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FOREST AND WATER MANAGEMENT IN MOUNTAIN WATERSHEDS

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Introduction

Territories located over 300 - 350 m above sea level are classified in Poland as mountainous areas. They are divided into foothills (300-500m) and mountains (over 500 m). Mountainous areas in Poland contribute 8.7% of the total land but mountains occupy only 3% of the total territory of Poland which is about 10 000 km². Polish mountains are located on the northern part of the Carpathian and Sudeten Mountains, extending about 700 km along the southern Polish border. They are of medium height - about 1500 m a.s.l with maximum 2500 m a.s.l (Rysy Peak). They cover about 950 000 ha in and have maximum elevation timber line about 1650 m a.s.l. with diversified climate, soil, vegetation and antropogenic impacts. Almost all area of Polish part of Sudeten and Carpathian mountains belong to Odra and Vistula river watersheds.

At present almost all mountain forests are under protection: from the passive protection in national parks and many nature reserves through the active protection to forests protecting soil, water and landscape. The most valuable natural or close to natural forests have been subject to protection in national parks, nature reserves, biosphere reserves, landscape parks and in areas of protected landscape. Nine of national parks have been established in Polish mountains. They cover about 102 000 ha and their forestage is estimated on 87%. Some of the nationally protected sites acquired also the international status.

In order to safeguard forest ecosystems under conditions of sustainable management nineteen so called Forest Promotional Complexes have been established and five of them are located in mountainous areas. These forest areas have specific ecological, educational and social importance in Poland.

Large mountain forest areas were included into the Natura 2000 network, between others mountain maple forests with high herbs, mountain maple forests on slopes and scree, mountain spruce forests.

The main problems of mountain watershed management are caused by biotic threats (insects, fungal diseases, damage caused by forest animals), abiotic factors (weather phenomena, water resources) and antropogenic activities (forest management, water management, industry).

Trends and threats to water, forests, soils, evidence of increasing hazards

At the end of the seventies last century symptoms of forest decline appeared in the Sudeten mountains. This process acquired the size of an ecological disaster, and its peak occurred at the beginning of the eighties. Acid rains were the main cause of the forest decline; they occurred due to air pollution from industrial, mainly from coal power plants, seated in this transborder region. They caused a weakening of forests, resulting in damage by pests. The widespread forest decline changed natural conditions of water circulation in mountain river and brook catchments. It influenced also on other processes linked with the surface water flow as e.g. intensification of erosion processes and changes in biogene compound cycles. In the years 1981-1997 the renewal over the extensive deforested areas covered about 160 km². This ecological catastrophe was an impulse to look for effective methods by which to preserve and protect endangered forest species and ecosystems. It has been decided to establish in 1995 the Forest Gene Bank in Kostrzyca (LBG) which safe the most valuable gene resources of forests through long-term storage of seeds in cold rooms in programmed temperature and humidity conditions. An integration part of LBG is an arboretum, being the collection of ligneous plants, on which research of great importance for forestry is carried out. To the others objectives of LBG belongs the catalogue forest ecosystems and plant stands in the Sudeten Mountain as well as promotion of environment protection and education.

The situation in the Carpathians was decisively more favourable than that in the Sudeten, especially because of the lower level of pollution and more fertile forest sites. However the process of forest decline since a few years became as a seriously one, specially in the Silesian Beskid which belongs to the western Carpathians. The main reasons of this forest decline are:

- Air pollution
Within the last decade a distinct decrease in air pollution level in the Silesian Beskid is observed due to improvement of technology and emission control, but existing level of wet and dry deposition on this area is still significant for functions of forest ecosystems.
- Changes of climatic conditions
Poland is located in the temperate zone with a climate characterised as quite variable in time and space. The climatic data from individual years demonstrate large deviation from the average long-term value, which contributes to occurrence of weather anomalies. The average temperatures increased by around one degree, and precipitation decreased by some 100 mm in the last 50 years. Changes of distributions of rainfalls and temperature during the year have important influence among others for water balance and the same for features of water run of forest watersheds. Climate changes with anomalous weather conditions resulted between others in floods, soil erosion, landslides as well as destruction of many species and ecosystems.
- Silviculture in the past
In the Carpathians species composition of the forests significantly differs from the primeval (natural) because of centuries of improper management (monoculture plantations, lack of natural tree regeneration, and the type of cutting system), for e.g. the coniferous sites occupy only about 3% but the average percentage of coniferous stands reaches almost 64% of forest area. Lack of conformity of stands and forest sites has negative influence on vitality of trees, susceptibility to insects, fungi, wind and health of plants communities.
- Insects and fungi
Presently the main typical species of insects in mountain forests in Poland are: *Ips typographus*, *Ips amitinus*, *Polygraphus poligraphus*, *Pityogenes chalcographus*, *Lymantria monacha*, *Pristiphora abietina*, *Zeiraphera diniana* and *Cephalcia* sp. *Heterobasidion*

annosus and Armillaria sp. are the most dangerous pathogens causing disease of the root system.

Projects to address to threats and trends in forest mountain watersheds

There are a few projects which objective is general protection of mountain environment as well as the mitigation of influence climate change on forest and water management in mountain watersheds:

- **National Programme for the Expansion of Forest Cover**
According to this program the country's forest cover will increase from presently 29 % to 33% by 2050. An important area for an increase in forest cover is constituted by the Sudeten and Carpathian Natural Regions which are characterised by relief and structure unwanted to agriculture as well as by vitally important function of forestry. Particularly intensive planting of the landscape is called for in areas with the greatest air pollution (such as the mountain voivodeships of Katowice, Kraków, Wrocław). The regulation of agricultural boundaries is also of great significance in the area. Account should be taken of local relief, as well as of the need to preserve meadows and pastures as traditional and ecologically-sound elements of the landscape.
- **Natura 2000 in forests**
Implementation of the Natura 2000 network which will cover about one fifth of the Polish forests (1880 thousands hectares) is going without bigger problems. There is no essential contradiction between the multifunctional forestry model of management which prevails in the Polish forestry and the concept of the Natura 2000 network.
- **Infrastructure and Environment Operational Programme**
The variation in time and space of main climate factors (temperature and precipitation) causes in Poland different weather phenomena. One of them is drought causing degradation of ecosystems, an increase of forests fire risk and the drying up of wells, ponds, torrents etc. On the other hand, sudden thaws and downfalls occur causing periodical water excess and dangerous floods. Mitigation of such phenomena is possible by integrated watershed management. In Poland since 2007 is under execution "The Infrastructure and Environment Operational Programme (IEOP)" which was approved by the European Commission for the period 2007–2013. One of the priority of this programme is "Resource management and prevention of environmental risks". The overall objective of this priority axis is to provide appropriate quantities of water resources to satisfy both the needs of the public and the demand of the national economy, minimize any negative effects of natural disasters and serious accidents, ensure good status of coastal waters, as well as strengthen the decision making processes by provision of reliable information on the state of the environment, as acquired under environmental monitoring system.

Specific objectives of the this priority axis are to:

- expand the quantity of disposable resources required to satisfy the needs of the public and the demands of the national economy, and enhance the flood control rate and that of counteracting the drought effects,
- expand natural retention in river valleys with preservation of their good ecological status,
- enhance the protection against natural risk impacts and counteract serious accidents, remove the effects thereof and restore the environment to its adequate status, and strengthen selected components of environmental management system,
- improve both the environmental monitoring system and the access to environmental information with the aim of strengthening the environmental decision making processes.

The State Forest General Directorate since 2006 is working on execution, in the frame of IEOP, two projects for lowland and for mountain forest. Aim of project for lowland forests is increasing of water resources by small retention measures like reservoir, regulation of outflow and restoration of wetlands.

Objectives of the second one titled “Mitigation of water erosion in mountainous areas and maintenance of torrents and connected infrastructure in good state” are increasing of water resources as well as protection against erosion and floods in mountain forests watersheds. It is planning to built 129 ponds, protection of slopes areas against surface water erosion (53 km of skidding paths and conservation of 173 km of torrents against bank and bed erosion. Total cost of this project is about 35 mln Euro.

Research results, experiences and case studies

There were carried out a lot of research in mountain areas specially in the threats areas. Many-years investigation on hydrological and erosion processes in experimental torrent catchments areas in Sudeten and Carpathians are carrying by Forest Research Institute. The results showed significant influence of forest decline and forest restoration on water cycle in mountain watersheds. As the research on water circulation in a spruce ecosystem shows out, the greatest impact of the vegetation in the vegetative period is linked with the requirements of stands for water, and it is connected with interception and evapotranspiration. In autumn-winter months this relation is connected with the water income from fog deposits and with water resources in soils and in forest litter. The forest relationships in water circulation are accompanied with a distinct impact of the forest on the nutrient balance of tree stands. The increased productivity of forest sites influence on the enhancement of the biological life and nitrogen ion concentrations what increasing of soil moisture and of water retention capabilities of the catchment.

Also nutrient cycling in artificial mountain spruce stands as a background for conversion and sites degradation in the Silesian Beskid was investigated last few years. This problem is connected with the conversion of artificial spruce stands on non adequate sites, because it is only one way for multifunctional management of forest ecosystems on this region. The results showed differences in concentrations of determined water features between the watersheds and differences of the dynamics of seasonal changeability by type of watershed and stand health. Authors of these research stated that in conditions of Silesian Beskid one of the many reasons of bad forest health is leaching of nutrients from the canopy, soil and finally from watersheds

Policy attention and adaptation strategies

The general legal bases for water and forest management in Poland are included in the *Water Law (2001)* and *Forest Act (1991)*. Also other legal acts refer to the provisions of this laws, including the *Environmental Protection Law Act (2001)*. References to sustainable water forests and forest management are also made in the *General Manager of the State Forests’ Ordinance No. 11 on Ecology-based Forest Management Improvement (1995)*, as well as in the *Principles of Silviculture (2000)* and *Forest Management Instruction (2003)*.

One of the important events in Poland in the period 2006-2008 was establishing in 2006 of the National Water Management Authority as well as elaboration of new national strategy of water management which should soon be accepted.

It should be also underline the contribution of Poland into preparation in the frame of Ministerial Conference on Protection of Forest in Europe which have been adopted in November 2007 at Warsaw.