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Sustainability Impact Assessment of the Forestry - Wood Chain

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Forest stands management and vulnerability to biotic and abiotic hazards

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Executive Summary

We have synthesized and reviewed the available information of the effects of forestry practices on stand vulnerability to biotic and abiotic hazards in European forests, concentrating on mammal herbivores, pest insects, pathogenic fungi, wind and fire.

Site selection plays a major role in the future vulnerability of newly established forest stands to disturbance agents. The most important site characteristics are topography and related thermal conditions which influence wind action and development of biotic hazards, and soil properties which influence the physiological resistance of trees against damaging agents.
Site preparation may affect the risks to forest health in both positive and negative ways, depending on the type of application and the type of risk. A positive effect is obtained via the reduction of breeding material and fuel by the management of cutting residues. No general recommendation concerning fertilization can be given since the results of experiments appear contradictory, with both positive and negative effects.

Tree species diversity can have various effects on ecosystem processes and stability against disturbances, but generally mixed forests are expected to be more resistant to biotic agents than pure stands. In particular mixed forests would be less prone to outbreaks of specialist species (developing on a limited number of related tree species) of herbivorous mammals, insects and pathogenic fungi due to lower

resource availability and higher impact of natural enemies. The picture is less clear for generalist species of damaging agents. Depending on the composition of tree species, some mixtures would be also more resistant to strong winds and fire.

Tree genotypes have been found to vary in susceptibility to biotic, and to a lesser extent to abiotic, damaging agents, presenting the opportunity for breeding programs to improve tree resistance. However the most relevant characteristics are often difficult to detect and select, they are sometimes negatively correlated to other selection criteria such as growth or shape and the genotype × environment interaction may reduce their expression. Also, extended use of improved tree varieties may lead to adaptation by insect pests or pathogenic fungi. It is because of these limitations that few breeding programs for tree resistance have been developed in Europe, and why tolerance is more often targeted in such programmes than true resistance.
3/88 Forest stands management and vulnerability to biotic and abiotic hazards. The largest influences of the type of forest regeneration on biotic risks are from: the quality and quantity of seedlings used in planting, the succession of silvicultural operations ending with artificial regeneration, and the vertical stand structure resulting from the regeneration process. In general it is apparent that artificial planting offers better conditions for pest and pathogen development than natural regeneration.

In intensively managed forests, cleaning and weed control have a positive effect on tree growth by decreasing competition for resources among the trees. However, although they may be beneficial for damage prevention (especially, by reducing forest fires and animal herbivores), their impact can also have negative impact on beneficial forest organisms, including the natural enemy fauna of many insect pests.

The change in the structure of the stand by thinning can have both positive and negative effects on forest vulnerability to biotic and abiotic hazards. Thinning can produce a cascade of possible effects, through the modification of the microclimate, changes in shape and vigor of remaining trees, and via the provision of food or shelters for beneficial or damaging organisms associated with dead wood and stumps. However, thinning probably has the largest effect on stand susceptibility to strong winds. It is difficult to assess overall changes in risk of disturbance following thinning, when taking the many different agents and different damage levels into account. Therefore, as there is no one thinning regime which lowers all the risks, an optimal regime must be adapted to the local conditions and risks.

Harvesting and tending are silvicultural operations that change ecological and physical characteristics in harvested and adjacent stands. These impacts relate to the method and intensity of harvesting and the time of logging at both yearly and forestry cycle scales. The impact of harvesting on damage by game, pest insects and fungal pathogens mainly results from the provision of food resources or accessible breeding material. Harvesting practices may also increase biotic risks of damage by mechanical injuries caused by the machinery.
The silvicultural operations that influence at most stand vulnerability to both biotic and abiotic hazards in European forests seem to be closely related to the species composition and the structure of the overstorey. Four main processes would drive the causal relationships between stand management and vulnerability: changes in individual tree physiology and development, effect on local microclimate, provision of fuel and resources to biotic and abiotic hazards, and enhancement of biological control by the natural enemies.