



Assessing forest degradation in Slovakia

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Abstract

Forests are key ecosystems for biodiversity conservation and ecosystem services provided to society. They are a source of wealth and jobs in rural areas and also contribute to the quality of the environment, because they contribute to water retention, flood protection, reduce climate change by absorbing and storing 10% of carbon emissions in the EU. EU forests and other wooded land now cover 155 million ha and 21 million ha, respectively, together more than 42% of EU land area (EU, 2015). Forests are not evenly distributed. Similarly, the qualities of forests and their management types in the various regions and countries are diverse. Despite the high value services that forests provide, they are not always adequately protected and effectively utilized. According to FAO about 13 million hectares of world forest are lost every year. Competing and conflicting demands for land use are likely to grow further towards 2050, when 9 billion people will be sharing one planet and its limited resources, under changing climate patterns and socio-economic conditions. The reasons of forest ecosystem degradation are diverse. According to the United Nations Framework Convention on Climate Change (UNFCCC, 2007) secretariat, the overwhelming direct cause of deforestation is agriculture. Subsistence farming is responsible for 48% of deforestation; commercial agriculture is responsible for 32% of deforestation; logging is responsible for 14% of deforestation and fuel wood removals makes up to 5% of deforestation. Threats to forests also threaten biodiversity hotspots, economic prosperity and development. From this aspect due attention should be given to the protection of forests not only at European level but also nationally. The paper is focused on the current status of forest degradation in Slovakia.

Key words: representative geoecosystems, forest ecosystems, Slovakia, degradation of forests, stress factors

1. Introduction

Forests in addition to production aspects, such as biomass production are also very important in terms of securing various ecological and environmental functions. Significant are not only from aspect of the biodiversity protection and protection of landscape stability, but significantly contribute to the protection of other landscape components (natural resources) - in particular to the protection of water and soil resources. They help to regulate a variety of landscape phenomena and processes. The important thing is also their role in protection against manifestations of natural risks and hazards, especially from occurrence of erosion-accumulation processes, landslides, floods, etc. Many fulfill a number of cultural services, such as rest-relaxation, recreation, scientific-educational function etc. Despite irreplaceable functions of forests in the landscape, forest resources in Slovakia are constantly threatened by various stressors.

The most important of them are: disproportional wood cutting in forest ecosystems and their current substitution by artificial monocultures, shrinkage of forest ecosystems due to spreading technosphere, endangering of forest copses as a result of developing recreational activities, extinction of forest ecosystems caused by various pests. Despite of these negative impacts on forest ecosystems there is still significant acreage of valuable forest ecosystems in Slovakia.

In Slovakia the forest ecosystems cover almost 41,1 % of the country's total area (2 015 368 ha). Timber land of the total area of forest land formed 96,4 % (1 941 531 ha), which represents the equivalent of 3,72 km² per 1000 inhabitants. Tree species composition of forests is quite varied. There is a positive proportion of deciduous trees (61.4%) compared to coniferous trees (38.6%). Out of these forests, 40 up to 45% are seminatural, their tree species composition differs only slightly from the primeval forests. These forests are from natural regeneration in general. The

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most important tree species of forest ecosystems in general are beech (*Fagus sylvatica* L.) (32,7 %), spruce (*Picea abies* L.) (27,5 %), oak (*Quercus* sp.) (11,3 %), Scotch pine (*Pinus sylvestris* L.) (7,7 %) and fir (*Abies alba* L.) (4,6 %). In our forests there are also introduced tree species (eg. *Acacia*, poplars, black pine and douglas fir, grand fir, eastern white pine, red oak, chestnut, horse chestnut and maple ashleaf). This is a total of 24 invasive kinds, and their proportion is 2.93%. The most widespread invasive species is *Robinia pseudoaccacia* L., *Acer negunda* L., *Ailanthus altissima* (Mill.), are problematic too (Ministry of Environment, 2014).

Most of the forests are economically exploited. On the commercial forests it accounts for up to 71.2%. Protective forests occupy 17.1% of total area of Slovakia and area of forests with specific statement is 11.7%.

From the perspective of the protection of biodiversity and the landscape stability, in which the predominant role played by forest ecosystems, it is necessary to maintain the widest possible range and diversity of natural forest ecosystems. In Institute of Landscape Ecology of the Slovak Academy of Sciences has elaborated methodology for the evaluation of the current status, as well as the protection and threat to forest ecosystems. Degradation of forest ecosystems is assessed in two aspects: quantitative and qualitative. To evaluate the quantitative changes the model of representative geoecosystems has been developed. The assessment of the qualitative aspects is based on the coefficient of species composition and coefficient of defoliation. The basic goal of the paper is to present the methodology for assessing forest degradation and its application in the territory of Slovakia.

2. Materials and methods

Forest ecosystems are threatened by various stress factors. Stress factors can have a natural and anthropogenic provenance (Izakovičová et al., 1997). Nature arise as a result of evolutionary forces in the nature. The climate change is a serious factor threatening forest ecosystems. Natural stress factors can be divided into two basic groups: the abiotic factors as all the harmful action of wind, snow, rime, and draught, and the biotic factors as mostly spruce bark and wood boring insects lead followed by the leaf-eating and sucking insects, putrefaction, tracheomycoses, and wild animals. However, there is much more dangerous effect of the anthropogenic stressors, anthropogenic stressors which are the negative impacts of human activities. Human activities operate in landscape as stress factors and it means environmental factors causing stress, which have either directly (primary stress factors) or indirectly (secondary stress factors) reduced and devastated landscape and its landscape elements (Selye, 1966). The load of forest ecosystems by stress factors is interpreted as a set of unsubstantial influences, which negatively acts in forests and its components and instigate various chemical, physical, bacteriological and other changes in landscape (Charvát, 1969; Balej, 2004).

Primary anthropogenic stress factors are represented by the physical occupation of the forests and alteration of natural ecosystem. The group includes any semi-natural and artificial anthropogenic elements (industrial and agricultural facilities, transport areas and lines, areas of intensive farming and forestry, areas of housing, and recreation). All of these primary stress factors can be specified according to the occupied area. Their positions in landscape causes changes in land-use and subsequently deforestation of landscape (Bürgi et al., 2004; Csorba, 1996; Jensen, 2000; Turner et al., 2001).

Secondary anthropogenic stress factors represent negative effects caused by human activities that cannot be specified only according to their scope. Secondary stress factors disturb and endanger the evolution of natural ecosystems. The most important secondary anthropogenic stressors include production of emissions and subsequent transport emissions, negative influences of logging, etc. (Scharpf, 1980; Balej, 2004; Izakovičová, Oszlányi, 2013).

3. Results

Effects of stress factors are reflected in both quantitative as well as qualitative threat of forest ecosystems.

3.1. Quantitative threat

Quantitative threat has been evaluated on the basis of representative forest geoecosystems. Representative Geoecosystems (REPGES) are comprehensive landscape-ecological units characterised by a set of abiotic components (of lithosphere, hydrosphere and atmosphere), biotic components (vegetation including the bio-geographical aspects). A system of representative potential geoecosystems on supraregional level at scale of 1: 500 000 (Miklós et al., 2006) has been developed for Slovakia. The aim was to prepare a systemic scheme for the strategy of protection for life forms and life conditions on the level of the state, in other words a list, which contains all strategically important forest geoecosystems of Slovakia in order to preserve and protect all valuable and representative forest ecosystems.

The basis for the delimitation of units was the choice of potential vegetation units and properties of abiocomplexes. Hence, the potential REPGES expresses the potential state of landscape free of any human interventions. In this way they provide information what types of forest ecosystems originally existed in the territory of Slovakia. Subsequently the REPGES have been reassessed based on the present use, the existing real vegetation and the species composition of forest.

Over history, Man has distinctly interfered in structure of REPGES particularly by taking in and deforesting the forest ecosystems and changing them into arable or grassland. Massive intensification of agriculture came in time of collectivisation and socialisation. It meant the deforestation, land consolidation, dryout, alteration of hydrological regime, and the like. Increased use of heavy machinery led to the removal of the remaining vegetation and the country gradually changed into the deforested, landscape-ecologically instable and heavily exploited agricultural landscape.

Apart from deforestation, intensified agriculture caused the disappearance of some representative forest ecosystems above all in geographical regions with favourable natural conditions for the development of agriculture, namely in the lowland and plain relief with the most fertile soils and encouraging climatic (warm) conditions. Examples of so affected Slovak regions include the lowlands and hill lands of the Danube Plain, Danube Hilly Land, East Slovakia Flatland and Hill Land, South Slovakian Basin. Ecosystems in mountain basins were also markedly affected (Basins of Zvolen, Rožňava, Žilina, Košice, Turiec, Basin of the River Hornád, and the Sub Tatra Basin).

Regarding the change of forest ecosystems into agroecosystems the REPGES of river floodplains, proluvial cones, loess tablelands and hill lands, big plains, lowland or basin foothill depressions with alluvial forests, bog alder woods, oak-hornbeam or turkey oak woods were the most changed. These REPGES have been changed because of the demand of massive agricultural production. Arable land dominates here as it covers more than a half of the area.

Urbanisation and industrialisation also significantly interfered into the natural structure of REPGES. The negative outcome was not only because of occupation of the area of natural ecosystems by technical objects but because of production of pollutants, noise, dust, and radiation, which affected the natural development of many ecosystems. As in case of agriculture, urbanisation and industrialisation altered the most of the lowlands and basins and particularly the river floodplains, terraces, proluvial cones, big plains, loess tablelands and hill lands, polygenic hill lands or dissected pediments.

From the spatial point of view the territories with the highest coverage of forest ecosystems are the mountainous areas with high representation of natural ecosystems, and in the opposite, only a small portion of forest ecosystems have been preserved in lowlands: the Danube Plain, Danube Hilly Land, East Slovakian Flatland, south Slovakian basins, Lower Morava Dell, Valley of the River Váh and the like. The dominant element of landscape structure here are large-blocks of arable land or urbanised areas. Adverse ecological quality of spatial structure is also in basins (Zvolenská, Turčianska, Žilinská, Žiarska, Pliešovská, etc.) where the share of forest ecosystems does not exceed 30% of the total area.

3.2. Qualitative threat

From qualitative aspects, forest ecosystems are threatened by several abiotic, biotic and anthropogenic factors. Due to abiotic factors, first of all the harmful action of wind, snow, rime, and draught, 1335,9 thousand m³ of wood was damaged, while more than 85,6 % of damage was caused by wind, in 2013. Among the damaging biotic agents in forests, the spruce bark and wood boring insects lead, followed by the leaf-eating and sucking insects, putrefaction, tracheomycoses, and game. The most important biotic agent was the spruce bark beetle (*Ips typographus* L.) with more than 89% share in total wood matter attacked by insects. Spruce trees are the most affected species (99.6 %). 500 m³ of wood were damaged by leaf-eating and sucking insects (Ministry of Environment, 2014). Phytopatogenic organisms damaged 215,2 thousands m³ of wood, while the most important pathogenic factor was Honey fungus (*Armillaria mellea* (Vahl) P. Kumm).

Different pollutants can be included to the anthropogenic factors most by threatening forest ecosystems and also negative effects of logging often accompanied by changes in species composition. Emissions represent 73% of anthropogenic factors. They are produced by the industry, urbanisation, and transports but there are also chemicals from forestry and agriculture. Among the most important harmful substances at present are sulphur, nitrogen oxides carbon monoxide, carbohydrates, organic substances and dust particles.

The biggest producers of pollutants escaping to the air (primary pollution) in Slovakia are still energy, transports, metallurgical engineering, and chemical industries. The principal sources of pollution in the rural areas are the individual heating systems/hearths. In 2013 there were specified forest areas threatened by emissions with total area of 3358 ha (of which 82.8% conifers). The most loaded areas are around big industrial centres such as Bratislava, Košice – Prešov, Dolné Považie (Trnava, Sereď, Šaľa, Galanta, Nové Zámky), Horné Považie (Trenčín, Púchov, Považská Bystrica), Central Spiš (Krompachy, Spišská Nová Ves), Horná Nitra (Prievidza, Handlová, Partizánske), Pohronie (Žiar nad Hronom, Banská Bystrica, Zvolen), Zemplín (Vojany, Strážske, Vranov nad Topľou, Snina, Humenné), Žilinská Basin (Žilina), Turčianska Basin (Martin), Popradská Basin (Poprad) and etc.

The least damaged trees are beech, European hornbeam and spruce (*Fagus sylvatica* L., *Carpinus betulus* L., *Picea abies* L.). The most damaged tree species are oak, scotch pine and fir (*Quercus* sp., *Pinus sylvestris* L., *Abies alba* L.). The areas with the worst long-term forest health remain Kysuce, Orava and Spiš-Tatra area.

Random factors threatening the forest ecosystems are also fires (Turner et al., 2001). In 2013, 233 forest fires on the total area of 270 ha were recorded in Slovakia (Ministry of Environment, 2014). The most often reasons of fires in forests are the burning fires in nature, deliberately igniting by unknown persons, burning grass and vegetation in spring months.

In spite of the negative impact on forest ecosystems, significant area of valuable forest ecosystems still remained in the territory of Slovakia. Semi-natural forests make up approximately 40-45% of the total forest area. These forests are naturally regenerated and their species composition is only little different from the natural forests. Slovakia maintains more than 70 fragments of natural virgin forests.

In terms of the coefficient of naturalness of plant associations, low values have been also identified in regions with high level of forestation but these are secondary forests with markedly changed species composition: the Valley of the River Váh, the Upland of Turzovka, Beskydy Upland, Borská Lowland, Valley of the Upper Hron, Oravské Beskydy Mts., Kozie Chrbty Mts., Moravsko-Sliezske Beskydy Mts., etc.

More than a half of natural forest ecosystems was found in 13 REPGES, which are mostly located in mountainous and areas with difficult access such as those in the Veľká Fatra Mts. Kremnické Mts., Levočské Mts., Skorušinské Mts., Oravské Beskydy Mts. and partially also in the High Tatras and Low Tatras. Many of them contain biotopes of national and international importance.

4. Conclusions and discussion

Human society and global economy are inextricably linked to forests. More than 1 billion people [depend](#) on forests for their livelihoods. And forest ecosystems play a crucial role in stabilizing the climate; providing food, water, wood products, and vital medicines; and supporting much of the world's biodiversity. Despite decreased deforestation rates in some regions, forest ecosystems are still under great threat. According to [World Resource Institute Research](#), 30 percent of global forest cover has been cleared, while another 20 percent has been degraded. Most of the rest has been fragmented, leaving only [about 15 percent](#) intact (WRIR, 2015). Similarly, forests in Slovakia are constantly threatened by diverse factors, natural or anthropogenic. History has shown that human beings have often considered the forest as a space that must be cleared in order to develop activities other than forestry (particularly farming), and used, eventually beyond its capacity to regenerate itself, as a wood and forage resource (Lanly, 2003).

From this aspect, to forest ecosystems proper protection should be given. In all countries, the decisions have to be taken respecting all aspects of forest ecosystems importance, their sound utilization and management based on good knowledge of situation and of changes. It is important at the outset to carefully distinguish between the underlying causes of deforestation and forest degradation, about which there might be divergent views, and the actual factors, which could be part of the area of objective observation (Lanly, 2003). Considerable attention needs to be paid to assessment factors threatening ecosystems. The factors are either direct landscape (Bürgi et al., 2004; Jensen, 2000; Turner et al., 2001) -in the case the replacement of a forest area by a agricultural land, antropogenous areas, or indirect (Balej, 2004; Izakovičová and Oszlányi, 2013), as the impact of air pollution, climatic changes, etc.

Many of the world's forests and woodlands are still not managed sustainably. Some countries lack appropriate forest policies, legislation, institutional frameworks and incentives to promote sustainable forest management, while others may have inadequate funding and lack of technical capacity. Where the forest management plans exist, they are sometimes limited to ensuring the sustained production of wood, without paying attention to the many other products and services that forests offer. View to ensuring effective protection of forest ecosystems and their services, it is necessary to apply sustainable forest management. Sustainable forest management addresses forest degradation and deforestation while increasing direct benefits to people and to the environment. At the social level, sustainable forest management contributes to livelihoods, income generation and employment. At the environmental level, it contributes to important services such as carbon sequestration and water, soil and biodiversity conservation (FAO, 2014). In view of ensuring sustainable use of Slovak forest ecosystems is needed:

- To strengthen the protection of forest representative ecosystems, especially those with low spatial representation and which are classified as priority forest habitats of European importance.
- To develop programs for protected areas which include its forest ecosystems, complete zoning of national parks based on ekosozological principles.
- To resolve compensation to owners for property losses resulting from the limited use of forest ecosystems from the aspect of their protection needs.
- To revitalize the damaged forest ecosystems particularly in the region: Tatry, Veľká Fatra, Jelšava, Ľubeník, Vihorlat, Orava, Kysuce a pod.
- To prevent the destruction and degradation of riparian forests and other riparian vegetation, which are threatened by either direct drive due to the implementation of investment activities, as well as in consequence of indirect action, such as changing the hydrological regime, contamination of the environment etc.
- To create functional territorial system of ecological stability. The biocentres must be represented by all representative forest ecosystems of the regions, in case their absence it is necessary to complete them or to revitalize
- To implement technological measures focused on reducing the stress factors which negative endanger forest ecosystems (elimination of sources of pollution).
- To strengthen research of the impact assessment of climate changes on forest ecosystems and to realise to necessary measures

To complete or develop a complex and systematic monitoring system aimed to obtain information on the status of forest ecosystems.

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