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SUSTAINABLE LANDSCAPE MANAGEMENT OF THE TATRY BIOSPHERE RESERVE OF UNESCO

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Abstract

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The paper is aimed at the presentation of the proposal of sustainable landscape management of the Tatry BR in consideration of landscape and ecological properties of the area. On November 19, 2004 a massive windstorm swept through the area of the transboundary Tatry Biosphere Reserve (Tatry BR) shared by Slovakia and Poland. The windstorm strongly harmed and locally completely damaged 14% of the total area of the Tatry BR in Slovakia. Suddenly, new landscape and ecological conditions were established in the Tatry BR. Consequent problems required urgent scientific assessments and relevant responses. Professional ecologists in Slovakia well understood this ecological challenge and offered their capacity, experiences and know-how in order to contribute to addressing this challenge competently.

The main goal of the study is to define existing landscape-ecological and socio-economic problems, design measures to eliminate those problems and/or to prevent new problems to arise. The study also aims at setting up regulations (limits) for social and economic development, in consideration of the primary objectives of biodiversity conservation, territorial stability, conservation and rational use of natural resources and environment protection. Ultimate goal of the effort is to achieve that management practices are in harmony with potential of the area in largest possible extent.

Key words: Tatry Biosphere Reserve of UNESCO, sustainable landscape management, criteria and principles of sustainable development, landscape-ecological plan

Introduction

On November 19, 2004 a massive windstorm swept through the area of the transboundary Tatry Biosphere Reserve (Tatry BR) shared by Slovakia and Poland. The windstorm strongly harmed and locally completely damaged 14% of the total area of Tatry BR in Slovakia. More specifically the windstorm affected 7.1% of the small scale protected areas present in BR and subjected to the fifth, i.e. most strict protection regime[1], 7% of the area of habitats

[1] Slovak Nature and Landscape Conservation Act No 543/2002, through its §11 establishes five levels of area protection. While the 1st level of protection applies to the national territory of Slovakia, the fifth level of protection represents the most strict protection.

of European importance present in BR[2] and 1.5% of the Protected Bird Areas[3] overlapping with BR. Suddenly, new landscape and ecological conditions were established in the Tatry BR. These problems required urgent scientific assessments.

The main goal of the paper is to define the existing landscape-ecological and environmental problems, design measures to eliminate those problems and/or to prevent new problems to arise. The study also aims at setting up regulations (limits) for social and economic development, in consideration of the primary objectives of biodiversity conservation, territorial stability, conservation and rational use of natural resources and environment protection. Ultimate goal of the effort is to achieve that management practices are in harmony with potential of the area in largest possible extent. Thus, basic principles applied in sustainable landscape management included:

- protection of nature, biodiversity and landscape stability,
- protection of natural resources, including water, soil, genetic resources, forests, air/atmosphere, etc.,
- protection of cultural-historical resources, including, inter alia, protection of cultural monuments, protection of historical landscape structures, etc.,
- protection of the human environment.

Description of the target area

The study targets Slovak part of the transboundary Tatry Biosphere Reserve (Target Area), designated in 1992. The area of the Tatry BR in Slovakia 100% overlaps with the Tatry National Park, including its protective zone and covers 110,685 ha. The Biosphere Reserve encompasses the three mountain ranges of the region, the High Tatras, the Western Tatras and Belianske Tatras (White Tatras). It has a special position within a network of protected areas in Slovakia due to its outstanding attributes including (Izakovičová, Oszlányi, 2004)

- unique high mountain relief with distinct features of former glacial activity,
- numerous glacial lakes (tarns),
- numerous endemic plant and animal species (Carpathian endemics),
- largest alpine zone in Slovakia,
- outstanding alpine *Larix decidua* and *Pinus cembra* forests,
- well preserved natural forests in spruce forest zone.

The Tatry BR is of high importance also for nature research, health care, tourism development and sports, particularly for the following reasons:

- long history of nature research which dates back to 18th century,
- unique mountain climate has a strong healing effects on human organism,

[2] Habitats referred to in the Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora amended by Council Directive 97/62/EC of 27 October 1997.

[3] Protected Bird Areas are areas designated pursuant to Council Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds. the Bird Directive of the EU.

- social-economic infrastructure is available for development of healing and tourism activities (i.e. numerous spa and health facilities, high mountain chalets, sport facilities, etc.),
- the High Tatras belong to popular international tourist destinations.

Theoretical-methodical approaches

The need of sustainable landscape management comes from pragmatic needs, as it is required by constantly rising environmental and existence problems. The sustainable land use is considered to be intrinsically linked to the concept of multi-functionality (Brandt et al., 2003; Fry, 2001; Helming, Wiggering, 2003; Vos, Meekes, 1999; Wiggering et al., 2007; Miklós, Izakovičová, 1997; Zonneveld, 1995). The rationale addresses the interdependence of social, economic and environmental effects of land use, taking into account commodities and both negative and positive externalities. Land and the rural environment provides a variety of functions or goods and services, covering production, regulation, habitat and information. Multifunctionality therefore is a key feature for implementing sustainable land development. (Wiggering et al., 2007)

The sustainable landscape management is based on an integrated landscape research in its three basic dimensions, environmental, social and economic, analysing the connections and dependencies between the dimensions with the target to define such landscape management, which would regulate socio-economic development of the region with its natural, human, cultural and historical potential. It is based on matching the offer, which is represented by the resources in the region, and demand which is represented by the community needs of growth and development. The discrepancy between offer and demand (not respecting the properties of landscape resources) is the determining factor of formation not only environmental but also human problems. The approach is focused on solving the problems stated – elimination of current and prevention of formation of new environmental and socio-economic problems and from long-term perspective secures rational utilisation of the natural and cultural-historical resources.

Sustainable landscape management is based on seeing the landscape as integration of natural resources in certain area (Miklós, Izakovičová, 1997). As the area is representing the integrating scope, scene in which all resources are occurring as layers (geological sources, water and soil sources, climate, biotic sources, and morphometric parameters) which are mixing together. It is seen as understanding the space as integration of particular natural sources in given area. Every point of earth surface presents specific homogeneous entity of mutual combination of listed sources (landscape building components, which through its attributes are capable to satisfy human needs and as such in relation to human society act as natural resources) and also understanding the relationship between these resources.

The basic principles of the sustainable landscape management are (Izakovičová et al., 1997):

a) **preservation of the overall ecological stability of landscape** as the most general and complex condition for conserving gene pool, biological diversity, stability and the natural

functioning of ecosystems and through that also for conserving the natural production capacity of landscape. The preservation of ecological stability is therefore primarily achieved by the landscape-ecological optimisation of the spatial structure of landscape – through the suitable distribution of landscape elements in space, their proper utilization or protection.

b) **protection and rational utilization of natural components (natural resources)**, in particular of air, water, soil, biotic resources, mineral resources. The state of natural resources is determined by their quantity, quality conditions, Protection and rational utilization of natural resources is realized partly through the optimal collocation of objects and activities in the area and by application of the suitable technologies.

c) **protection of the close human environment –** that means: preserving the quality of air, drinking water and food chain, reducing negative influences like noise, radiation and waste, preservation of aesthetic quality and human environment etc. The protection of the environment against the unfavourable influences means mainly the optimisation of technological processes of production branches and preservation of the aesthetic quality of the environment means mainly the optimal land cover.

d) **ensuring social and cultural diversity** – by respecting the national, religious and cultural-historical peculiarities of individual communities that form region. This objective – like the preceding one – can be ensured through the "ecologisation" and humanization of the above structure, especially by the interaction of economic and legislative tools and by the humanization of social consciousness. The basic goal of this principle is protection and preservation of historical landscape structure – traditional forms of the land use.

The consequence of the above means that sustainable landscape management is the process aimed at the landscape-ecological optimum spatial organization, utilization and protection of landscape which results to the proposal of most suitable localization of demanded human activities within the given territory (where? – e.g. the most suitable locality for arable land) and successively to the proposal of necessary measurements ensuring proper environmental functioning of those activities on the given locality (how? – how to apply the most suitable way of soil-management – and ways to reduce natural risks and hazards). It is a method for to answer the question where and how to provide human activities in the territory that would be in least contradiction to natural conditions (Ružička, Miklós, 1982).

Sustainable landscape management is based on confrontation of society requirements for area development with landscape properties. Landscape properties represent excluding, limiting or possibly supporting development regulations (limits). This has to be followed with consequent spatial harmonization, i.e. defining optimal spatial organisation of single activities aimed at eliminating of existing and avoiding new landscape-ecological, environmental and socio-economic problems.

LANDEP (LANDscape-Ecological Planning) methodology (Ružička, Miklós, 1982) represented a methodological framework for sustainable landscape management in the Tatry Biosphere Reserve. Since the target area is a distinct area with dominating nature protection objectives and is subject to various conservation regimes established through Nature Conservation Act, it was necessary to adapt LANDEP methodology for the purpose of the present study.

Methodology

The methodology comprised the following steps:

- analyses
- evaluations
- propositions.

1. ***Analyses*** – represent selection, development, description and spatial definition of landscape quality indicators and quality indicators of single landscape components. Analyses were based on assessment and homogenisation of various specialised researches for the purpose of ecologically optimal spatial organisation of landscape. Analytical indicators were acquired through excerptions from existing documents, processing of statistic data and data from various sectoral databases, etc. Some special analyses included field tests/surveys. Perceptions of existing problems and development strategies by local population were also analysed. Analyses were split up as follows:

- ***analyses of legal acts and documents regulating management of the BR area*** – these included analyses of laws, regulations and strategic documents, which have relevance to area management and nature protection in particular. These also included stakeholder analyses.
- ***analyses of abiotic landscape components*** – these included analyses of abiotic natural resources, i.e. those elements of landscape structure that constitute a primary and permanent foundation for other landscape structures. They represent factors determining development of life forms within a defined territory. Analyses were focused on geomorphology, geology, hydrology, climate and soils.
- ***analyses of biotic conditions*** – these included specification, description and spatial definition of biotic landscape components. More specifically, it included vegetation characteristics (both potential and actual) and fauna description. Significant species, communities and habitats present within area of biosphere reserve were described. Forest habitats received major attention, since their represent a dominating ecosystem type in BR. Beside species composition, also other characteristics of forests were analysed including naturalness (conservation status), age structure, stand density, vertical structure, etc.
- ***analyses of actual landscape structure*** – actual landscape structure reflects actual land use in target area. It represents a foundation for impact assessment of use of natural resources, since it allows for identification of activities that have negative impact on the target area. Actual landscape structure constitutes a combination of natural, semi-natural and anthropogenic landscape structures. The following were mapped for defining actual landscape structure: vegetation, areas of revealed substratum, waters, agricultural/industrial areas and settlements. Linear elements in focus included cable lines/ski lifts, roads, railways and rivers/streams. These analyses confirmed that forest ecosystems with coverage of 37.8% of the total BR area dominates in the BR. Dwarf pine communities and meadows and pastures represent respectively 9.9% and 9.4% of the BR area. Arable land represents 13.5% of the BR territory and is concentrated in the southern part of the BR. Settlements cover 2.3% of the BR. It can be concluded that structures with high eco-stabilising effects prevails in the BR (Izakovičová, Oszlányi, 2004).
- ***analyses of positive social-economic factors*** – these included assessment of social and economic measures that are supportive to nature protection, conservation of natural resources and overall contributes to optimal use of natural resources. Primary attention was paid to analysing of various area-based designations, including, *inter alia*, small scale protected areas, designated elements of ecological network, forest management classification, water protection measures, etc. There are in the Tatry BR, 27 National Nature Reserves (NNR) covering 37,977.13 ha, 24 Nature Reserves (NR) covering 1063.34 ha, 2 National Nature Monuments (NNM) a 2 Nature Monuments (NM). Small scale protected areas are unevenly distributed in the BR. The area of BR is important for the protection of forest and water resources. Protective forests cover 23,346 ha and are primarily designated for the soil protection. Special purpose forests occur on an area of 13,670 ha and are designated for nature protection and emission control purposes. Furthermore there are significant sources of underground water in the BR. From rivers and streams, there are respectively 13 and 26 recognised (designated) as significant for water supply and water management. There are gravel and limestone deposits in the transition zone of the BR (protective zone of the Tatry National Park).
- ***analyses of stress-inducing factors*** – these included assessments of social and economic activities negatively impacting on the landscape quality and/or on qualities of single landscape components. Both primary and

secondary stress-inducing factors were analysed. Primary stress-inducing factors included pollution sources, while secondary stress-inducing factors included polluted/harmed landscape components – polluted air, contaminated soil, areas exposed to noise load, damaged vegetation, etc. Damage to vegetation is considered the most serious stress-inducing factor in the BR. It is caused by natural processes such as wind, ice, drought, land-sliding processes, etc, as well as by anthropogenic factors such as emissions, fires, tourism and forest management. The most extensive damage to vegetation ever recorded was caused by windstorm on 19 November 2004. As much as 12, 000 ha of forests were destroyed that time, representing some 2.7 mil.l m^3 of wood. From the other stress-inducing factors, air pollution has to be mentioned. It is particularly serious in the southern part of the BR, where there are several large and medium-sized pollution sources, namely in municipalities of Liptovský Mikuláš, Liptovský Hrádok, Poprad, Svit and Kežmarok. Higher depositions of sulphur and nitrogen, originated from long-distance transfers were also recorded in the BR. Transportation contributes to overall load on the area with emissions and noise. Area that is most exposed to negative impacts of road transportation include the section of Cesta slobody (Road of Freedom) between Podbanské and Tatranská Kotlina and connecting roads to Cesta slobody (Road of Freedom) from the municipalities of Spišská Belá, Kežmarok, Veľká Lomnica, Poprad, Svit, Mengusovce, Tatranská Štrba. Noise load is particularly serious along local railways and cable lines. Water quality is overall satisfactory in the BR. In the core zone underground water is of high quality, only negligible level of pollution has been locally recorded. In the B a C zones of the National Park, locally high concentrations of pollution in underground water were recorded, particularly in the eastern part of the BR within cadastral territories of Poprad, Svit, Veľký Slavkov, Mlynica, Nová Lesná and Starý Smokovec. Smaller areas of polluted underground water are located in the vicinities of Liptovský Hrádok, Štrba and Hybe.

- ***analyses of social-economic structure*** – these were focused on assessing human potential in the BR, such as demographic aspects and sectoral activities. These analyses were aimed at identification of actual status of social and economic development in the BR and future development pressures. Currently recreation and tourism, health care and forest management dominate among economic activities. Agriculture and industry is developed in the protective zone of the national park (transition zone of BR), later it is concentrated in larger municipalities situated along the southern limits of the target area, namely in municipalities of Liptovský Mikuláš, Liptovský Hrádok, Poprad, Svit and Kežmarok. Agriculture is based on production of potatoes and corns (oats, barley, rye). Cattle grazing dominate in animal production. Comeback of sheep production has been observed in the recent period. Nature conservation and environment protection laws limit the development of economic activities.

2. ***Evaluations*** – represent evaluations of actual land use on the basis of landscape ecological and environmental regulations (limits) that are defined in consideration of landscape attributes. Evaluations result in assessment of actual utilisation and management of the target area against landscape ecological and environmental regulations (limits), determination of areas with landscape-ecological problems, and areas where current uses are conflicting with landscape ecological principles, i.e. principles of sustainable use. Evaluations also involve assessment of social-economic problems arising from (i) inappropriate utilisation of cultural and historical resources present in the target area and (ii) inappropriate management.

Results

Numerous problems were identified in the target area. These problems are classified as follows (Izakovičová, Oszlányi, 2004):

A) Problems that represent threats to biodiversity and territorial stability – these problems are caused through spatial overlapping of stress-inducing factors and biologically and ecologically significant elements, such as protected areas, NATURA 2000 sites, elements of ecological network and other landscape elements that have ecostabilising effects. In the target area these problems include, but are not limited to:

- threats caused by tourism and recreation to ecologically significant ecosystems, protected areas, elements of ecological networks, internationally significant habitats. Particularly serious load originating from tourism activities was observed in tourist centres of Hrebienok, Skalnaté Pleso, Štrbské Pleso, Tatranská Lomnica, Zuberec, etc.,
- negative impacts of constructions (chalets, houses) on ecologically significant ecosystems, recorded in Podbanské, Račková doilna valley, Tatranská Štrba, Zuberec, foothills of the Vysoké and Belianske Tatry Mts etc.,
- threats to particular elements of ecologically significant ecosystems and protected areas caused by waste dumping, and particularly illegal waste dumping – typical feature widely spread across the BR. Waste is particularly visible along hiking trails and tourism centres, namely at Hrebienok, Skalnaté Pleso, Štrbské Pleso, Tatranská Lomnica, Solisko, Jakubová Lúka, etc.,
- disturbance to vegetation cover caused by windstorms, insect infestations, snow-breaks, ice-breaks, fall winds in Ticha dolina valley, and in the area between Podbanské and Tatranská kotlina basin. Large-scale damage to forest ecosystems was caused by windstorm on 19 November 2004,
- threats to protected areas and elements of ecological network caused by increased concentration of air pollution; threat is particularly serious in C zone and protective zone of the Tatry National Park, where significant pollution sources are located. In the area between municipalities of Jalovec-Zuberec-Vitanová, increased depositions of nitrogen and sulphur were recorded,
- threats to designated protected areas and to elements of territorial system of ecological stability from increased concentration of pollution in underground waters (Pribylina, Štrbské Pleso, Hybe, Východná, etc.),
- negative impact of disturbance of natural succession in alpine and subalpine zone as result of the former pastoral activities; removing of mountain pine grows and spruce stands on the (former) upper forest limit,
- negative impact of disturbance of natural forest ecosystems and their substitution with spruce monocultures that are extremely vulnerable to air pollution,
- risk of pollution of designated ecostabilising areas and soils from road transport emissions: particularly along Cesta slobody and connecting roads from municipalities of Spišská Belá, Kežmarok, Veľká Lomnica, Poprad, Svit, Mengusovce, Tatranská Štrba,
- risk of disturbing of biota on designated ecostabilising plots (i.e. biocentres, biocorridors, small-scale protected areas) by increased noise (increased noise loads recorded along aforementioned road transport corridors, along railways with diesel powered carriages between Studený Potok and Tatranská Lomnica, along Tatry railway, including also cogwheel railway. Increased noise is also caused by processing of salvage felling timber,
- threats to water biota and riverside habitats from decreased water quality – particularly in water courses of Mlynica, Biely Váh, Belá, Velický potok, etc.,

- disturbance of the elements of territorial system of ecological stability as a consequence of barrier effects of antropogenic objects – division of biocentres and biocorridors by transport corridors, settlements etc.,
- disturbed spatial stability of the area – establishment of monotonous agricultural landscape with prevailing arable land and without ecostabilising elements such as bushes, tree lines, etc.,
- destruction of valuable ecosystems by fire – most recently in the area between Tatranská Polianka – Smokovce, in the past – in Kôprova and Tichá dolina valleys, on slopes below Slavkovský štít p Peak, west from Vyšné Hágy, etc.,
- risk of insufficient implementing of conservation function of the national park/biosphere reserve as result of intensive urbanisation – continuous enlarging of the municipality of Vysoké Tatry comprising extensive areas from Podbanské in the western part of the target area to Tatranská kotlina basin in the eastern part of the BR,
- secondary succession of peat bogs – overgrowing of peat bogs decreases its conservation importance,
- overgrowing of grasslands after land abandonment; lack of conservation management of these grasslands result in decreasing of landscape and ecological values on the affected sites.

B) **Problems that represent threats to natural resources** – these problems are caused through spatial overlapping of stress-inducing factors and respective natural resources. In the target area these problems include, but are not limited to:

- risk of contamination of water sources from contaminated soils, particularly if soil is polluted in hygienic zones of drinking water sources: increased concentrations of lead and tin in soils were recorded around drinking water source in Starý Smokovec,
- pollution of water courses that are designated to serve water management and water supply functions (rivers/creeks of Váh, Poprad, Biely Váh, Belá, Mlynica, Velický potok, Kežmarská Biela Voda, etc.). Presumably, also other water sources in the target area are polluted, however water quality monitoring if not established on these streams,
- risks of pollution of underground water from inappropriate waste disposal (illegal landfills),
- pollution of underground waters in hygienic protection zones of water sources – Hybe, Východná, Pribylina, Liptovský Hrádok, Dovalovo, etc.,
- threat posed to water sources by processing of wood in forests affected by windstorm, particularly if the forests are located in hygienic protection zones,
- threats posed to water sources by development of intensive forms of tourism, conflict recorded in the areas of Zuberec, Habovka, Podbanské, Starý Smokovec, Štrbské Pleso, Tatranská Lomnica, etc.
- risks of pollution of underground waters from disposing manure on unpaved areas, or on paved localities with insufficient capacity, for instance along the Štrbský potok creek, in the area between Tatranská Štrba and Štrba municipalities, west from Mengušovce municipality, west from Mlynica, in the vicinity of Gerlachov, east from Nová Lesná, west from Stará Lesná municipality, north from Mlynica, north-west from Veľká Lomnica, etc.,

- risk of contamination of environment by waste waters, particularly in municipalities lacking sewage system, namely in municipalities of Hybe, Jakubovany, Jalovec, Jamnik, Konská, Liptovská Porúbka, Liptovský Trnovec, Malý Slávkov, Rakúsy, Stráne pod Tatrami, Važec, Veľký Slávkov, Vitanová, Východná, Žiar, Liptovské Matiášovce, Liptovské Beháровce, Bobrovček, Gerlachov pod Tatrami,
- risks of damage to water regime posed by logging,
- eutrophication, acidification, pollution of tarns originated from mountain chalets,
- locally threatened soils due to increased contamination (e.g. increased concentration of lead and tin was recorded in the vicinity of Starý Smokovec municipality, increased concentration of arsenic was recorded near Jalovec and Žiar municipalities),
- risk of contamination of soils from intensive transport and spreading of materials used in road maintenance during winter season – soils along intensive transport corridors: road sections between municipalities of Poprad–Kežmarok–Spišská Belá, Svit–Poprad, Liptovský Hrádok–Hybe, Starý Smokovec–Tatranská Lomnica, Starý Smokovec–Poprad, etc.,
- risk of contamination of soils from increased concentration of air pollution; there are 67 large and 26 small pollution sources recorded in the area. The highest concentrations of pollution are recorded in the southern part of the target area, where most pollution sources are located – municipalities of Poprad, Svit, Liptovský Mikuláš, Liptovský Hrádok, Kežmarok, Pribylina, etc.,
- risk of decreasing of quality of soils due to erosion – particularly on steep slopes, where soils are currently stabilised by vegetation (forests in particular).

C) **Problems that represent threats to environment** – these problems are caused through spatial overlapping of stress-inducing factors and humans/human ambient. In the target area these problems include, but are not limited to:

- threats to housing areas from intensive transportation – the highest emission and noise loads has been recorded in municipalities of Svit, Poprad, Kežmarok, Spišská Belá, Poprad, Štrbské Pleso, Tatranská Lomnica, Liptovský Miluláš, Štrba, Starý Smokovec, Tatranská Kotlina, Ždiar, Tatranská Javorina, Podpspády,
- threats to municipalities from increased radon exposure – recorded in municipalities of Zuberec, Vitanová, Pribylina, Hybe, Tatranská Javorina, Bobrovec, Jalovec, Jakubovny, Važec, Štrba, Mengušovce, Svit, Batizovce, Gerlachov, Ždiar, Kežmarok, Veľký and Malý Slavkov, Huncovce, Veľká Lomnica, Stará Lesná, Mlynica and Poprad,
- increased air pollution around large and medium-sized pollution sources – particularly in cities of Kežmarok, Svit, Poprad, Liptovský Mikuláš, Liptovský Hrádok and Starý Smokovec.
- threats to quality of housing areas, conflicting hygienic zones around sewage treatment plants with housing areas in municipalities of Podbanské, Tatranská Lomnica, Mlynica, etc.,
- increased ammonia load in municipalities of Štrba, Pribylina, Liptovský Trnovec, Hybe, Kežmarok, Východná, Zuberec, Žiar, Liptovský Hrádok, etc. resulting from conflicting hygienic zones of farms with housing areas,

- increased noise and stink loads in municipalities of Svit, Poprad, Kežmarok, Liptovský Hrádok resulting from conflicting hygienic zones of industrial areas with housing areas,
- continuous decreasing of the quality of spa environment due to air pollution from industrial sources, but particularly from mobile sources and long-distance sources located outside of the target area,
- decreased quality of spa environment and disturbance of healing functions due to destruction of forest by windstorm,
- risk of decreasing of recreation quality of the area due to increased avalanche risks. Overall, 1042 of avalanche routes have been recorded in the Tatras,
- threats to recreation areas from gravitation processes (falling down of rocks, etc.),
- inappropriate locations of landfills near houses, such landfills are source of bacterial pollutions and decreasing of aesthetic quality of the environment,
- threats to human health as a consequence of consumption of polluted waters (increased concentrations of iron, manganese in water sources near municipalities of Kežmarok and Veľká Lomnica, Starý Smokovec, increased concentrations of aluminium in water sources in the vicinity of Bušovce municipality, increased concentrations of arsenic in sources in the vicinity of Kežmarok municipality),
- disturbance of aesthetic quality of environment (i) by establishment of intensively utilised agricultural landscape (in southern part of the target area), (ii) through introduction of technical elements (industrial areas) and corridors (such as railways) into landscape and (iii) through establishment of anthropogenic relief forms as a consequence of minerals extraction (in the vicinity of Batizovce, Podspády, Zuberec, etc.),
- disturbance of biological and aesthetic quality of environment by fencing of former hunting ground managed by the Lesný závod (Forest Enterprise) in Tatranska Lomnica.

D) Problems related to social and economic activities and area management – they are caused by inappropriate development activities and inappropriate practices applied in area management. They include but are not limited to:

- inappropriate area management caused by overlapping and insufficiently clarified competencies in area management, particularly between Ministry of Agriculture that have responsibility for forest management and Ministry of the Environment that is overall responsible for nature protection in the target area. At the target area, the former is represented through forest enterprise "State Forests of Tatry National Park", while competencies of the later are implemented by Administration of the Tatry National Park[4]. The Tatry National Park Administration also coordinates the implementing of BR functions. However, it has no decision-making power and thus its positions among various stakeholders within the area are rather weak,

[4] Administration of Tatry National Park is integral part of the State NAture COnservancy of the Slovak Republic – nation wide institution responsible for nature protection.

- unfavourable implementation of owners and users rights, insufficient enforcement of compensation measures (compensation for restrictions in forest management, game management, berry picking, etc.),
- absence of comprehensive and generally binding management strategy for the Tatry National Park, which would define management measures and assign responsibility for their implementation. Consequently, low level of cooperation between stakeholders has been observed in the Tatry BR,
- conflicting interests of stakeholders, lobbying for harmful development activities, preference to exploitation activities while neglecting conservation objectives, preference to businesses generating short-term benefits, etc.,
- lobbying for changes in legal acts, particularly for changes in conservation regimes and zonation pattern applicable in BR territory in order to allow more intensive land-uses,
- low representation of original inhabitants within local population and consequently weakened feelings/perceptions of local population for/of cultural, historical and natural values. The lowest representation of original inhabitants was noted in municipalities of Liptovský Peter, Liptovský Hrádok, Mlynica, Svit, Vysoké Tatry,
- unfavourable age structure, dominance of population in post productive age, ageing of certain municipalities, namely in Vysoké Tatry, Hybe, Važec, Liptovská Kokava, Východná and consequently low development potential,
- increased representation of Romas in local population particularly observed in municipalities of Rakúsy, Malý Slavkov, Veľká Lomnica, Stráne pod Tatrami, Gerlachov, Batizovce. Romas represent low qualified work force with low-level education, and consequently low development potential,
- lack of job opportunities in rural settlements and consequent movement for jobs into other municipalities. This is particularly typical for municipalities of Štôla, Hybe, Liptovská Kokava and Liptovský Peter,
- low standards of households and low potential for their enhancement as a consequence of unfavourable age structure of local population,
- insufficient services offered to local population, but particularly to visitors.

3. **Propositions** – include set of measures aimed at (i) eliminating identified landscape ecological, environmental, and social-economic problems in the target area and (ii) establishment of sustainable landscape management of the target area. This step was based on definition and delineation of specific spatial units so called "ecological–functional units". For each unit, specific recommendations were formulated that shall provide for optimum status of the respective units, i.e. status that is ecologically sustainable.

Recommendations on how to address specific problems were organised into the following categories of measures:

- Strategic-management recommendations – focused on overall coordination of management of the Tatry Biosphere Reserve, with special attention to its national designation as national park. The recommendations aim at (i) clarification of management competencies over the target area between Ministry of Agriculture and Ministry of the Environment, (ii)

implementation of compensation schemes, and (iii) development and due implementation of strategic consensus based development plan for the target area.

- Conservation measures – focused on conservation of ecologically valuable landscape structures and their respective elements, i.e. conservation of protected areas, NATURA 2000 sites, biocentres, biocorridors, and other ecologically significant elements in consideration of their actual importance. These include implementing of certain management principles in respective zones of biosphere reserve/national park, including prohibition of any human activity in A zone of the national park, restrictions on constructions in B zone of the national park, encouragement of sustainable social and economic activities in transition zone of the BR/ protective zone of national park. For the purpose of conservation of forest ecosystems it is necessary to promote site specific three species composition in forest stands, promote application of pioneer species in forest restoration, promote permanent regeneration period, stand density in the interval 0.6–0.8, secure implementing of non-production functions of forest, particularly water protection function. For the conservation of grasslands, it is necessary to control intensity of management (mowing, grazing) and exclude application of fertilisers on mountain meadows.
- Restoration measures – focused on restoration of damaged areas, particularly areas damaged by windstorm in November 2004. Affected areas in A zone of the National Park will be left for natural succession, no application of pesticides will be allowed in this zone, in case of insect outbreaks, pheromone traps will be employed to control insects. Other restoration measures include, for instance, restoration of access roads, restoration of riparian forests, particularly those that are recognised as biocorridors, assessment of environmental risks from log/assortment dumps and landfills and their subsequent sanitation/relocation and restoration of affected areas.
- Spatial organisation measures – focused on changes in spatial organisation of land-use elements, particularly in areas where current land use is conflicting with ecological attributes of landscape. These measures include: establishment of elements having high ecostabilising effects; completion of ecological networking (development of territorial system of ecological stability), particularly in agricultural landscape present in transition zone; increased representation of vegetation in municipalities; development of buffer zones (20–50 m) along water courses in basins for the protection of waters against pollution; introduction of measures to control soil erosion and land sliding; planting vegetation belts around pollution sources; industrial objects and farms, etc.
- Technological measures – focused on technological measures that have potential to decrease effects of secondary stress-inducing factors. These include, for instance, installations/ improvements of filters, sewerage systems, waste disposal systems, water protection measures, introducing progressive technologies in farms, etc.
- Diagnostic-precautionary measures – development of comprehensive monitoring system to monitor biodiversity, forest ecosystems, SO_x, NO_x O_3 and other pollution, water quality, soils, development of the territorial monitoring system.

Conclusion

The present study contains the results of our scientific research, including scientific information, arguments and standpoints. It was submitted to bodies competent to plan for further development and protection of the Tatry Biosphere Reserve. We are convinced that application of our findings and recommendations in decision making process should not only be possible, but also be beneficial to and necessary for meeting interests and expectations of local population, population living in regions surrounding the BR as well as of international community.

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