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GALE DISASTERS IN SLOVAKIA: CONSEQUENCES AND MANAGEMENT IMPLICATIONS

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Abstract

Gale disasters have an increasing tendency at the territory of Slovakia because of global climatic changes and a mean annual volume of 1 milion cubic metres of windthrow timber is prognosed in the future. AT the same time, periods of severe gale disasters are shortening and the volume of damaged timber is increasing. During the last decade, there were two severe gale disasters in Slovakia. In July 1996 and in June 1999 the severe gale disasters damaged 1.7 milions of cubic metres of timber in spruce mountain forests of the Slovenské Rudohorie Mts. (central Slovakia) and 1 milion of cubic metres of timber in beech and oak uplands forests in the southern and central part of Slovakia (Pohronský Inovec Mts., Tribeč Mts., Štiavnické vrchy Mts.), respectively. Soil erosion (mostly on steep slopes with limestone parent rock), mass weed infestation of gale-disaster areas, desintegration of forest stand walls due to wind as well as attack of aggressive bark beetles, and outbreaks of insect pests are the main consequences of gale disasters in Slovakia. There is a need for reforestation of large clearings (about 2600 ha in 1996 and 1700 ha in 1999) what is complicated by weed infestation, periods of drought considerably decreasing transplants establishment, as well as by game damages. Moreover, shortening of periods between severe gale disasters and increasing volume of windthrow timber cause problems in management of forests within a gale-disaster area due to increasing financial costs on elimination of gale-disaster effects and delaying planned tending and regeneration fellings with all the negative effects.

Wind as the most important injurious agent

Though health status of forests has been stabilized in Slovakia during the last ten years, it is still below the European average mainly because of poor health status of conifers. Global climatic changes and unfavourable health status of forests generate conditions for a permanent activity of injurious agents. Salvage-logged volume does not decrease below 40% for a long time, and from 1970 till 2000 was increasing from 14.5% to 49.2% although in 2001 and 2002 it decreased to 39.5% and 35.1%, respectively. During last 20 years windthrow damages played an important part in a total volume of salvage felling (41%).

Wind plays an important role in environment and it significantly affects also forest ecosystems. Strong wind damages trees, it breaks crowns, trunks or branches, it uproots trees and it deforms shape of crowns and trunks through a long-lasting effect. Gale disasters, mostly windbreaks and/or windfalls often at large areas, represent the most serious negative effect of wind on forest ecosystems. An occurrence of gale disasters has an increasing tendency in Slovakia and a mean annual volume of 1 million of cubic metres of windthrow timber is prognosed in the following decade (Konôpka 1997).

While mainly spruce forests have been damaged by wind before 1910, from 1910 forests with fir were damaged as well and at present wind damages appear also in beech forests. The analysis showed that severe gale disasters have been appearing every 15-18 years before 1910, from 1910 till 1950 every 12-15 years and from 1950 every 5-9 years. Gale disasters reached the highest intensity in Slovakia in 1961-1985 when altogether 21.5

millions of cubic metres of windthrow timber were treated with a mean interval of 3-4 years and with a peak in 1967 when strong wind in November damaged more than 4.5 millions of cubic metres of timber mainly in spruce forests. From 1985 wind damages start to appear also in beech forests and at present damages due to wind in these forests have reached a calamitous character. Periods between gale disasters are shortening and an extent of wind damages is increasing (Kodrík 2000).

The latest severe gale disasters in Slovakia

There were two severe gale disasters in Slovakia during 1990-2000. The first one has arisen in July 1996 when the extremely strong windstorm with a speed of over 200 km/hour damaged 1.7 millions of cubic metres of timber in spruce mountain forests of the Slovenské Rudohorie Mts. (central Slovakia). The windstorm destroyed relatively stable premature and mature spruce forest stands with fir and broadleaved trees during 12 minutes. Localization of damages varied considerably – somewhere from a valley up to a ridge, elsewhere from or to the half of slopes, and somewhere through the middle part of a slope. Altogether 2600 ha of clearings have originated (Fig. 1, Tab. 1). Since mainly forests with a predominance of spruce were damaged, the risk of an aggressive spruce bark beetles (*Ips typographus*, *Pityogenes chalcographus*) mass outbreak was high. This problem was coped successfully and the bark beetles outbreak was supressed thanks to a massive and effective use of pheromone-baited traps (Tab. 1) as well as to the sanitation of timber suitable for bark beetles development.

Stormy weather with strong wind caused also arising the second gale disaster in June 1999 when the windstorm following after long-lasting heavy rains has destroyed about 1 million of cubic metres of timber in beech and oak uplands forests in the southern and central Slovakia (Pohronský Inovec Mts., Tribeč Mts., Štiavnické vrchy Mts.). The windstorm destroying during a night premature and mature broadleaved forest stands mostly on valley slopes and ridges. Fully leaved trees growing on drenched, humic soils were unable to resist the strong wind. Altogether 1700 ha of clearings have originated (Fig. 2). Since the beech windthrown timber was highly predominanting (80%), there was no reason to expect a mass outbreak of insect pests. However, there was real threat of destroying beech timber due to wood steaming. For a comparison, In Slovakia, there is a total timber supply of 415.6 millions of cubic metres at a area of 1.9 millions of ha with an annual calculated cut of about 5.5 millions of cubic metres of timber.

Time of appearing these two severe gale disasters was atypical (July and June, respectively). According to Stolina et al (1985), summer windstorms are rare in central Europe and do not cause high damages to forests. Increasing frequency of summer windstorms indicates that the last decade of the 20th century was already influenced by changes in a climatic situation which leads to changes of weather in central Europe related to the uncommon occurrence of injurious meteorological events. It is caused by the so-called European monsoon in June and July which is characterised by a period of rainy and colder weather with a temporary change of atmospheric circulation in a cyclone likewise in typically monsoon areas of the world (Lapin et al 1994). Moreover, orographic configuration in Slovakia regulates a local occurrence and intensity of windstorms caused by the summer monsoon. Changes of circulatory conditions in central Europe are probably related to the greenhouse effect and atmospheric warming. As a result of this, the phenomenon of summer cyclones will take an important part in forest damages in future.

Fig. 1: Gale-disaster area in spruce forests with fir and broadleaved trees in surroundings of the village Osrblie (Slovenské Rudohorie Mts.) - situation in 1996 (above) and after seven years (bellow)

Fig. 2: Gale-disaster area in oak-beech forests of the Štiavnické vrchy Mts. - situation in 2003.

Management and economic consequences of gale disasters

Shortening of periods between severe gale disasters cause continual operating troubles with processing windthrown timber mainly because of work concentration as well as delaying planned tending and regeneration fellings in undamaged forest stands. Direct economic losses due to gale disasters have been related mainly to the premature liquidation of forest stands before achieving felling maturity, worsening physical, mechanical and qualitative properties of wood as well as decreasing wood yield due to mechanical damage to wood, increasing costs of logging operations and skinning, decreasing quality of wood due to infestation by insects and fungi as well as to disturbing a planned system of felling and silvicultural operations, plantation establishment and timber trade including decreasing price of wood due to its surplus.

Reforestation of clearings

Reforestation of gale-disaster areas was realized mostly using artificial regeneration (Fig. 3, Tab. 1) which was complicated by a great extent of reforestation at large areas as well as by a lack of transplants. Because of this, the number of transplants per hectare was decreased. Very good results have been achieving by using container-grown and balled transplants. Percentage of natural regeneration at clearings was relatively high, especially in the vicinity of forest stand walls where spruce, ash, maple but also oak and beech regenerated naturally. Percentage of natural regeneration decreased toward a clearing centre. On the other hand, clearings have been occupied by natural seeding of pioneer trees (e.g., hazel, aspen, birch, rowan, willow) which has been growing up successfully and which excepting positive effects (e.g., browsing trees for game, maintenance of suitable microclimatic conditions) represented also a severe competition for growing-up transplants or seedlings of commercial tree species.

Fig. 3: A comparison of the same plot situated near Osrblie in 1996 (above) and 2003 (bellow) - the clearing was reforestated artificially but there was also an abundant natural seeding of pioneer trees

Tab. 1. Some data on the gale-disaster area in the forest district Osrblie which was the most damaged area in July 1996

Forest district Osrblie	**4200 ha**	**annual felling volume: 20 000 m^3**
Gale-disaster area (ha)	917	
premature forest stands	657,5 (71,7 %)	
mature forest stands	259,5 (28,3 %)	
Windthrown timber (m^3)	372 335	
tree species conifers	294 729	spruce 220 432 (59 %)
		fir 71 364 (19 %)
broadleaves	77 606	beech 69 049 (18%)
		other trees (pine, larch,
		maple,ash) 11 490 (4 %)
Reforestation (number of seedlings)	spruce	1 112 000 37 %
	fir	223 000 7 %
	larch	246 000 8 %
	beech	1 104 000 37 %
	maple	284 000 10 %
	pine	28 000 1 %
	alder	1 000
	TOTAL	2 998 000
Natural regeneration (ha)		247 27 %
Reforestation loss (ha)	TOTAL	114 12 %
	- drought	
	- extremly poor, rocky and shallow sites	
	- weed	
Hardly reforestated sites (ha)		134 14 %
Protection of young forest stands since 1997 to 2002 (ha)	weeding	1552 average (ha/year) 259
	game	910 average (ha/year) 152
	bark beetles	
	Ips typographus	1997 pheromone traps
		catched beetles 18 490 000
	Pityogenes chalcographus	511 pheromone traps
		catched beetles 61 999 000
Young growth tending	cutting of weed trees	330 ha

Sowing was used for reforestation as well. It proved useful for spruce but it was not successfull in beech mainly because of damages to beech nuts caused by small rodents which were overcrowded at clearings perhaps as a result of a lack of predators. Drought caused by extremely high temperatures and by a lack of water mainly during the spring and summer of 2000 was another cause of increasing transplant mortality, especially in beech.

Problems

Mass weed infestation of clearings, especially on fertile sites, represented a serious problem. Brambles and blackberries but also other forbs and graminoids competed strongly with seedlings and transplants for a space, nutrients, water, and light. However, weed was helpful for growing seedlings and transplants while it did not overgrown them because it maintained suitable microclimatic conditions especially during a drought period.

Protection of clearings especially on steep slopes with the limestone parent rock against soil erosion was another specific problem. Piling brushwood into lines along contours proved

to be a suitable method. Special attention was paid to skidding tracks where the danger of soil erosion was extremely high.

Hoofed game caused significant damages of transplants although damages were scattered over large areas. A winter stock mainly of red deers exceeds highly the standard game stock what resulted in damaging plantations. An individual selective protection of transplants using mechanical control and repellents was preferred against a whole-area protection. The Forest Research Institute has tested experimentally also using smell deterrents, especially at large clearings where the individual or whole-area protection of plantations are impossible.

Fig. 4: Desintegration of stand walls in an oak-beech forest due to oak dieback (Štiavnické vrchy Mts.)

Desintegration of forest stand walls along gale-disaster areas, especially in spruce forests, is a serious problem. While the desintegration of forest stand walls due to wind and bark beetles is proceeding at smaller clearings, it were stopped at larger clearings for this time perhaps also because of an intensive use of pheromone traps. However, there is still high risk of forest stand walls desintegration owing to a disadvantageous slenderness ratio of trees, low adaptation of trees to ecological conditions at stand walls, and increasing frequency of climatic extremes (e.g., droughts, windstorms). On the other hand, increasing mass dieback of oaks due to tracheomycosis as well as permanently increasing population level of the European oak bark beetle (*Scolytus intricatus*) were found in stand walls of oak forests affected by the gale disaster (Fig. 4).

Pine weevils (*Hylobius* sp.) and black beetles (*Hylastes* sp.) have been overcrowded locally and caused severe damages to coniferous plantations. They damaged up to 56% of spruce plantations examined and more than 50% of transplants was damaged in 11% of plantations. From other insect pests, adelgids (Adelgidae) caused damages to seedlings and transplants of the fir (*Dreyfusia nordmannianae*) and the larch (*Sacchiphantes viridis* and *Adelges laricis*). Special attention was paid to the sanitation of logging residues at clearings which have an important role for aggressive bark beetle (*Ips typographus*, *Pityogenes chalcographus*, *Pityokteines* sp.) surviving and development.

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