

MANAGING FOREST DISTURBANCES IN A CHANGING CLIMATE



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Background

Unprecedented climate-driven extreme events with consequent increasing disturbance frequency and severity are putting immense pressure on Europe's forests. RESONATE results show that disturbance risks will further increase in the future at continental scale, indicating more severe impacts with every degree of future global warming. Recent analyses reveal disturbance hotspots, where forests face heightened vulnerability to climate extremes, challenging their functioning and capacity for natural recovery. This evolving situation underscores the need to evaluate the impacts of escalating disturbances as well as to identify effective climate change adaptation measures.

Disturbances are an integral component of natural ecosystem dynamics. However, under current rapid

climate change, disturbance regimes are changing. RESONATE results indicate that in addition to climate change, the frequency and severity of disturbances (or impacts of disturbances) are also affected by previous forest management, e.g. tree species and forest structure choice. Extreme climatic events have magnified disturbances in a way that was not expected in forestry practice. Traditional forest management approaches are thus no longer sufficient. Adaptive management needs to consider novel disturbance regimes resulting from appearances of certain disturbance agents in new regions (e.g. fire in Central Europe), emerging pests and diseases, and interactions between disturbance agents that were previously rare or much less intense (e.g. drought-incited bark beetle outbreaks followed by forest fire).



Photo: Successful forest restoration through natural regeneration after windstorm in 2014 and subsequent bark beetle outbreak in Tatra mountains, Slovakia. Marcus Lindner/European Forest Institute.

Main findings

1. Disturbances increase

- All natural disturbance agents recently showed increasing trends in Europe. One example are impacts of bark beetles, another example is fire regime shifts to larger and more intense wildfires, both magnified by extreme weather events.
- Two-thirds of Europe's forest area experienced linked increases in natural and human disturbances. That means that both natural disturbances by fire, wind, or bark beetles and canopy openings by human land use are increasing simultaneously.
- Due to the high climate sensitivity of natural disturbances, we must expect strong increases of damages by up to threefold levels until the end of the century compared to late 20th century levels. Future disturbance hotspots will emerge throughout large parts of the continent, driven most likely by fire, drought, and bark beetle events.

2. Disturbances interact

- Interlinkages between disturbances can magnify the impacts, e.g. bark beetles and wildfire often build on initial wind and drought disturbances.
- Human land use and natural disturbances can affect each other, which also implies that effective risk management can substantially lower disturbance events. However, at a continental level, areas with more intense management are currently seeing more natural disturbances.
- Resource limits for species sensitive to disturbances (e.g. declining spruce forest area in Europe) might reduce future bark beetle outbreaks, but no similar limits are expected for wildfires.

3. Adaptation can help preventing and mitigating disturbances

- Tree species diversity (≥ 3 species) buffers large scale mortality events.
- Proactive strategies like creating forest stands with diverse structures enhance resilience. However, due to their complexity these stands require skilled expertise in the field. They also demand more frequent interventions and result in more diverse types of wood supply.

4. Disturbances can be an opportunity for adaptation

- Recovery after disturbances opens a window of opportunity for increasing species diversity, and for promoting more climate-adapted species.
- Mimicking disturbances in forest management (e.g. prescribed burning, natural dynamics silviculture) allows increasing forest resilience and biodiversity.

5. Awareness and action are crucial

- Forest owners are aware of the risks of climate change but often see adaptation as something to address in the future rather than today.
- Proactive measures, such as promoting diverse and climate-adapted tree species, are generally accepted but not widely applied.

6. Disturbances impact the wood value chain

- In primary processing, disturbances lower wood quality and stability of supply.
- In some regions, like Czechia, Slovakia, Austria, and Germany, the wood industry will face conifer resource supply limitations with increasing transport distances. This could happen in Southern Sweden and Southern Finland in the future as well and calls for wood industry transformation and enhanced technological development.



Recommendations

1. Adapt Forest Management to Disturbances

- Consider short-term costs vs. long-term benefits: proactive management is more expensive upfront but reduces future damage.
- Actively exploit disturbed patches as opportunities for climate change adaptation in forest management, using canopy openings to transition to mixed, climate-resilient tree species.
- Incorporate post-disturbance forest structures into management (rather than eradicating them) to achieve important goals of sustainable forest management (e.g. increasing deadwood stocks in forests).
- Adopt proactive approaches in both high-risk stands and those expected to become vulnerable in the future. These approaches may include establishing advance regeneration, reducing stand density and shortening rotation periods to lower risks.
- Implement effective browsing control plans, which can be a decisive factor in post-disturbance restoration.
- Develop best practices in adaptive management with recommendations for different forest conditions and disseminate to forest owners in national languages, e.g. via forest extension services.

2. Adapt regulations and infrastructure to support climate change adaptation

- Support forest owners in realizing adaptation measures with a combination of policy instruments, such as financial support, competence building and increased flexibility of regulations.
- Remove the salvage requirement that is still a legal imperative in many EU countries and allow longer time windows for forest recovery following disturbances. This will facilitate the establishment of more diverse resilient forests.
- Enable adaptation to climate change in guidelines for nature restoration and in habitat regulations for Natura2000 areas.
- Safeguard nursery capacities and improve seed availability with the desired seeds for restoration, enabling potential use of reproductive material from neighbouring regions with suitable climate.
- Support the establishment of storage and transport infrastructure to increase resilience in the wood value chain.

3. Improve Data and Planning

- Forest restoration requires close monitoring and silvicultural interventions to ensure desired long-term development.
- Mainstream newly available information on potential future disturbance risks into landscape level planning tools and process-based models to guide management decision making.
- Use emerging remote sensing approaches to apply targeted disturbance management strategies.



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