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WIND RISK

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➢ Forest Management and Storms in the EU

1. Challenges for Forest Management in the EU

The forests of the EU exceed an area of 161 million hectares and in total make up 4 % of the worldwide forest. These 161 million hectares correspond 38 % of the total area of the EU but are inadequately distributed. From 1990 until the year 2000 the total area of forests in the EU increased by about eleven million hectares due to both natural development as well as reforestation measures. Unfortunately, the EU does not dispose a common forestry policy and also there is no official common definition of the term 'forest'. Nevertheless, for EU-wide statistics it is determined that 'forests are territories, whose area amounts more than 0.5 hectares, whereof at least 10 % have a canopy cover and in which trees are able to reach a height of at least five meters' (cf. Website European Parliament 2016).

In the EU there are many different forest types, reflecting the EU's geo-climatic diversity. Although the distribution of the different forest types depends on climatic conditions, soil types, altitude and topography, all types have in common that 88 % of their area are shaped by man. Only 4 % of the EU's forest area has never been formed by human interventions. Therefore, it is little surprising that 134 of the 161 million hectares of forested area are used for timer production. Timber is widely used for energy generation (42 % of the EU's timber volume) but also for paper and panel industry. In total the forestry sector accounts for approximately 1 % of the EU's gross domestic product (GDP) and plays a great economic role, especially in rural areas. It is estimated that about 2,6 million people in the EU work in the forestry sector.

Besides their economical role, forests in the EU are also of great importance regarding the environment. "[T]hey help protect the soil (against erosion), form part of the water cycle, and regulate the local climate (mainly via evapotranspiration) and the global climate (in particular by storing carbon). They also protect biodiversity, by providing a habitat for numerous species." But forests in the EU are threatened by various factors. Regarding abiotic factors, threats include (wild)fires , atmospheric pollution due to emission, drought and especially storms. During the last 60 years, two storms a year have hit EU forests on average and caused significant damage. Furthermore, about 6 % of the forested areas in the EU are, on top, affected by biotic threats like insects or diseases. (Cf. Website European Parliament 2016)

With continuing climate change, the threats to Europe's forests are becoming even more severe. "Climate change is likely to affect the forests' rate of growth, their range, the range of certain parasites, and even the frequency and intensity of extreme weather events." (Website European Parliament 2016) It is therefore the aim of the Wind Risk Prevention Project to give recommendations concerning forest management in the EU with a focus on adaptation to storms. Detailed recommendations can be found in Wind Risk Prevention Project Report D.5.

1.1 Risk Factors for Forests towards Storms

Storms can cause both direct and indirect damages to forests. Direct damages embrace damages to trees, e.g. if branches break down or whole trees become uprooted. Indirect damages on the other hand also embrace economic costs and the reduction of the stock diversity, which is increasing the risk for consequential damages. (Cf. Albrecht et al. 2008: 1)

As was discussed in Wind Risk Prevention Project Report C.1, scenarios on future storm occurrence are highly uncertain. Unfortunately there is no clear trend in the development of storm pathways or their intensity. It

even cannot be proven that there is a general causality between the frequency of storms and climate change, due to a lack of data. (Cf. Albrecht et al. 2008: 2f.)

The European Environmental Agency (EEA) states that it is likely that the strongest, most damaging storms will increase in Europe in the future (cf. EEA 2012: 70-72). Researchers from Germany furthermore assume assumed that there will be a decrease in storms during the summer and an increase of storms during the winter months, especially in the months December till February. Also a slight shift in occurrence of winter storms towards the autumn (months October, November) can already be noticed. For the future, researchers are still expecting the most damaging winter storms from a western direction. (Cf. Albrecht et al. 2008: 2f.)

Hence, the main challenge forest management has to face is that storms have a great impact on forests but are unpredictable in their character and occurrence. ALBRECHT et al describe the dilemma of forest management as follows: 'In case the intensity of storms is increasing, the controllability of damages by silvicultural measures is going to decrease. For the occurrence of damages caused by extreme wind speed is less dependent on the silvicultural condition of the forest stands than on the storm tracks' (own translation following Albrecht et al. 2008: 3). Researchers also fear that the slightest change in storm activity may lead to disproportional, so far unpredictable damages. (Cf. Albrecht et al. 2008: 3; Kaulfuß 2012: 1)

Nevertheless, potential damages by storms can be lowered by knowing general vulnerability factors and by addressing these through silvicultural measures. Therefore, several general parameters determining a forest's (or tree's) susceptibility towards storms are investigated. Of course the following parameters do not mean to be a concluding list of risks parameters, especially because forest types and tree species vary throughout Europe and the local conditions (e.g. soil quality etc.) need to be taken into account. Nevertheless, the following parameters generally determine forest's (or tree's) strength to withstand storms (cf. Kaulfuß 2012: 1):

- tree species,
- tree height and age,
- tree location,
- forest (stock) structure,
- thinning and
- tree health

Besides the hazards and vulnerability components, also the coping capacity of a system determines the damages that arise from storms. In forest management, especially the monitoring of forests (before and after a storm) is affecting the capacity to cope with storms. If data and knowledge exist on the state and structure of a forest and are constantly monitored and reported, adequate strategies and measures can be implemented to maintain and foster (more) resilient forests. (Cf. Website UNFCCC 2016)

Further measures that account for the coping capacity may also take place after a storm event. For example, the entering of a forest can be prohibited for a certain amount of time in case there is a justified risk, e.g. of loose branches falling and potentially causing injuries. An example how this may be implemented can be taken from the German Federal Forest Law. Therein in § 14 (2) the entering of forests may be restricted, 'especially for […] the protection of visitors or for the prevention of significant other damages.' (Cf. § 14 BWaldG)

2. Forest Management in Germany, Slovenia and Croatia

The three Wind Risk Prevention Project partner countries are very different in their total and percentage of forest coverage. While Slovenia has more than 60 % of its area covered by forests and other wooded land (OWL), Germany only has about half that much, despite the country is seventeen times bigger than Slovenia.

Table 1: Basic data on forests in Germany, Slovenia and Croatia (2015)

Country	Land area [1,000 ha]	Forest[a]		Other Wooded Land (OWL)[b]		Forest and OWL	
		[1,000 ha]	% of land area	[1,000 ha]	% of land area	% of land area	Forests and OWL per inhabitant [ha]
Germany	34,861	11,419	32.8	0	0.0	32.8	0.14
Slovenia	2,014	1,248	62.0	23	1.1	63.1	0.62
Croatia	5,596	1,922	34.3	569	10.2	44.5	0.59

Note:
[a] ***Forest****: land spanning more than 0.5 ha with trees higher than 5 meters and a canopy cover of more than 10%, or trees able to reach these thresholds in situ.*
[b] ***Other Wooded Land (OWL)****: land not classified as 'forest', spanning more than 0.5 ha, with trees higher than 5 meters and a canopy cover of 5-10%, or trees able to reach these thresholds in situ; or with a combined cover of shrubs, bushes and trees above 10%.*

Source: own depiction following FOREST EUROPE 2015: 243, 244.

In the following, the most important legal documents and strategies concerning forest management in the three partner countries are summarized.

2.1 Forest Management in Germany

In the past 25 years, Germany had to face several winter storms with hurricane strength that led to large damages, especially to the forestry sector. The most recent storm *Kyrill* (January 2007) destroyed about 10 % of the forests in the Ruhr Area and led to costs of some € 2 billion. *Kyrill* was a very typical winter storm phenomenon (depression), lasting for several days with a great geographic extent and peak wind gusts of 144 km/h in Germany. (Cf. Deutsche Rückversicherung 2015: 21; DWD 2014: 7; Website GDV 2007)

There are several relevant legal document and strategies concerning forest management in Germany:

Laws and Directives in Forest Management	Strategies and Guidelines in Forest Management
Federal Nature Conservation Act (Bundesnaturschutzgesetz, BNatschG)	Sustainability Policy for Germany (Nachhaltigkeitsstrategie)
Federal Forest Law (Bundeswaldgesetz, BWaldG)	Forest Management Strategy North-Rhine Westphalia
State Forest Law (Landesforstgesetz Nordrhein-Westfalen, LfoG NW)	Technical Regulations on Road Construction; Section Landscape Conservation (Richtlinie für die Anlage von Straßen, Teil Landschaftspflege ; RAS-LP)
	FLL Guideline on Tree Inspection (FLL-Baumkontrollrichtlinie)

2.2 Forest Management in Slovenia

Slovenia belongs to the most forested countries in Europe. By the 1,184,526 ha of forests, the Slovenia is covered more than a half of its territory (forestation amounts to 58.4 %). Most Slovenian forests are located within the area of beech, fir-beech and beech-oak sites (70 %), which have a relatively high production capacity. The 71 % of forests in Slovenia are in private property and 29 % of forests are public (owned by the state or communes). Larger and undivided forest estates of state-owned forests enable good professional management (Website Slovenia Forest Service).

There are several relevant legal document and strategies concerning forest management in Slovenia:

Laws and Directives in Forest Management	Strategies and Guidelines in Forest Management
The Forests Act	Rural Development Programme 2014–2020
Decree on protective forests and forests with a special purpose	

2.3 Forest Management in Croatia

The basic principles of the Croatian forestry are the sustainable management, aiming to preserve the natural structure and biodiversity of forests, and the continuous rise of the stability and quality of the commercial and welfare functions of the forest. The Forest Act prescribes an integral forest-management area in the Republic of Croatia, which is further divided into management units. Forests and forest land in Croatia is managed in line with the Forest management plan, adopted for the period of 10 years.

The Forest management plan defines the ecological, commercial and social basis for the biological improvement of forests and the growth of forest production. The goal of the forest management in Croatia is a sustainable and harmonious usage of all the forest functions and the continuous improvement of their condition.

There are several relevant legal document and strategies concerning forest management in Croatia:

Laws and Directives in Forest Management	Strategies and Guidelines in Forest Management
Nature Conservation Act (Zakon o zaštiti prirode)	Ordinance on Forests Conservation (Pravilnik o čuvanju šuma)
Law on Forests (Zakon o šumama)	Ordinance on Monitoring Damage of Forest Ecosystems (Pravilnik o načinu motrenja oštećenosti šumskih ekosustava)
	Ordinance on the Method of Data Collection, Keeping the Register of Conditions for Using Data on Forest Fires (Pravilnik o načinu prikupljanja podataka, vođenju registra te uvjetima korištenja podataka o šumskim požarima)

3. Recommendations Concerning Forest Management and Storms

The previous subchapter clarified hazard and vulnerability components of forests towards storms. In order to meet these components adequately, good forest planning and management should be promoted in order to increase the coping capacity and to reduce the risk of forests towards storms.

In forest planning HEIN et al. plead for a stronger awareness of potentially hazardous natural events. They especially see a need for deriving sophisticated maintenance and usage concepts for different stocks referring to their level of risk. These concepts should be designed in a manner that allows adjustment in case of changing climatic conditions and changing levels of risk. Furthermore, the researchers demand for a long-term assessment of all above mentioned risk factors (see chapter 1.1) and a debate on potential adaptation strategies. (Cf. Hein et al. 2008. 4f.) Currently the researchers see no reason to doubt that deciduous trees have advantages regarding their stability towards storms. Nevertheless, it needs to be kept in mind, that there also are other climatic factors influencing the suitability of a tree species, e.g. its resistance to drought. Therefore, it constantly needs to be surveyed how future changes influence forests. (Cf. Hein et al. 2008: 1)

In forest management the overall goal should be to develop and manage structurally diverse, native tree species that are designed stable and 'aerodynamic', best in mixed forests (cf. Kaulfuß 2012: 2; Albrecht et al. 2008: 4) as to promote risks prevention. These mixed forests should be managed according to flexible strategies that allow regular adjustment, e.g. by revising the rating of the climate resistance capacity of a tree species (cf. Hein et al. 2008. 1).

Some general guidelines for good forest management can be derived from the literature. First of all, it is advisable to create a mixture of different tree species; in best case deciduous trees are admixed with coniferous trees. Secondly, thinning and rejuvenation are measures that lead to stabilization of the forest but should be conveyed carefully because both can increase the risk of the forest towards storms. Moreover, an active shaping of the edge of a forest is advisable so that it rises in slight slope and is more wind permeable than if the edge consists of old stock trees of the same height and species. Also, the prevention of trunk violation (and hence growth of rot and fungi) should be enhanced via good forest work. (Cf. Kaulfuß 2012: 2)

Regarding timber production and management, two guiding principles may be stated. Firstly, new models should be introduced that promote a relatively fast achievement of production aims so that trees are still young and do not fall under the risk category of tree age (cf. Hein et al. 2008: 1). Furthermore, a constant usage of trees fit for cutting is necessary so that the inventory (and therein the damage potential) does not enlarge disproportionally. (Cf. Kaulfuß 2012: 2)

For Germany, one of the main challenges for both forest management as well as city tree management is global climate change. Trees have to face more and more aggravated growth conditions, e.g. a general decrease in precipitation while heavy precipitation increases. Especially in densely populated urban areas, the risks for urban heat islands increases and trees have to face heat waves and draught periods. (Cf. Haering unpublished: 21) Another major challenge for city trees is the occurrences of summer storms like Ela that are nearly impossible to project but nevertheless will probably occur more often due to changing climatic conditions, triggering thunderstorms. (Cf. DWD 2015: 25) Leading Federal Agencies expect that events will appear more often the more extreme they are. Despite some periodical fluctuations a nearly linear increase in the probability of occurrence of extreme wind speeds is projected. The most significant trends were projected in winter storms so that it is stated that between 2070 and 2090 the number of winter storms will be doubled in comparison to the reference period 1961-1990. (Cf. DWD/BBK/THW/UBA 2012: 65, 70)

Good practice examples need to be established and further research has to be conducted on good forest and tree management. There already are some decent legal documents and strategies in Germany that address the

above mentioned challenges. Strategies exist for every administrative level, e.g. the German Sustainability Policy (national level), the Forest Management Strategy North-Rhine Westphalia (regional level) and the FLL Guidelines on Tree Inspection (local level). Of high relevance is furthermore the GALK 'List of City Trees' that gives good advice on the climatic and other location related factors of different tree species. A good practice example for Germany is the Forest Management Strategy of North-Rhine Westphalia. It explicitly addresses the challenges resulting from global climate change and gives various examples and strategies for adaptation measures. An advantage of such a forest management strategy on the regional level is that the authorities of the local level have an adequate framework and set of measures which they can adapt and enhance according to the local circumstances. Furthermore, it needs to be stressed as a good example that the Forest Management Strategy of North-Rhine Westphalia already identifies the most relevant stakeholders for the implementation process of forest management measures. This simplifies the question of responsibility on the local level.

Besides the good practice examples that exist in Germany, there also are some demands for further development in the field of forest management. Most importantly, there is a need for a stronger awareness of potentially hazardous natural events. As also claimed by HEIN et al., sophisticated maintenance and usage concepts need to be derived for the different existing (and future) stocks, paying special attention to their varying level of susceptibility towards storms and other climate change stress factors.

Moreover, the example of summer storm Ela impressively showed that Europe will have to face new types of storm events that need to be dealt with and adjusted to. It may therefore be demanded that a debate on the higher administrative levels (national level, EU) needs to take place and that forest management strategies should be expanded also to city tree strategies.

In Slovenia there is a need for including the most frequent wind direction into forest management strategies. An example can be taken from Ljubljana. The city's urban forest is affected by high gusty wind during storms with unknown main wind direction, which is why damages occurred in the past. Recommendations are to plant special tree species that are more wind resistant and to place vegetation on the forest's edges in order to reduce sharp edges, which are more susceptible to storms.

In Croatia, the Nature Conservation Act prescribes obligation of competent authorities to prepare a program for conservation of forests containing measures to their protection. According to this Act, this program shall be publicly available. However, it is not legally prescribed that the plan producer or other competent authority has the obligation to actively present the Plan to the general population, with the emphasis on parts of the community that may be particularly vulnerable in the possible accident caused by natural or other causes (fire, strong wind, etc.), or can provide a greater contribution to reducing the damage or actively contribute in repairing of consequences of the event.

In addition to plans for forest protection, it is necessary to prepare plans for management of forest vegetation in urban areas, both from the aspect of protection of city trees and reducing the potential damage for residents and infrastructure. These plans should contain guidelines and instructions for intervention by emergency services in case of natural disasters, plans for mitigate the damage and potential danger for the population, as well as guidelines and tips for civil population in accidental situations.

The biggest potential threats to forests in Croatia are forest fires, there is an obligation of the competent authorities concerning monitoring and data collection regarding forest fires. Register on forest fires is kept at the Croatian forests Ltd. The register has archived historical and current data on all relevant information on forest fires. This data can be used in forest management and preparation of plans and programs regarding forest fire protection. Based on this experience, similar registry can be created with information on accidents

cause by other natural causes, like wind, rain or thunder storms which could improve planning, and action plan preparation in forest management. This could be particularly useful in urban areas where there is usually no systematic management of forest vegetation in the sense of safety and action plan preparation for response in case of natural disasters. Historical information from this register could also be used for a scientific analysis of forest vegetation in urban areas, as well as for the preparation of future document of urban planning for planning architecture and species of forest vegetation in urban areas.

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