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SUSTAINABLE USE OF THE NATURAL POTENTIAL OF THE POĽANA BIOSPHERE RESERVE

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Abstract

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The contribution is focused on the assessment of the current state of use of the landscape potential of the Poľana Biosphere Reserve and the specification of the basic landscape-ecological problems associated with the inappropriate use of the potential. In this area, we have singled out the following: problems of biodiversity and ecological stability threats, caused by stress factors linked to the inappropriate use of the landscape's potential and its elements with high ecological-stabilizing functions (forests, water bodies, meadows, pastures or public greenery); problems of natural resource endangerment – resulting from improper human use of natural resources; problems threatening the human society's environment, arising from stress factors linked to socioeconomic activities impacting humans and their surroundings; and problems threatening biocultural landscape values, arising from inappropriate landscape management, which endangers rare landscape types. The assessment subsequently resulted in a proposal for basic measures to eliminate the specified problems and a proposal ensuring sustainable utilization of landscape potential Poľana Biosphere Reserve. The methodological procedure based on an integrated approach after some modification can also be used in other biosphere reserves.

Key words: Poľana Biosphere Reserve, conflicts of interest, landscape-ecological problems, sustainable development, landscape potential.

Introduction

A biosphere reserve (BR) is a large-scale protected area established within the framework of the international UNESCO Man and the Biosphere program. These areas represent representative examples of cultural and natural landscapes in which humans and their activities play an important role (UNESCO, 2025). Most biosphere reserves include both natural and disturbed areas. This allows for the study of conflicts between humans and the natural environment and for the promotion of biodiversity in disturbed areas.

Each biosphere reserve fulfils three basic functions (UNESCO, 2025):

1. Conservation of biodiversity, ecosystems, and landscapes.
2. Sustainable economic and socioeconomic development of the local population.
3. Support of science, research and education with an emphasis on building partnerships at the local, regional and international levels.

Biosphere reserves are internationally recognized study areas for the application of interdisciplinary approaches to understanding and managing changes in social and ecological systems and their interactions, including conflict prevention and biodiversity conservation. These areas have become an important tool for supporting the implementation of global conventions and policies that promote sustainable development, such as the 2030 Agenda, the Land Convention or the Convention on Biological Diversity. One of the primary objectives of the MaB program for 2015–2025 according to the Lim action plan is the conservation of biodiversity, the restoration and enhancement of ecosystem services, the promotion of sustainable natural resource use and the development of sustainable, healthy societies and thriving human activities in harmony with nature (UNESCO, 2016).

Despite the mission of BRs, their natural potential is not always used in accordance with the principles and criteria of sustainable development, as evidenced by a number of landscape-ecological and environmental problems in many biosphere reserves (Izakovičová, 1995; Kühne, Jenal, 2020; O'Neill, Walsh, 2000; Mao et al., 2023; Overstreet, Sørensen, 2025; Izakovičová et al., 2025).

The aim of the paper is to present a methodological procedure for assessing problems associated with the inappropriate use of natural potential and to present basic principles for ensuring sustainable use of natural potential in the study of the Poľana BR (Slovakia).

Methodology

The methodological procedure is based on an integrated approach grounded in the concept of the landscape as a geosystem (García-Martín et al., 2016; Miklós, Izakovičová, 1997;

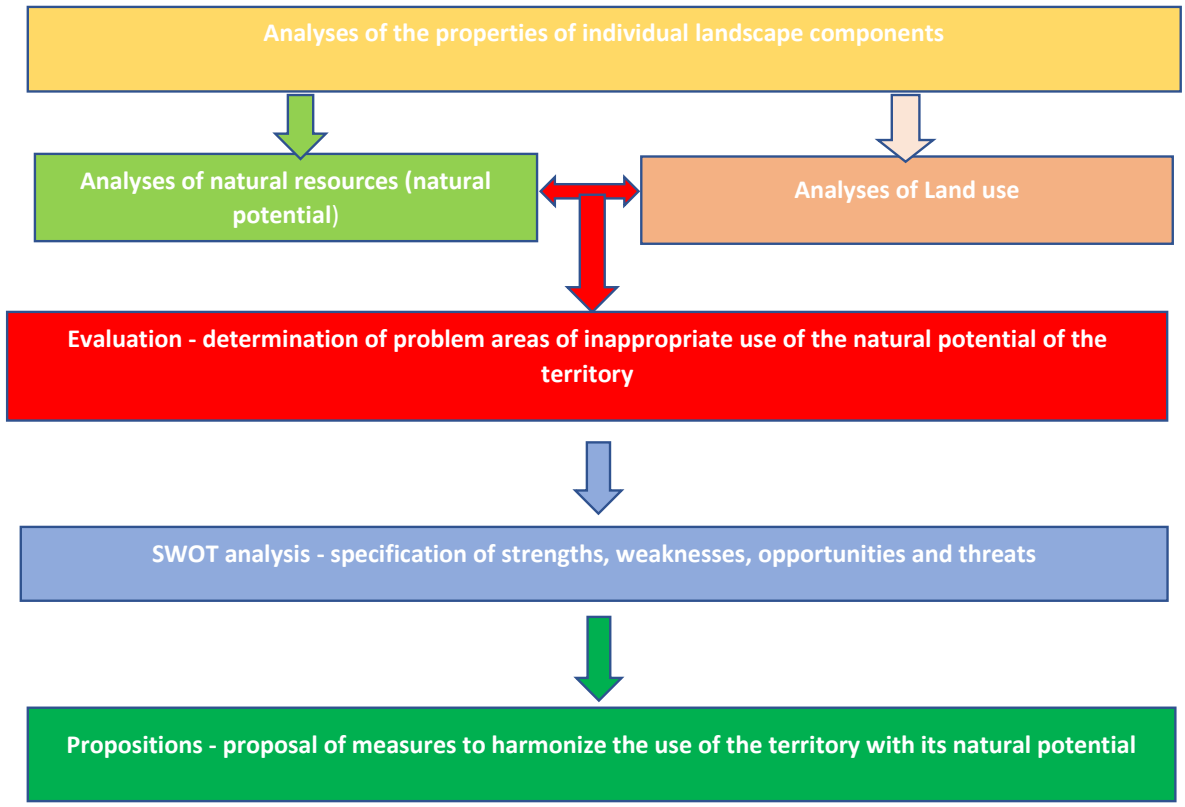

Fig. 1. Methodological procedure.

Izakovičová et al., 2019). The methodological procedure comes out from methods of landscape-ecological optimization of the territory, GIS methods and SWOT analysis. The methodological procedure is shown in Fig. 1.

Study area

The Poľana BR represents a volcanic mountain and is considered one of the best-preserved inactive volcanoes in Europe. Its total area currently spans 24,158.23 ha, encompassing 13 cadastral areas. Located at the northern edge of the Ľubietovský Vepor hill lies the geographical centre of Slovakia (Hrb Peak – 1,255 m a.s.l.). Due to an altitudinal range of nearly 1,000 m (from the lowest point at 460 m to the highest at 1,458 m a.s.l.), both thermophilous and montane plant and animal species occur in a relatively small area. The landscape is highly diverse. The area is also of high significance for the conservation of biological diversity. Approximately 1,220 species of vascular plants have been identified, including 80 protected species. The region also hosts 390 species of fungi, 160 species of lichens and 130 species of bryophytes. The fauna comprises 278 species of vertebrates, 222 of which are protected, with birds and mammals being the most dominant groups. Among the invertebrates, numerous Carpathian endemics have been recorded (Okániková et al., 2014).

The area has a well-preserved historical mosaic landscape structure, formed by strip ploughlands alternating with meadows and pastures on former fields and spanned by boundaries overgrown in places with rose hips, sloes and wild cherries. In this area, horses and traditional agricultural tools are still used for agricultural work. The unique landscape character is completed by traditional wooden houses, haystacks, potato cellars, wooden painted crosses and preserved traditions of folk art (Vitálišová et al., 2025) (Fig. 2).

Results

Natural capital

The occurrence of natural resources is determined by the characteristics of the area. From the perspective of geological and geomorphological conditions, the dominant feature of the territory is the Poľana massif, which, together with the Zvolen Basin, forms part of the Slovenské stredohorie Mountains (Urban et al., 2016). The eastern part of the territory extends into the Veporské vrchy Mountains, which belong to the Slovenské rudohorie Mountains. Poľana represents a distinctly individual unit with an almost circular ground plan approximately 18 km in diameter. Volcanic activity has shaped a number of unique surface formations, many of which have been designated as specially protected natural sites. The most notable among these are the natural monuments Veporské skalky, Melichova skala, Kalamárka, Jánošíkova skala and the 23-m-high Bystrý Brook Waterfall (Vodopád Bystrého potoka) (Vitálišová et al., 2025). The significant altitudinal variation also conditions the diversity of climatic zones. The majority of the Poľana BR (more than 70%) lies within a moderately cool and very humid climate region, while

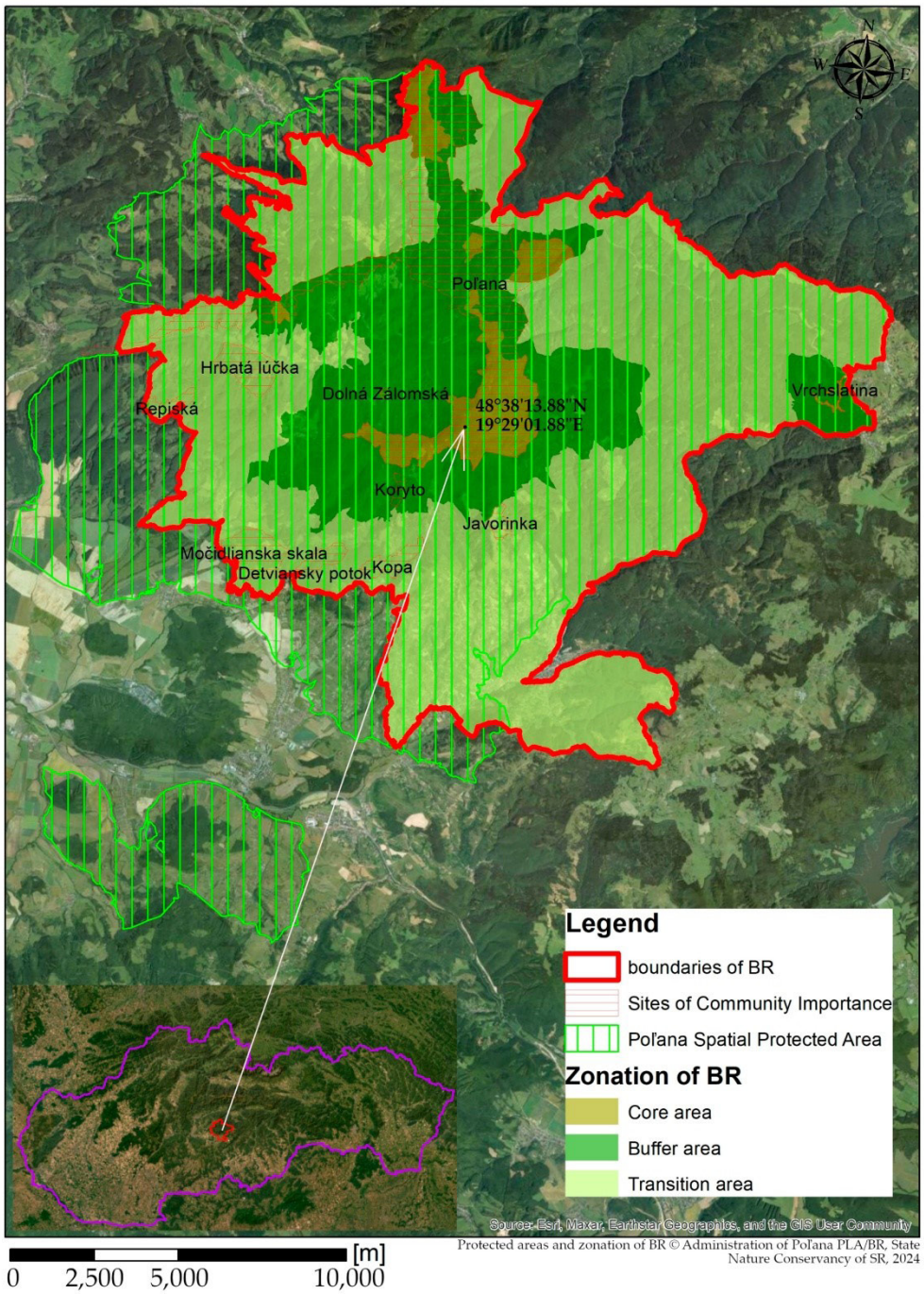

Fig. 2. Localization of the Poľana BR and zonation.

the southern parts extend into a moderately warm, very humid highland climate region (over 14%). In the southwestern area, this transitions into a moderately warm, moderately humid hilly to highland climate region. The highest parts of the territory fall within a cold mountainous, very humid climate region (Lapin et al., 2002). These factors also influence the characteristics of other natural resources in the area of interest:

- **Soil resources:** The dominant soil type within the area of interest is Cambisol, particularly typical Cambisol. In the highest elevations with acidic bedrock, these soils transition into Podzols, characterized by a strongly leaching regime caused by high precipitation totals. The most specific soil type in the Poľana BR is Andosol, which occurs on the andesitic bedrock of the main ridge of Vysoká Poľana. Its presence is determined by the nature of the parent rock – particularly the volcanic glass content – and local climatic conditions. In the lower elevations of Vysoká Poľana, Andosols gradually transition into Andic Cambisols. On deep

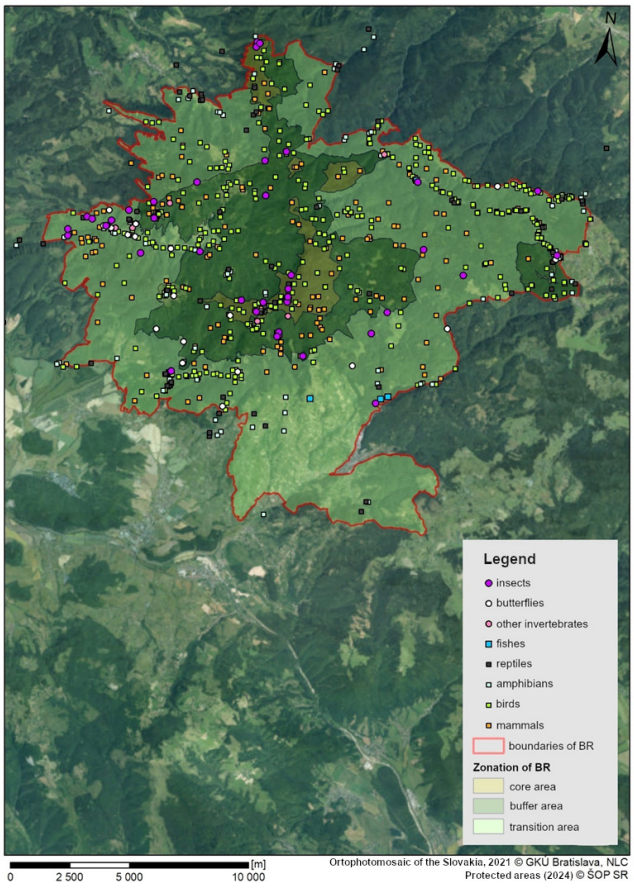

Fig. 3. Occurrence of animal species in the study area by Complex Information and Monitoring System (ŠOP SR, 2025).

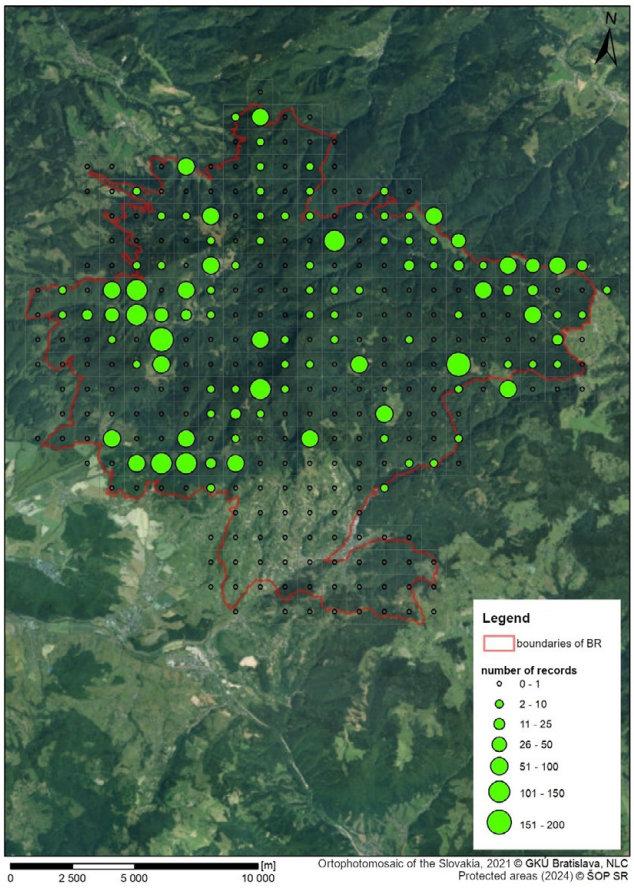

Fig. 4. Occurrence of bird species in the study area from Complex Information and Monitoring System (ŠOP SR, 2025).

alluvial cone sediments at the foot of the slopes, especially in the southwestern foreland of Poľana, Pseudogley soils occur locally, characterized by an uneven moisture regime. In the floodplains of small watercourses with elevated groundwater levels, Gleysols and Organosols are present. Along larger watercourses within inundation zones, Gleyic Fluvisols can be found, which are influenced by irregular flooding events. The shallowest soils include initial soils such as Leptosols and Regosols, which occur patchily across the territory. On exposed, steep, rocky slopes, Rankers are also present. In the northern part of the area, a small patch of Rendzinas has been recorded (Šály, 2000). The highest-quality soils in the Poľana BR are protected through the designation of evaluated soil-ecological units. These units cover a total of 1,286.17 ha of agricultural land, primarily in the southern parts of the region, such as around town Hriňová and Detva. These protection measures are aimed at preventing the unauthorized conversion of high-quality soils to non-agricultural uses.

- **Water resources:** The watercourses within the Poľana BR belong to the Hron River sub-basin. The most significant streams in the area, in addition to Hučava, include Hukava and Slatina in the southeastern part of the territory, Kamenistý potok in the northeast, Hutná in the northwest and Zolná in the west (ŠOP SR, CHKO Poľana, 2015). An important water feature of the area is the Hriňová water reservoir, constructed between 1961 and 1965 on the upper course of the Slatina River (SVP, 2024). In terms of groundwater, levels are found at a depth of 2–5 m in approximately 57% of the area, at less than 2 m in 22% and at 5–10 m in 21% of the territory. Water resources in the Poľana BR are protected by hygienic protection zones (HPZ), including those around the Hriňová water reservoir, which is designated as a drinking water reservoir, as well as the Hronček reservoir. HPZs have also been established around groundwater sources, such as Farská studnička (in Lom nad Rimavicou cadastral area) and three springs in Hrochoť (Pípošová, Abčiná and Studená). These protection zones impose certain restrictions and limitations on the development of specific socio-economic activities.
- **Forest resources:** The altitudinal gradient of nearly 1,100 m contributes significantly to the floristic and faunal diversity of the area. A wide range of vegetation zones is represented from the second zone (oak-beech) to the seventh zone (spruce). Oak-beech and beech-oak forests occur only marginally. The most widespread are beech and mixed fir-beech-spruce stands, which extend up to the ridge elevations. The highest elevations are occupied by original summit spruce forests, encircled at lower elevations by a narrow

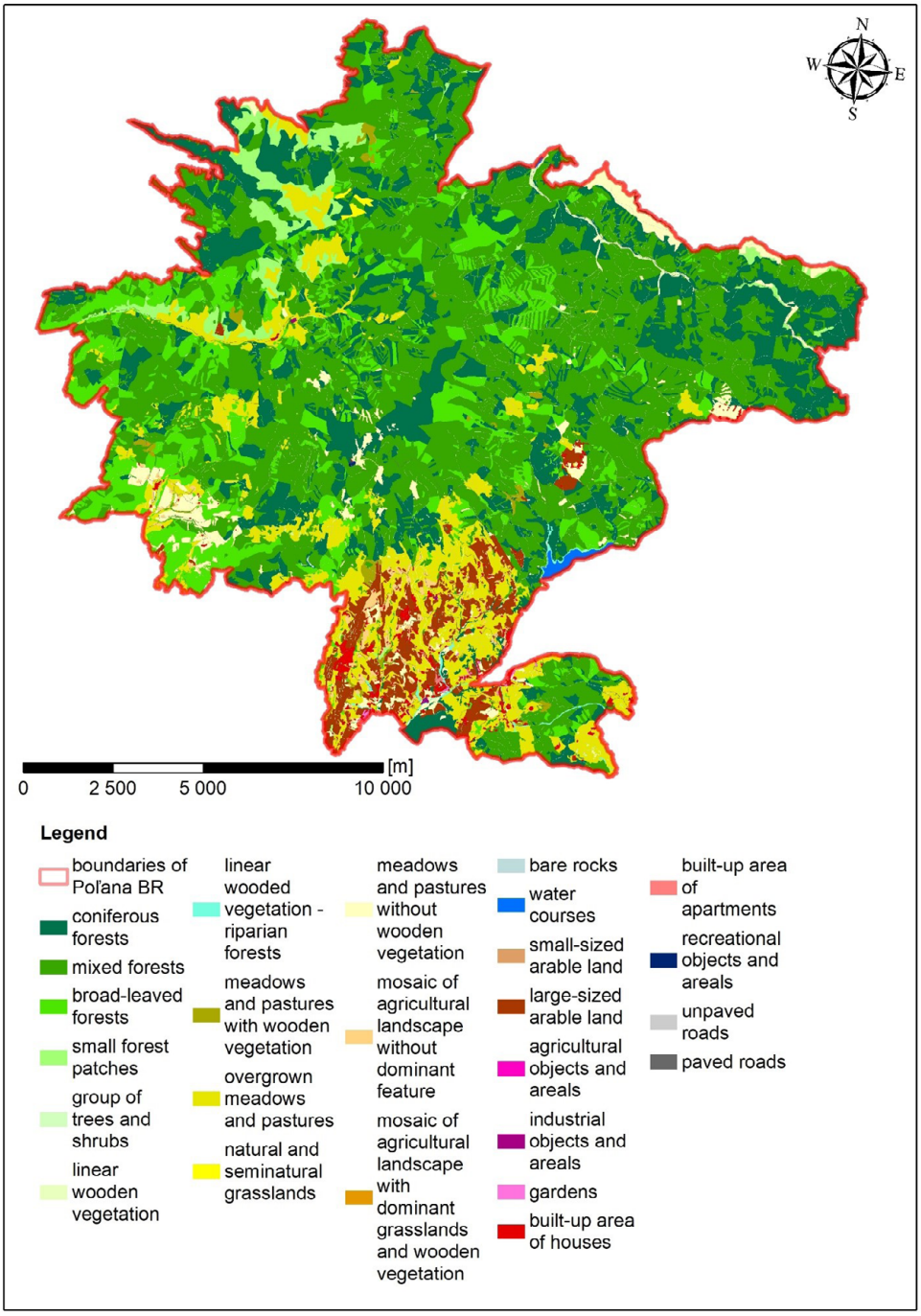

Fig. 5. Current landscape structure (ESPRIT, 2020).

belt of spruce-beech-fir forests. This area represents the southernmost occurrence of true spruce forests on volcanic bedrock in the Western Carpathians. The Poľana region has also preserved valuable primeval forests, which are a notable tourist attraction. Forest protection is ensured through two categories: (a) protective forests, covering 10.09% of the total forested area, primarily serve ecological functions, and (b) special-purpose forests, accounting for 14.34%, are important for their environmental roles, particularly in the provision of ecosystem services.

- **Other biotic resources (flora and fauna):** Among the non-forest ecosystems, particularly valuable are the semi-natural grasslands and riparian habitats. Typical biotopes of Poľana include semi-natural dry grasslands and scrubland facies on calcareous substrates (Šuvada, 2023). The permanent herb-grass vegetation is also composed of biotopes such as mountain hay meadows, mesophile pastures, *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils, hygrophilous tall herb fringe communities of plains and of the montane to alpine levels, Atlantic and sub-Atlantic

humid meadows, eutrophic humid grasslands of *Alopecurus pratensis* and lowland hay meadows. Wetlands and spring areas (including seasonally flooded grasslands, sedge and reed communities, peat bogs, fens and springs) are among the most sensitive ecosystems, home to many rare or endangered plant species. Permanent grasslands and their fallows (both intensive and extensive meadows and pastures) significantly contribute to the area's overall biodiversity, hosting numerous notable, rare and protected species. Although Poľana is located in the Alpine biogeographic region, it is ecologically interesting due to the overlap with Pannonian species (mainly in the southern and southwestern parts up to 800 m a.s.l.) and Carpathian zoogeographic species (mainly in central, northern and eastern parts at higher elevations) (Program starostlivosti o Chránené vtáčie územie Poľana na roky 2019–2048, 2018). This creates a unique mix of both thermophilic and mountain species, many of which are legally protected (Fig. 3). Poľana hosts a rich variety of invertebrates, though some groups are still poorly known. Many species are endemic, relict, rare and threatened, with several of European and national conservation importance. The most species-rich invertebrate class is insects, with *Diptera* being one of the best-studied groups – over 2,675 species from 95 families, which represents more than 50% of the known Slovak *Diptera* fauna (Roháček, Ševčík, 2009). Blooming meadows and forest edges attract numerous species of butterflies. Out of 109 protected beetle species in Slovakia, 31 species (nearly 30% of legally protected beetle fauna) have been recorded in Poľana (Program starostlivosti o Chránené vtáčie územie Poľana na roky 2019–2048, 2018). Mountain and submountain streams provide habitats for various fish species such as river trout (*Salmo trutta morpha fario*) and protected species like freshwater sculpin (*Cottus gobio*), asp (*Aspius aspius*) and grayling (*Thymallus thymallus*), along with many aquatic invertebrates. Among vertebrates, birds are the most numerous group. Their diversity in Poľana is exceptionally high, and the area offers suitable conditions for many rare, endangered and protected bird species, important both nationally and across Europe (Fig. 4). These factors led to Poľana being designated as both an Important Bird Area (IBA) and a Special Protection Area (SPA). A total of 187 bird species have been recorded here, including 134 breeding species and 16 species of European conservation concern that led to the designation of Poľana SPA (Krištín, 2010; Program starostlivosti o Chránené vtáčie územie Poľana na roky 2019–2048, 2018). The mammalian fauna of Poľana includes 63 species, with all major native large carnivores present: brown bear (*Ursus arctos*), eurasian lynx (*Lynx lynx*), grey wolf (*Canis lupus*) and European wildcat (*Felis silvestris*). In recent years, the golden jackal (*Canis aureus*) has also begun to appear in the southern parts of the Poľana region. Among game species, red deer is the most widespread and has a high trophy value. For red deer management purposes, the Poľana Protected Hunting Area was established.

Biocultural landscape types: These are synthetic landscape units that have emerged from the interaction between nature and human activity. They represent specific types of landscapes shaped by traditional and sustainable land-use practices. These landscapes typically consist of mosaics of dispersed settlements, small arable fields and grasslands, which reflect historical agricultural structures and are perceived as aesthetic values (Špulerová et al., 2017). The significance of this unique landscape configuration was highlighted by the Ministry of the Environment of the Slovak Republic, which in 2016 awarded the town of Hriňová the Slovak Landscape Award for the project *Hriňovské lazy – landscape of values* (MŽP SR, 2016). This award is granted every 2 years to organizations for their contribution to the implementation of the European Landscape Convention at the national level.

Land use

Land use in the area is closely tied to the degree of nature protection. The territory is divided into three zones: the core area covering 1,332.70 ha, the buffer area covering 6,418.53 ha and the transition area covering 16,407.00 ha. The buffer zone primarily focuses on forestry and agriculture with the goal of preserving the unique fauna and flora. In the transition zone, all economic activities are conducted in accordance with nature conservation interests. By analysing the current landscape feature (ESPRIT, 2020), Fig. 5 and Table 1 show the unbalanced distribution of main elements of the current landscape structure, dominated by forests, with a low share of agricultural land; however, significant mosaics of agricultural lands linked to historical agricultural landscape structures are present. Watercourses, water bodies and settlements have the lowest representation within the studied area.

From the perspective of economic development and land use, forestry dominates the area. Forests cover approximately 80% of the territory, which is managed by two main forest enterprises: the Poľana Forest Enterprise and the Horehronie Forest Enterprise. Smaller forest units are managed by private individuals and municipal forests. The annual timber harvest volume reaches approximately 644,000 m^3. About 10% of the forests are designated as special-purpose forests with significant ecological and environmental functions. Hunting activities also take place within the forests. The area includes several game reserves for deer and large predators. The core of Poľana is declared a protected hunting area due to the genetically highest-quality population of red deer in Slovakia as well as a diverse species composition of both furred and feathered game.

The second most important economic sector in the area is agriculture. Agricultural land occupies 3,008.96 ha (12.46% of the study area) and is primarily used as permanent grasslands covering 2,552.65 ha (10.57% of the study area) and arable land covering 452.71 ha (1.87% of the study area) (PPA, 2024). Mosaic structures dominate the agricultural landscape, consisting of small-block fields, orchards, gardens and permanent grasslands. Historically, the main crops grown in the area were cereals, potatoes and fruit crops. However, recently, mainly for economic reasons, maize and oilseed rape have gained prominence. This shift has led to the development of monocultures, spread of invasive species and a decline in the original floral biodiversity of the Poľana BR. In terms of animal husbandry, the region was traditionally known for sheep and cattle breeding, which still dominate. However, the number of farm animals is declining annually, contributing to the loss of the original landscape character. Several factors contribute to the decline of agriculture in the area: physically and time-demanding work with uncertain economic

Table 1. Area size and share of features from current landscape structure.

Features of current landscape structure	Area size [ha]	Share within study area [%]
Coniferous forests	5,017.00	20.77
Mixed forests	10,640.00	44.05
Broad-leaved forests	2,910.00	12.05
Small forest patches	618.60	2.56
Groups of trees and shrubs	40.99	0.17
Linear wooden vegetation	53.28	0.22
Linear wooden vegetation – riparian forests	46.30	0.19
Meadows and pastures with wooden vegetation	133.60	0.55
Overgrown meadows and pastures	2,363.00	9.78
Natural and semi-natural grasslands	27.51	0.11
Meadows and pastures without wooden vegetation	707.00	2.93
Mosaic of agricultural landscape without dominant feature	177.30	0.73
Mosaic of agricultural landscape with dominant grasslands and wood vegetation	1.47	0.01
Bare rocks	2.71	0.01
Water courses	52.52	0.22
Small-scaled arable lands	1.38	0.01
Large-scaled arable lands	762.90	3.16
Agricultural objects and areas	0.14	0.00
Industrial objects and areas	7.20	0.03
Gardens	12.27	0.05
Built-up area of houses	203.50	0.84
Built-up area of apartments	4.00	0.02
Recreational areas	1.71	0.01
Unpaved roads	274.50	1.14
Paved roads	98.11	0.41

benefits, an aging farming population, lack of interest from the younger generation, weak farmer support, unexpected negative impacts of climate change, high costs, low profits and others.

Besides supplying water for the population, watercourses and water bodies in the area are also used for fishing purposes. There are six fishing districts: Ľubietovský potok brook, Zolná brook, Hučava brook, Detviansky potok brook, Čierny Hron brook and the Hronček water reservoir. All of these belong to the salmon-trout zone, characterized by high water purity. Recently, due to the impacts of climate change causing water levels to drop, there has been a gradual decline in fishing activities.

Built-up areas are used for residential purposes, service facilities and recreation. The area is typical for its dispersed rural settlement pattern, which is currently evolving towards the development of recreational and leisure spaces, including cottage tourism. In many cases, large and ornate cottages are being built, often featuring non-traditional elements such as artificial swimming pools, golf courses and tennis courts, which gradually alter the traditional character of the landscape.

Conflicts

Natural resources, representing the natural capital of the area of interest, are not always used optimally, which leads to the emergence of various landscape-ecological and environmental problems. The most significant groups of these problems include the following (Izakovičová et al., 2025):

- **Problems of biodiversity and ecological stability threats**, caused by stress factors linked to the inappropriate use of the landscape's potential and its elements with high ecological-stabilizing functions (forests, water bodies, meadows, pastures or public greenery). The result is the endangerment of biodiversity and spatial ecological stability of the area. A major issue is the occupation and degradation of natural ecosystems due to forestry activities. Poorly timed logging threatens animal species within SPAs (Special Protection Areas), as many forest stands are harvested during the nesting season. Negative consequences of past human interference with natural ecosystems also persist – such as the changes in the species composition of forest biotopes in large parts of the BR, for example, replacement of beech communities with spruce monocultures and the slow return to native species compositions. Biodiversity is also threatened by changes in ecological conditions for plants, animals and their ecosystems. These changes are caused by several factors, such as environmental burdens (MŽP SR, SAŽP, 2024), including landfills in ecologically valuable areas, the release of pollutants from local heating sources, production facilities in the area, transport from surrounding sources and agricultural enterprises (manure and slurry leachates can release substances into surrounding meadows, leading to eutrophication and degradation of EU-important habitats). Hydric biocorridors and other valuable wetland ecosystems are endangered by water quality deterioration in

streams due to wastewater discharge and leakage risks from domestic septic tanks. Biodiversity and ecological stability are also endangered by increasing recreational use – recreation, such as hiking or cycling, brings growing threats in the form of trampling of habitats and species off-trail, vegetation damage, wildlife disturbance, nest destruction and littering. Altered ecological conditions also favour the spread of invasive alien plant species. The most common invasive species in the area include common ragweed (*Ambrosia artemisiifolia*), Canadian goldenrod (*Solidago canadensis*), knotweeds (*Fallopia* spp.), Himalayan balsam (*Impatiens glandulifera*) and giant hogweed (*Heracleum mantegazzianum*). All these species negatively affect the development of natural ecosystems.

- **Problems of natural resource endangerment** – resulting from improper human use of natural resources. This leads to a decline in both the qualitative and quantitative properties of individual resources. Besides elevated concentrations of foreign substances contaminating resources, environmental burdens also threaten soil ecological properties, lowering soil fertility. Waste dumps, especially illegal ones, are uncontrollable water pollution sources. Dumps have been identified in the protection zones of the Hriňová water reservoir. Although the area was remediated, there remains a risk of pollutant infiltration into water. Soil contamination, especially around protected water management zones in Hriňová and Hrochoť cadastre area, poses risks of pollutants entering local water sources. Soil resources are also threatened by the users themselves – agriculture that does not always operate sustainably. Unsuitable soil tillage often leads to the initiation of natural risks and hazards – erosion and landslides (Klukanová et al., 2002). All four erodibility classes are identified in the area (VÚPOP, 2024). The most dominant is potential water erosion with high erodibility (level 3), covering 13.90% of the BR (10–30 t/ha), and extreme erodibility (level 4) on 66.15% of the BR (>30 t/ha). This category is dispersed throughout the BR.
- **Problems threatening the human society's environment**, arising from stress factors linked to socioeconomic activities impacting humans and their surroundings. Local industrial and manufacturing operations endanger environmental quality through noise, odours, light pollution and emissions from industry and transport. Larger agricultural enterprises contribute to environmental pollution via odour emissions. Recently, the most significant environmental threat has been increasing transport intensity, which is expected to grow. Heavily trafficked roads include the 2nd class road no. 526 (sections 91710 and 91711) with a daily traffic of 7,200–7,600 vehicles and the 2nd class road no. 529 (section 91701) with 1,100–4,600 vehicles per day. Air quality is negatively affected by pollutant transport from nearby sources, especially in towns Zvolen and Banská Bystrica, as well as from the Žiarska kotlina Basin and Horná Nitra Basin. Bacteriological pollution of the environment may also come from environmental burdens and landfills, particularly unregulated ones located near residential areas.
- **Problems threatening biocultural landscape values**, arising from inappropriate landscape management, which endangers rare landscape types. The main issue is the gradual abandonment of agricultural land. The number of sheep in the four districts within BR Poľana (Banská Bystrica, Brezno, Detva and Zvolen) dropped by 25% between 2010 and 2023, with a 37.75% decrease in Detva, which covers the largest part of BR Poľana (Statistical Office of the Slovak Republic, 2024). Permanent grasslands are endangered by succession, leading to community degradation, loss of species diversity, overgrowth by woody species and increased dominance of competitive grass species. Land abandonment also occurs on small-block arable lands – older farmers are unable to maintain the land, and younger generations are not interested in such farming methods, resulting in agricultural land abandonment. This process is accompanied by the spread of synanthropic and invasive plant species. Another problem is the threat to biocultural landscape types, particularly the traditional dispersed settlements, due to the transformation of residential and farm buildings into modern cottages and recreational structures with urbanized features like swimming pools, golf and tennis courts and ornamental gardens with exotic trees. Increasing pressures have been recorded for planting spruce on unnatural sites and the use of non-native, exotic trees around residential and recreational buildings, which is changing the traditional character of the landscape into a modern artificial one.

SWOT analysis

The SWOT analysis was aimed at assessing the factors supporting the development of the territory (strengths), at assessing the weaknesses that represent certain barriers to development and at identifying opportunities and threats that affect the sustainable development of the territory. The SWOT analysis was prepared based on expert assessment. It was prepared by five key experts who were selected to cover the individual components of the landscape – abiotic, socioeconomic, biotic and complex landscape-ecological syntheses. The SWOT analysis is presented in a tabular form (Table 2).

Discussion

Biosphere reserves are considered one of the best concepts for ensuring sustainable development and the conservation of biological diversity. Nevertheless, many of them face various environmental and socioeconomic challenges (Izakovičová, 2000; Morea, 2020; Stoll-Kleemann, O'Riordan, 2017; Yang et al., 2017).

Approaches to the concept of 'sustainable development' on a global scale are currently very rich and diverse. They are examined from a wide range of perspectives, such as 'a form of natural resource management (air, water, soil, mineral resources) and living systems, including humans, that ensures the achievement of the highest sustainable quality of life' (IUCN, UNEP, WWF, 1991), 'development that acknowledges the limits of consumption and the use of natural resources' (Rifkin, 1980), 'a way of life that approaches the ideals of humanism and harmony in the relationship between humans and nature, within a time frame that is unlimited' (Vavroušek, 1990) and 'ensuring a form of societal development that considers and respects natural conditions' (Izakovičová et al., 1997).

The main goal of sustainable development is to harmonize economic growth with the protection of nature, natural and cul-

Table 2. SWOT analysis.

Strengths
Territory included in the international network of BR MAB UNECO
Occurrence of protected areas – Poľana SPA, Poľana Protected Landscape area, small-area protected areas
Unique territory - the highest volcanic mountain area in Slovakia, One of the largest extinct volcanoes in Europe, rare and attractive relief
Climate diversity: from moderately warm to cold mountain climate zone, determining the diversity of biota
Diversity of forest ecosystems from oak-beech stage to spruce forests (5 forest vegetation stages), also conditioned by relief conditions - rubble forests, preserved primeval forests
Occurrence of endemic, relict, rare and endangered species of plants and animals
Territory important in terms of the deer gene pool
Significant reserves of surface and groundwater
The occurrence of significant biocultural landscape types, especially historical structures of the agricultural landscape, dispersed settlement
The territory represents a natural laboratory for education, training and cognition
Favourable quality of the environment
Weaknesses
Surface water pollution - exceeding the limit values of microbiological and biological indicators, exceeding the limit values of quality indicators: chemical oxygen demand by permanganate, manganese and iron
Exceeding the limits of foreign substances in soils - Cd, Pb and partly Zn
Transport of pollutants from surrounding pollution sources, air pollution due to local heating objects
Localization of environmental burdens – Hriňová town‘s heavy engineering objects, Fangová municipal landfill
Risk of threat to the territory due to natural stress factors – erosion, seismic risk, tectonic risk
Threat to biodiversity due to declining interest in agriculture, especially the abandonment and overgrowing of meadows and pastures
Spread of invasive plant species
Overpopulation of selected animal species (brown bear)
Impacts of global climate change issues
Pressures from tourism development on the natural and cultural-historical values of the area, especially cottage development in areas of dispersed settlement
Weak promotion of the natural and cultural-historical values of the territory
Opportunities
More significant support for BR by the government, including strengthening legislative protection
Increasing financial and human resources for BR management, compensation for lost profits for BR management
Increased support from regional and local governments
Possibilities of drawing EU funds for joint development projects
Support for farmers operating in BR within the CAP for the years 2023-2027
Support for the development of traditional crafts, customs and traditions
Increasing environmental awareness and strengthening the population‘s positive relationship with the BR
Increasing the promotion of regional values
Diversification of land use forms
Application of landscape ecological regulations into spatial planning and decision-making processes
Threats
Impacts of global megatrends on the territory, including the impacts of climate change
Continued indifferent government approach to the functioning of the BR – weak financial and legislative support
Insufficient management of the territory in terms of the occurrence of dangerous species of carnivores
Negative demographic development, aging of the population
Decline of agriculture, abandonment of agricultural lands
Decline of folk traditions and crafts
Growth of urbanization, application of modern elements in settlement development, gradual disappearance of rural scattered settlements
Intensive spread of invasive alien species
Weak cooperation between regional and local governments
Persistent negative trends in urbanization development – investor pressure, disrespect for landscape and ecological regulations in spatial development
Increasing consumer lifestyle

tural-historical resources and the environment. The objective is to create a management system within a territory that aligns the development of various socioeconomic activities with the natural, socioeconomic and cultural-historical potential of the area. This system will ensure the elimination of current environmental problems and the prevention of new ones, thereby securing the long-term sustainability of the territory (Nilsson, 2016).

To ensure the elimination of the specified problems in the Poľana BR and to secure the effective use of the area's natural potential, it is necessary to implement a comprehensive set of measures, which can be divided into the following main groups:

- **Spatial-organizational measures**: focused on changing land-use elements in locations where land use does not comply with landscape-ecological requirements, especially the supplementation of eco-stabilization areas – completing the functional framework of the Territorial Systems of Ecological Stability (TSES); securing buffer zones approximately 20 m wide along watercourses to protect them from pollutant runoff; supporting traditional land management; applying appropriate management of permanent grasslands; introducing anti-erosion farming methods on erosion-prone soils – arable land on higher slopes and grassland with a slope of more than 20°; planting isolation vegetation around mobile emission sources, especially in intensively loaded roads which are located in the southern and southeastern parts of the Poľana BR; eliminating environmental burdens including waste dumps; prioritizing small protected areas and water source protection zones, etc.
- **Technological-functional measures**: aimed at proposing and completing water supply and sewage systems in individual settlements; ensuring gasification or preference for environmentally friendly heating forms; applying integrated forest protection based on effective ecological forest management technologies, especially in the central zone of BR Poľana; harmonizing timber harvesting in TSES element areas with their eco-stabilizing functions; coordinating timber harvesting with animal breeding seasons; constructing ecoducts to mitigate negative impacts of anthropogenic barriers; and optimizing forest field roads.
- **Revitalization measures**: prioritizing the revitalization of sites representing TSES elements; ensuring gradual change in species composition of anthropogenically affected sites towards the dominance of natural species; regularly removing invasive species, especially along roads and in built-up areas, on the edges of settlements and near watercourses, such as the Slatinka and Hutná brooks, as well as on the edges of forests, such as Kozí chrbát, Javorinka, Šulkov vrch and Hrochoťský les; avoiding the planting of site-unsuitable woody plants; prohibiting logging in the core zone of the Poľana BR in specially designated forests; and securing water regime adjustments in areas representing hydric biocorridors (limiting excessive water extraction, eliminating wastewater discharge into watercourses, etc.).
- **Spatial-protective measures:** focused on proposing legislative protection for ecologically valuable landscape structures and their components; ensuring protection of biocentres of all levels, biocorridors and other ecologically significant elements based on their actual importance; ensuring protection of the National System of Protected Landscape Areas; ensuring the protection of historical structures of agricultural landscape; regulating functional changes of residential areas in dispersed settlement zones of Hriňová cadastral area; and leading to the conservation of the traditional landscape character.
- **Diagnostic-preventive measures:** establishing a comprehensive regular monitoring system aimed at obtaining information about the condition of environmental components; conducting agricultural surveys to determine the content of foreign substances in soils and assess their contamination levels; ensuring regular water quality monitoring; organizing regular collection and separation of household waste as prevention against illegal dumping; and monitoring the impact of environmental burdens on the landscape and its components, primarily the Fangová landfill, the remains of heavy machinery plants in the Hriňová cadastral area as well as other recultivated landfills.
- **Compensatory-supportive measures:** aimed at supporting management that ensures protection of natural and cultural values of the area; preserving traditional farming practices; strengthening research, education and promotion to foster environmental awareness; and reinforcing the position of the BR within the protection system. It is important to note that these are framework proposals that should be elaborated in more detail within the landscape-ecological plan or the territorial development strategy and subsequently applied in land-use planning documentation and sectoral planning documents. Resources from the Slovakia's Common Agricultural Policy Strategy Plan 2023–2027 can be a significant source of support.
- Presented methodological approach is based on an integrated framework. The concept of integrated management is widely recognized as the most suitable framework for managing natural resources and optimal utilization of the natural potential of the territory. Integrated landscape management is considered an innovative approach aimed at reducing the size, duration and intensity of human impacts on the landscape while also serving as a framework for achieving economic and social objectives, such as the fair and efficient use of ecosystem services (Dick et al., 2018) The focus is on the harmonization of human activities in the landscape with nature resources protection. The importance of perceiving the landscape as a holistic complex is emphasized by several authors (O'Neill, Walsh, 2000; Miklós et al., 2011; Svensson et al., 2020; Vitálišová et al., 2025).

Conclusion

Also, biosphere reserves are envisioned as model regions for sustainable development, where approaches can be applied and tested if they achieve the main objectives. Functioning as 'learning places for sustainable development', they emphasize the active involvement of local communities and stakeholders in the planning and management processes; moreover, they serve as 'sites of excellence', facilitating the testing of interdisciplinary approaches to address and manage changes and interactions within social and ecological systems (UNESCO, 2016). The paper presents an example of the assessment of landscape ecological and environmental problems resulting from inappropriate use of natural potential and establishes basic framework measures for the effective use of the natural potential of the territory, which will ensure the

sustainable use of the BR. The methodological procedure, which can also be applied in other biosphere reserves, is presented on the example of the Poľana BR.

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