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Forestry, mountain catchments and floods in the Czech Republic

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ABSTRACT: A short introduction of historical overview and current situation refer to forestry problems of the country. Local climate is characterized and impacts of natural phenomena are described, as well as the impacts of human beings. The influence of forest management is mentioned and discussed in relation to latest catastrophic floods. The territory of the Czech Republic is damaged especially by a high intensity of atmospheric precipitation abnormal values which lead to a local or regional damage. In the catchment areas of torrents, damage leads to faster soil erosion, development of ravines, landslides, moving of soil sediments and their deposition, devastation of watercourse beds and properties, flooding while the flooding rates of flow represent a danger for the life of inhabitants. Important elements and results of respective research are described in brief. E.g. research of precipitation and its relation to the runoffs in the small mountain catchment areas with the forest stands restoration, as well as the forestry-hydrologic monitoring of forest environment, which has been taking place since 1928, and tradition of the service for torrent control. Forestry-hydrologic research gradually documents that a favorable flood-control performance of forest is limited. However, this is not a reason for not taking care of flood-control measures in the mountain afforested areas. These measures and importance of forest for the protection of land are historically verified and justified. In closing the mankind behavior to the landscape is underlined as a question mark.

Keywords: forestry; erosion; precipitation; floods; hydrology

The Czech Republic is a country located in the central part of Europe. A prominent feature of its climate is a mutual penetration and mixing of oceanic and continental influences. A prevailing occurrence of a western wind is typical and intensive cyclonal activity is caused by a frequent change of air mass with a relatively frequent precipitation.

The area of the Czech Republic is 78,866 km^2, of which 25,222 km^2 (32%) is located at the altitude from 500 m to 1,000 m and only 827 km^2 (1%) above 1,000 m. The area of forest land is 26,370 km^2, which represents 33.4%.

In the Czech Republic, the hydrographic network is precisely delimited in the system of demarcated watercourse catchment areas (BĚLSKÝ et al. 2003). There is total 76,000 km of water courses of which approximately 15,300 km are important from the water management point of view and about 60,700 km of other small water courses. Each such water course has, defined by the law, a professional administration with the defined obligations ensured by a concrete administrator. A state enterprise Forests of the Czech Republic is one of the three important administrators while it manages approximately 20,000 km of small water courses – torrents those catchments are predominantly forested. They are located mostly in the mountains and thus forestry activities are closely associated with the erosion-control and flood-control activities and measures.

Since the year 1884 up to now, there were regulated approximately 1,300 km of torrents including the ravines. Important regulations were performed till the year 1940, so they allowed a permanent development of the mountainous areas and their use.

The territory of the Czech Republic is damaged especially by a high intensity atmospheric precipitation of an irregular occurrence. Its abnormal values lead to a local or regional damage. In the catchment areas of torrents, damage leads to faster soil erosion, development of ravines, landslides, moving of soil sediments and their depositing, devastation of watercourse beds and properties, flooding while the flooding rates of flow represent a danger for the inhabitant's life. The occurrence of avalanches or rock falling, which represents a local natural phenomenon, is quite extraordinary in the Czech Republic.

Management of mountain catchment areas

Mountain forests are located in border areas of the country. Since the Middle Ages the usage of these forests has its typical development. Originally it was the game management interests, pasture and production of grass because of the developing farming, later the aimed interest of the wood production as firewood and for mining, iron industry or glass industry needs. The beginnings of the intentional management in these areas could have been seen only since the beginning of 19th century. Also, a concentrated harvesting – clear cutting – started to be used. With regard to the level of forestry in those days only natural regeneration has been used in reforestation.

A change in the forestry management occurred only by publishing of the Forest Act in 1852 that regulated also the procedures for harvesting and reforestation of mountain forests or forests on steep slopes. Consequently, there appeared also the first forest stands as a forest with a special purpose – a protected forest. It had, together with the increase of artificial afforestation, a positive impact on keeping and going up of the upper tree line.

Afforestation was performed also from the reason of erosion-control protection of soil on the turn of 19th and 20th centuries. The flooding-control protection represents another reason after a disaster precipitation at the end of 19th century. This afforestation was performed in the public interest and was significantly supported by the state.

Forestry management procedures changed significantly tree species composition and space structure of forest stands. Fir-beech forests prevailed in mountainous forests of the 17th century, while spruce only on mountainous ridges. Norway spruce became a prevailing tree species on the turn of 19th and 20th centuries. However, it still meant mixed plantations of spruce, fir, beech, and pine as well as of oak. In the 20th century, spruce was continuing to get even larger area on the account of beech and fir. A result of this development, having been taken place for three centuries, there are spruce monocultures – mostly artificially established plantations. Vast spruce plantations are, however, endangered by wind, snow, insect pests and, after the World War II in a visible manner, also by the air pollution – but this problem began much sooner. Mostly northern part of the country was damaged and Norway spruce stands disrupted by the calamities were, in 70ies, replaced by so-called substitute tree species. There is assumed a gradual restoration of so called "transitory stands of substitute species", when spruce is the main tree species of the natural species composition of the mountainous forests at its 60% target share. Concerning unsatisfactory forest condition, too high number of the ungulate deer must not be omitted.

Currently, in accordance with site type survey, a required proportion of soil-improving and reinforcing tree species (particularly broadleaved and fir) is planned in regeneration, not to repeat the errors from the past when predominantly spruce monocultures were established.

Forest research related to hydric functions of forests

The research on hydrologic forests functions is a part of the complex of the ecological research on forest ecosystems. At numerous research plots, some partial elements of the water balance of forest stands (throughfall, depositions, soil water, water chemistry) have been observed with regard to the monitoring and research on the anthropogenic influence on forests (notably the impact of industrial air pollution). At several experimental watersheds, the precipitation-runoff course has been monitored in a complex way. This research already started in 1928. Since 1953 until now the continuous measurements and evaluation of the precipitation-runoff course has been carried out at two experimental watersheds in northern Moravia (BÍBA, JAŘABÁČ 2003). At the same time, the mensurational characteristics of forest stands were changed on purpose there (accelerated regeneration using clear-cutting system) and consequences have been monitored.

The results have documented complexity of processes of the precipitation-runoff course creation so far (BÍBA et al. 2004). In common conditions, it is not possible to regulate the resulting runoff directly and effectively, simply by changing some of a few parameters that can be influenced by man. Besides quantity and the time distribution of precipitation and the terrain geomorphology, which cannot be influenced, the dynamics of ground vegetation (including clear-cut stages) and other factors connected with stand growth dynamics play a significant role. These factors have eventually stronger impact on hydric functions than the change of some mensurational forest stand characteristics themselves.

The retention capacity of forest soils is also quite naturally limited (effectively in the range from 20 to 50 mm of precipitation in accordance with the saturation of forest ecosystem with water and in accordance with the thickness of soil layer). Thus forest stands have a decisive role, from the run-off transformation point of view, in particular during the usual precipitation sums. However, during the extreme precipitations the retention ability of forest stands is very limited (KANTOR, ŠACH 2003). Under these conditions technical and bio-technical measurements for safe and harmless drainage of the concentrated precipitation become important. These measurements include i.a. the appropriate care of streamside stands. Generally, there is a very high quality of water running off forested catchments (LOCHMAN et al. 2002).

From the point of view of the balanced fulfillment of all forest functions and demands made on forests, particularly those that are connected with their hydric function, the long-term stability and resistance of forest ecosystems are the most important factors. Consequently, the optimal approach seems to be the effort for species and spatial diversity of forest stands, promotion and usage of site-suitable tree species and shift to refined methods of management practices. It is reflected by a trend of a return to the close-to-nature forest management, which is currently more and more preferred – not only in principles of state forestry policy but also in forestry practice. It is taken into account also by Forests of the Czech Republic, State Enterprise – the largest forest estate manager in the country.

Forestry-hydrologic research has, up to date, provided background materials, that there is not taking place any provable change in the runoff despite the situation when reforestation is speeded-up. It means when felled mature stands are replaced by the cultures and young stands of the first age class in comparison with catchments where a high share of the higher age classes stands is maintained and only a sanitary cutting is performed. Different ways of management, i.e. methods of clear felling and, on the contrary, sensitive treatment does not prove any impact on runoff from the precipitations.

The research in a concrete catchment has provided results that after the complete exchange of main economic "timber tree species", there is a certain change of water runoff from the catchment area. Particularly during the precipitation-rich periods it can be higher when e.g. spruce is planted instead of beech (but it should not be a recommendation!).

Damages by flooding

Damages in regional scale are caused by natural phenomena of an extraordinary scope when particularly transportation possibilities, public transport services, housing, supplying inhabitants, water and energy distribution are disturbed. Damages of this character and scope are a consequence of natural disasters and the course of flooding. In the catchment areas of water courses – torrents, that are associated with forestry management, such developments occurred for the first time in March 1845 in the catchment area of the lower Labe River and lastly nearly in the territory of the whole country in August 2002.

Disaster flooding situations occurred explicitly in the mountainous areas of the territory of the Czech Republic in 1883, 1897, 1903, 1997 and 1998. The other occurred in the spring parts of watercourses, up to the altitude of approximately 600 m. In all cases, consequent impacts were visible along the rivers and in their beds.

The direct damage of 1997 flooding on forests were calculated at the value of 1.5 billion CZK (48,364 mill. USD). The flooding in 1998 caused damage in forestry at the value of 106 million CZK (3,418,000 USD). Unfortunately it seems that 2002 floods overcome everything what ever happened before (BĚLSKÝ et al. 2003).

The assessment of collected and evaluated data of the last flooding situations allows finding out real and critical reasons for the origin of the extraordinary disasters. It is a huge amount of precipitation that is prominent by the fact, that the mountainous catchment areas of the Czech Republic are located in the temperate climatic zone. A daily sum of precipitation here, with a rate of repetition once every one hundred years reaches 160 mm, while this value is exceeded in the course of disasters. Over-saturation of the catchment areas originated from a very substantial precipitation in a short period of time has a direct impact on the origin of disasters.

Forest environment is a dynamic system those elements has influence only within the natural boundaries. Soaking ability of forest soil, keeping waters in soil and runoffs delaying have limited possibilities with regard to time. Hydrologic measurements of occurrence, volume and culmination of damaging flooding waves have still not clearly proved relations between the disturbed forest stands, air pollution and increase in the flooding damage. Forestry-hydrologic research gradually documents that a favorable flood-control performance of forest is limited. If there is created a critically intensive rain, in addition, covering a large area, then the consequences are a result of nature.

However, this must not be a reason for not taking care of flood-control measures in the mountainous forested areas, rich for precipitation. Erosion-control measures and importance of forest for the protection of soil on the mountainous slopes are unambiguously historically verified and justified.

Secondary damages in lowland areas are usually of anthropogenic origin due to non-respecting experiences, knowledge gained and sometimes also respective legislation. Also disregarding of preventive measures in relation to lack of funds can be mentioned.

If there occurs a disturbance of the basic use of territory for the activities existing before the disaster, it is only a possibility of the state to provide assistance during the restoration of the area.

A forecast service is used just only for the extreme flooding situations. There can be created a forecast for the areas at the lower parts of rivers in accordance with the news on the facts how, in the upper part of a water course, water levels are changing depending on the precipitation occurred. However, such solution cannot be used in the mountainous terrain for a fast occurrence of a high precipitation, fast runoff from the catchment area. Such catchment areas are not, in the majority of cases, monitored and a measurement of precipitation is not performed in them. Such phenomena in the mountainous catchment areas are subject to the principles of precautionary measures with the stabilization of the originated sediments at the place of their origin and a safe deflecting of flooding waters. For this purpose, there was established a service of torrent control in 1884 and this has been, in the Czech Lands, performed continuously till present.

In the mountainous catchment areas, there are more frequently occurring local flooding situations repeated also in less than 10 years. Unfortunately, not only for the regional flooding situations, but also for the local flooding situations, there has not been paid attention to the institutions ensuring flood-control protection of inhabitants and the territory. A result of this situation is that their owners recklessly situated recreational, but also housing facilities situated against the effects of flooding and erosion phenomena. On the contrary, after the disaster flooding situations, a non-professional public is negatively evaluating constructions built in the favor of public.

A state service body for flood-control protection of the mountainous catchment areas of watercourses has been already for 120 years the service for torrent control. The state is mostly the owner of forestland there. But state influences by the direct relations of the forest management (in accordance with forest management plans), also the other forms of ownership. It is done, in particular, for the maintenance of quality of forests through the sustainable forest management and consequently also for the maintenance of water quality in the country.

Needs for the future

Since the mid of the last century, the torrent control service was frequently transformed and prevention and measures in the upper parts of the catchment areas were not performed. Responsibility of torrent control were included into the new Forest Act (1996), however, financing of these

measures stayed completely dependent on the state budget possibilities and prevention from damages and erosion is not insufficient yet. Besides the legal changes regarding torrent and ravine control and protection of their catchment areas the Czech Technical Standard ČSN 75 2106 *Torrent and ravine control* was issued in 1998. However, in relation to the Directive 2000/60/EC it is still necessary to adjust gradually the respective Czech legislation.

The organization stability and procurement of the torrent control service, a precise definition of its tasks and obligations, shared financing measures, are in the interest of the state when ensuring flood-control protection of inhabitants and territory. It is necessary to reach again the level that was proved to be efficient in the past in the Czech Lands. An inclusion of respective measures into the legal regulations is an important topic as well.

Also improvement of awareness on general forestry issues, including forests important role in watershed management, and stressing the cross-sectoral responsibility for forests should be taken into account. Last but not the least, facing to the latest floods, it will be necessary to take notice of the landscape and to respect nature laws and phenomenon, as flooding are part of it. We must understand the landscape as a "multifunctional space", both in rural areas and towns, with an important functions including ability to respond for intensive rainfalls. But more attention, political and particularly financial, is necessary to pay in the mid-term horizon to the systematic and reasoned out measurements. It does not mean any new specific investments against floods and their effects but adaptation of all economic activities in the landscape respecting i.a. possible occurrence of floods. And last but not the least, a national debate on sustainable forest management has to include also a sustainable watershed management and respective research. The National Forest Programme, just prepared, gives the opportunity to do so.

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Lesnictví, horská povodí a povodně v České republice

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ABSTRAKT: Příspěvek obsahuje krátký historický přehled a nástin současné situace týkající se lesnických problémů země. Charakterizuje místní klima a popisuje dopady přírodních činitelů včetně vlivu lidské populace. Je diskutován vliv lesního hospodářství a jeho vztah k posledním katastrofickým povodním. Území České republiky je zvláště poškozováno intenzivními abnormálními atmosférickými srážkami, které způsobují místní nebo oblastní škody. V povodí potoků vyúsťují škody v rychlejší půdní erozi, ve vznik rozsedlin, půdní sesuvy, pohyb půdního sedimentu a jeho depozici, v devastaci říčních koryt a majetku a v zátopy, jejichž prudkost ohrožuje život obyvatel. Jsou stručně popsány důležité složky a výsledky příslušného výzkumu – např. výzkum srážek a jejich vztah k odtoku v malých horských povodích s obnovenými lesními porosty, lesnicko-hydrologický monitoring lesa, který se provádí od roku 1928, a tradiční úprava potoků. Lesnicko-hydrologický výzkum postupně dokazuje, že příznivý vliv lesů na zabránění povodní je omezený. Není to však důvodem pro to, aby se přestala budovat opatření v horských zalesněných oblastech pro zabránění povodním. Tato opatření a význam lesa pro ochranu půdy jsou historicky ověřeny a ospravedlněny. V závěru se kritizuje chování lidstva ke krajině.

Klíčová slova: lesní hospodářství; eroze; srážky; povodně; hydrologie

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