material elements (both natural and man-made or transformed) and phenomena resulting from their composition, spatial configuration, and interrelations [20,21,26]. The complex of individual landscape components (abiotic and biotic) determines the natural capital of individual homogeneous landscape units for land use.
Stakeholder engagement—public consultations	Slovakia involves the public in the creation and approval of spatial planning documentation through public comment and through the approval of this documentation through their elected representatives. However, it should be noted that investors are often more successful in decision-making.

The identified weaknesses and the most significant issues, together with proposals and recommendations that should be implemented in legislation, management, or in practice for better implementation of landscape ecological planning in practice, are listed in Table 2.

Table 2. Weaknesses of landscape ecological planning in practice.

A number of landscape ecological concepts as a basis for spatial planning	unify concepts (sustainability, ecological networks, ecological carrying capacity, ecosystem services, and green infrastructure, etc.) and create one basic synthetic document, e.g., a landscape study, which would take into account all the above-mentioned aspects of the environment
Formal processing of studies, Poor application of LE study results to spatial planning	create a unified methodological procedure for processing a landscape study, enshrine it in legislation, specify its strict position within spatial planning processes, and specify basic indicators/regulations for spatial planning
Insufficient quality of processing of landscape ecological documentation	create interdisciplinary teams, require professional competence for processing landscape ecological studies, ensure accessible databases, create geoportals, and constantly update them
Poor level of coordination between individual spatial levels, poor stakeholder involvement	create a single, interconnected planning system, from the national to the regional to the local level, involving the widest possible pub-lic in decision-making, and management of the territory
Absence of compensation for the application of the land-scape-ecological measures	introduce an effective support system for the implementation of “green measures” in the territories, ensure an effective control sys-tem, and regular monitoring of implemented measures

Representatives of territorial units, especially municipalities, do not receive any financial resources for “green measures”, and therefore investment plans are often preferred. The effectiveness of control over the implementation of proposed measures is also weak.

The evaluation of the weaknesses and strengths of the implementation of landscape ecological documentation was carried out on the basis of a sociological survey and semi-structured interviews. This is a time-consuming and organisationally demanding method. It is especially difficult to correctly record answers during the interview, since 70% of respondents did not agree to audio recording.

The advantages of this method are direct social interaction between the respondent and the researcher, the possibility of the researcher adapting to the respondent in asking questions with terminology that is acceptable to the respondent, the possibility of explaining to the respondent the meaning and significance of the question asked, and an opportunity for the researcher to penetrate deeper into the attitudes of the respondent. The method also has certain shortcomings. One of the disadvantages is the possibility of bias or influencing the respondent. Since the interviewer plays an active role in conducting the interview, their personal prejudices, assumptions, or interpretations may unintentionally shape the participants’ answers. This may threaten the objectivity of the collected data. Another restriction is the time-consuming nature of semi-structured interviews. Conducting interviews, transcribing, and analysing data can be a lengthy process that requires a significant amount of time and resources.

5. Conclusions

The landscape ecological plan can be considered a crucial tool for sustainable land use, as it regulates territorial development in each area so that it is in the greatest possible harmony with the natural conditions of the area, and ensures stability, landscape diversity, protection of natural resources, and environmental protection. A positive and progressive factor of landscape ecological planning in Slovakia is that it transcends the sectoral approach to landscape management and replaces it with integrated management based on the concept of the landscape as a geosystem. It does not allow the development of one sector at the expense of another. For example, intensive use of soil resources at the expense of protection of water resources, etc., is not possible [18,47–49].

Guiding territorial development based on landscape ecological regulations is a preventive tool for eliminating landscape ecological problems resulting from conflicts of interest in the landscape and represents a basic tool for implementing effective utilisation of natural resources. From the point of view of ensuring sustainable development of the area in real practice, it is necessary to reflect the regulations resulting from the submitted landscape ecological studies into individual territorial planning documentation in the conditions of Slovakia, and to the proposal for functional and spatial development of the territory within the framework of spatial planning documentation. It is not efficient to develop separate landscape ecological documentation without a connection to spatial planning. For local government representatives, this is an unnecessary complication, as they do not know which documentation to prefer.

The landscape ecological regulations resulting from the landscape ecological documentation plan can also be a suitable tool for decision-making processes in terms of the localisation of new human socio-economic activities in the territory, and can form a suitable starting point for the processing of E.I.A. studies (environmental impact assessment studies of buildings and activities). The selection of human activity in each territory must respect all limits resulting from landscape ecological conditions of the territory planning, i.e., it cannot be localised in areas where there is a limit or restriction for the given activity. The spatial planning and functional use of the territory should take into account a certain time horizon; it cannot be subject to constant alteration through frequent amendments and modifications to spatial planning documentation. For the implementation of landscape ecological measures, it would be desirable to provide individual territorial units with certain financial compensation, as is in some countries, e.g., Germany, England, and the Czech Republic, etc. Many respondents pointed out that the priority of municipalities, given economic conditions, is not the implementation of landscape ecological measures but economic measures, and that many environmental measures are often implemented on a voluntary basis.

Author Contributions: Conceptualization, Z.I. and F.P.; methodology, Z.I. and F.P.; software, Z.I.; formal analysis, Z.I. and F.P.; investigation, Z.I. and F.P.; writing—original draft, Z.I. and F.P.; writing—review and editing, Z.I. and F.P.; funding acquisition, F.P. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by the Ministry of Education of the Slovak Republic and the Slovak Academy of Science [grant number VEGA 1/0578/24].

Data Availability Statement: Data is contained within the article.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Maes, J.; Barbosa, A.; Baranzelli, C.; Zulian, G.; Batista e Silva, F.; Vandecasteele, I.; Hiederer, R.; Liqueste, C.; Paracchini, M.L.; Mubareka, S.; et al. More Green Infrastructure Is Required to Maintain Ecosystem Services under Current Trends in Land-Use Change in Europe. *Landsc. Ecol.* **2015**, *30*, 517–534. [CrossRef]
2. Mederly, P.; Hreško, J.; Halada, L.; Topercer, J.; Gajdoš, P.; Petrovič, F.; Majzlan, O.; Kostra, I.; Dobrucká, A.; Vlčková, T. *Krajinnoekologický Plan—Mesto Považská Bystrica*; Regioplán: Nitra, Slovakia, 2002; 182p.
3. Saarikoski, H.; Primmer, E.; Saarela, S.R.; Antunes, P.; Aszalós, R.; Baró, F.; Berry, P.; Blanko, G.G.; Gómez-Baggethun, E.; Carvalho, L.; et al. Institutional Challenges in Putting Ecosystem Service Knowledge in Practice. *Ecosyst. Serv.* **2018**, *29*, 579–598. [CrossRef]
4. Izakovičová, Z.; Miklós, L.; Miklósová, V. Integrative Assessment of Land Use Conflicts. *Sustainability* **2018**, *10*, 3270. [CrossRef]
5. Ministry of the Environment of the Slovak Republic. *Aktualizovaná Národná Stratégia Ochrany Biodiverzity do Roku 2020*; Ministry of the Environment of the Slovak Republic: Bratislava, Slovakia, 2013; 40p.
6. Hersperger, A.M.; Grädinaru, S.R.; Pierri Daunt, A.B.; Imhof, C.S.; Fan, P. Landscape Ecological Concepts in Planning: Review of Recent Developments. *Landsc. Ecol.* **2021**, *36*, 2329–2345. [CrossRef]
7. Mörtberg, U.M.; Balfors, B.; Knol, W.C. Landscape Ecological Assessment: A Tool for Integrating Biodiversity Issues in Strategic Environmental Assessment and Planning. *J. Environ. Manag.* **2007**, *82*, 457–470. [CrossRef]
8. Marine, N. Landscape Assessment Methods Derived from the European Landscape Convention: Comparison of Three Spanish Cases. *Earth* **2022**, *3*, 522–536. [CrossRef]
9. EUR-Lex. Directive 2001/42/EC (SEA Directive). Available online: <https://eur-lex.europa.eu> (accessed on 10 December 2025).
10. Miklós, L.; Diviaková, A.; Izakovičová, Z. *Ecological Networks and Territorial Systems of Ecological Stability*; Springer: Cham, Switzerland, 2019; 152p.
11. Available online: www.bundesumweltministerium.de (accessed on 10 December 2025).
12. Available online: www.iale-europe.eu (accessed on 10 December 2025).
13. Available online: www.iplo.nl (accessed on 10 December 2025).
14. Available online: www.gov.uk (accessed on 10 December 2025).
15. Goodspeed, R.; Liu, R.; Gounaridis, D.; Lizundia, C.; Newell, J. A Regional Spatial Planning Model for Multifunctional Green Infrastructure. *Environ. Plan. B Urban Anal. City Sci.* **2022**, *49*, 815–833. [CrossRef]
16. Ministerstvo životného prostredia. *Správa o Stave Životného Prostredia SR za rok 2022*; MŽP SR: Bratislava, Slovakia; SAŽP SR: Banská Bystrica, Slovakia, 2023; 218p.
17. Hrnčiarová, T.; Ružička, M.; Izakovičová, Z.; Hrašna, M.; Bedrna, Z.; Drdoš, J.; Supuka, J. *Metodický Postup Ekologicky Optimálneho Využívania Územia v Rámci Prieskumov a Rozborov pre Územný Plán obce*; Krajina 21; MŽP SR: Bratislava, Slovakia, 2000; 138p.
18. Izakovičová, Z.; Špulerová, M.; Petrovič, F.; Hrnčiarová, T.; Miklós, L.; Dobrovodská, M.; Halada, L.; Gajdoš, P. *Metodické Pokyny pre Tvorbu Územných Systémov Ekologickej Stability*; Krajina 21; MŽP SR: Bratislava, Slovakia, 2000; 90p.
19. PBL. *Lessons Learned from Spatial Planning in the Netherlands*; PBL Netherlands Environmental Assessment Agency: The Hague, The Netherlands, 2018; Available online: <https://www.pbl.nl> (accessed on 10 December 2025).
20. Krcho, J. Georelief as a subsystem of landscape and the influence of morphometric parameters of georelief on spatial differentiation of landscape-ecological processes. *Ecology (CSFR)* **1991**, *10*, 115–158.
21. Miklós, L.; Izakovičová, Z. *Krajina ako Geosystém*; Veda: Bratislava, Slovakia, 1997; 152p.
22. Miklós, L. Stabilita krajiny v Ekologickom genereli SR. *Zivotn. Prostr.* **1986**, *20*, 87–93.
23. Serra, V.; Defraia, S.; Ledda, A.; Calia, G.; Corona, F.; De Montis, A.; Mulas, M. Ecological Network, Ecosystem Services, and Green Infrastructure Planning: A Method for the Metropolitan City of Cagliari, Italy. *Netw. Spat. Econ.* **2024**, *25*, 95–120. [CrossRef]
24. Ružička, M.; Miklós, L. Landscape-Ecological Planning (LANDEP) in the Process of Territorial Planning. *Ekológia (ČSSR)* **1982**, *1*, 297–312.
25. Izakovičová, Z.; Oszlányi, J. *Krajinno-Ekologicky Optimálne Priestorové a Funkčné Využitie Územia Biosferickej Rezervácie Tatry*; ÚKE SAV: Bratislava, Slovakia, 2004; 149p.
26. Miklós, L.; Špinerová, A.; Offertálerová, M. Critical Approach to Landscape-Ecological Mainstream Topics. *Acta Univ. Sapientiae Agric. Environ.* **2019**, *11*, 60–71.
27. Izakovičová, Z.; Miklós, L.; Miklosová, V.; Petrovič, F. The Integrated Approach to Landscape Management—Experience from Slovakia. *Sustainability* **2019**, *11*, 4554.
28. Petrovič, F. 2021 Hydrological Impacts of Climate Change and Land Use. *Water* **2021**, *13*, 799. [CrossRef]
29. Moyzeová, M. Názor verejnosti na zelenú infraštruktúru, prírodný kapitál a ekosystémové služby [Public opinion on green infrastructure, natural capital and ecosystem services]. In *Fyzickogeografický Sborník 16: Fyzická Geografie a Krajinná Ekologie—Výzkum, Výuka, Aplikace/Physical Geography and Landscape Ecology—Research, Education and Applications*; Masarykova Univerzita: Brno, Czech Republic, 2018; pp. 74–80.
30. Belčáková, I.; Izakovičová, Z.; Petrovič, F.; Paudišová, E. *Metodické Pokyny pre Vytvorenie Dokumentácií Územných Systémov Ekologickej Stability*; MŽP SR: Bratislava, Slovakia, 2025; 146p.

31. Moyzeová, M.; Miklós, L.; Šatalová, B.; Izakovičová, Z.; Oszlányi, J.; Kenderessy, P.; Štefunková, D.; Krnáčová, Z. *Hodnotenie Kvality Životného Prostredia Vidieckych Sídiel (na Príklade Vidieckych Sídiel Okresu Trnava) [Evaluation of the Quality of the Environment of Rural Settlements (on Example of Rural Settlements in Trnava District)]*; UKE SAV: Bratislava, Slovakia, 2015; 280p.
32. Schilleci, F.; Todaro, V.; Lotta, F. Connected Lands: New Perspectives on Ecological Networks Planning. In *Connected Lands: New Perspectives on Ecological Networks Planning*; UNIPA Springer Series; Springer International Publishing: Cham, Switzerland, 2017. [\[CrossRef\]](#)
33. Špulerová, J.; Dobrovodská, M.; Izakovičová, Z.; Kenderessy, P.; Petrovič, F.; Štefunková, D. Developing strategy for the protection of traditional agricultural landscapes based on a complex landscape-ecological evaluation (the case study of mountain landscape in Slovakia). *Morav. Geogr. Rep.* **2013**, *21*, 15–26. [\[CrossRef\]](#)
34. Karlík, L.; Gábor, M.; Falt'an, V.; Lauko, V. Monitoring of vineyards utilization: Case study Modra (Slovakia). *Geogr. Cassoviensis* **2017**, *11*, 22–32.
35. Nozdrovická, J.; Dostál, I.; Petrovič, F.; Jakab, I.; Havlíček, M.; Skokanová, H.; Falt'an, V.; Mederly, P. Land-Use Dynamics in Transport- Impacted Urban Fabric: A case study of Martin-Vrútky, Slovakia. *Land* **2020**, *9*, 273. [\[CrossRef\]](#)
36. Grežo, H.; Močko, M.; Izsóff, M.; Vrbičanová, G.; Petrovič, F.; Straňák, J.; Muchová, Z.; Slámová, M.; Olah, B.; Machar, I. Flood Risk Assessment for the Long-Term Strategic Planning Considering the Placement of Industrial Parks in Slovakia. *Sustainability* **2020**, *12*, 4144. [\[CrossRef\]](#)
37. Belčáková, I. Strategic environmental assessment—An instrument for better decision-making towards urban sustainable planning. *Procedia Eng.* **2016**, *161*, 2058–2061. [\[CrossRef\]](#)
38. Belčáková, I. Landscape planning framework in the environmental assessment—Linkages and mutual benefits. *Ekológia* **2012**, *31*, 1–11.
39. Chaker, A.; El-Fadl, K.; Chamas, L.; Hatjian, B. A review of strategic environmental assessment in 12 selected countries. *Environ. Impact Assess. Rev.* **2006**, *26*, 15–56. [\[CrossRef\]](#)
40. EEA. How Green Are European Cities? EEA Briefing. 2025. Available online: <https://www.eea.europa.eu> (accessed on 16 December 2025).
41. Leibenath, M. Exploring Substantive Interfaces between Spatial Planning and Ecological Networks in Germany. *Plan. Pract. Res.* **2011**, *26*, 257–270. [\[CrossRef\]](#)
42. Dick, J.; Turkelboom, F.; Woods, H.; Iniesta-Arandia, I.; Primmer, E.; Saarela, S.-R.; Bezak, P.; Mederly, P.; Leone, M.; Verheyden, W.; et al. Stakeholders' Perspectives on the Operationalisation of the Ecosystem Service Concept: Results from 27 Case Studies. *Ecosyst. Serv.* **2018**, *29*, 552–565. [\[CrossRef\]](#)
43. Available online: <https://biodiversity.europa.eu/> (accessed on 10 December 2025).
44. Available online: www.bio4climate.org (accessed on 10 December 2025).
45. Available online: www.climate-laws.org (accessed on 10 December 2025).
46. Available online: www.pub.nordregio.org (accessed on 10 December 2025).
47. Muchová, Z.; Konc, L.; Petrovič, F. Lands plots valuation in land consolidation in Slovakia: A need for a new approach. *Int. J. Strateg. Prop. Manag.* **2018**, *22*, 372–380. [\[CrossRef\]](#)
48. Muchová, Z.; Hrnčiarová, T.; Petrovič, F. *Miestny Územný Systém Ekologickej Stability na Účely Pozemkových Úprav*; SPU: Nitra, Slovakia, 2013; 119p.
49. Muchová, Z.; Daxnerová, S.; Hafezi, S.M.; Moradi, E. Comments on some evaluation criteria for the official prioritization of land consolidation projects in Slovakia. *J. Ecol. Eng.* **2025**, *26*, 15–23. [\[CrossRef\]](#)

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.