

EFI Policy Brief 6

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Climate Change Impacts and Adaptation in European Forests



Foreword

This Policy Brief was compiled within the Models for Adaptive Forest Management (MOTIVE) project, a large-scale integrated project in the 7th Framework Programme of the EU. MOTIVE seeks to develop and evaluate strategies that can adapt forest management practices to balance multiple objectives under changing environmental conditions. The objectives of this policy brief are to outline the status of current knowledge on the climate change impacts and adaptation in European forests, and to identify the challenges that need to be addressed for successful responses in policy and management.

Climate change is a main concern for the EU. Europe is aiming to cut its greenhouse gas emissions substantially and develop a strategy for adapting to the impacts of climate change that can no longer be prevented. The Directorate-General for Climate Action (“DG CLIMA”) helps the EU to deal with the consequences of climate change and meet its targets for 2020. The core pillar of the Europe 2020 strategy is to generate more growth by using fewer resources, and to reach a low carbon future by the sustainable management of natural resources which, in turn, will help society adapt to climate change. Recently, identifying suitable adaptation strategies was also the focus of the Standing Forestry Committee ad hoc Working Group on Climate Change and Forestry. Further development and implementation of adaptation strategies is now the task of the EU member states and will require actions at all levels down to practical management decision making.



It is time to act now

Climate change is already affecting European forests today. Growth rates have increased in northern latitudes, while some species have declined on dry sites close to their southern distribution limits. Also, the recent increases in abiotic and biotic disturbances can at least partly be attributed to climate change. We can react to the circumstance in different ways: do nothing or try to mitigate and adapt to climate change and its impacts. Mitigation includes decreasing greenhouse gas emissions and increasing carbon stocks; however, since earth is already committed to at least some climate warming, adaptation is also needed. In this brief we focus on adaptation – how we can change our forest management to deal with climate change and its impacts on European forests.



Aarno Isomäki / Vastavalo

Since 1990, several storms have caused widespread damage in European forests, resulting in the yield reduction of recoverable timber and considerable carbon releases.

Impact of climate change on European forests

Wind

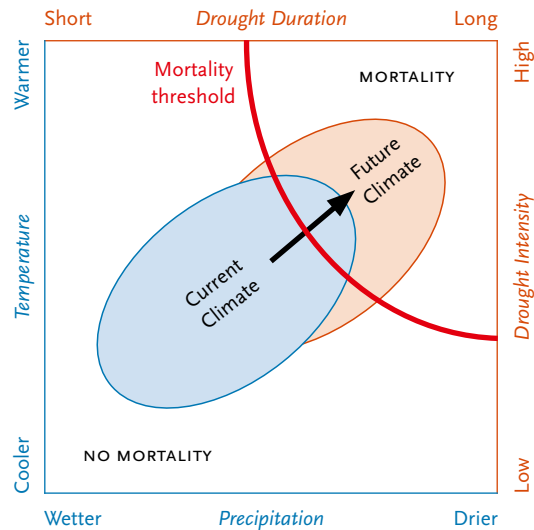
The changes in climate will have associated consequences for abiotic disturbances; for example, wind storms of high intensity are projected to become more frequent in the Boreal, Temperate Oceanic and Temperate Continental zones. While high winds can break and uproot single trees, storms can fall a great number. For example, in December 1999 approximately 180 mil-

lion m³ of timber was blown down in Europe because of storms. Wind damages also cause increased costs as a result of unscheduled cuttings and problems in forestry planning.

Drought

Because trees are adapted to the local average water availability, extreme events cause growth responses across site conditions. Increased

drought is likely to lead to reduced plant growth, primary productivity and altered plant recruitment. The drought stress of trees will also predispose forests to infestation by insect herbivores and fungal diseases.



Climate change is expected to increase the average temperature and precipitation is likely to decrease in southern and south-eastern parts of Europe thus increasing the likelihood and duration of drought periods in the regions. Extended droughts have much more drastic consequences on tree growth and survival than gradual changes in average climate conditions (from Allen et al. 2010, *Forest Ecology and Management* 259:666–684.).

Fire risk

Prolonged droughts and hot spells will further aggravate the risks of forest fires. As vegetation dries it becomes combustible and thus fuel for fires. Severe fires destroy organic matter and nutrients are lost through volatilisation. Frequent fires can also increase soil erosion, reduce plant regeneration and, in dry areas, may accelerate desertification. Currently, the main threat of extreme forest fires is in the Mediterranean region; however, fire risk is also expected to increase in other parts of Europe.

There are every year on average 50 000 forest fires where almost 500 000 hectares are burned in the Mediterranean region only.

Riccardo Arata / www.fotolia.com





Temel Cokturk, Artvin Forest, Bugwood.org



Petr Kapitola, State Phytosanitary Administration, Bugwood.org

The European spruce bark beetle has benefited from warm and dry summers as well as from storm events in recent decades in large parts of Europe.

Pests and pathogens

Population dynamics, the occurrence of insect herbivores and the pathogenicity of fungal diseases will be strongly influenced by altered environmental conditions. The consequences for certain species will differ by geographic region and the extent of climatic change: some species

will respond positively with increased development rates, an increased chance of survival and reproductive potential; for other species, however, negative effects like decreased growth rate and reduced fecundity are possible. Climate change will impact frequencies of pest outbreaks and the spore formation and colonization suc-

cess of fungal pathogens. Upward (in altitude) and northward (in latitude) shifts and expansions of the distributional ranges are expected for various herbivore and pathogen species. The potential risk of high impact responses to different disturbances is significantly increasing under climate change.



Besides altering species and provenance choice in forest regeneration, tending and thinning may also include altering the composition of tree species.

Adaptation options

There are several stand-level measures available to adapt to climate change: in forest regeneration; at the tending and thinning stages; and during harvesting.

Forest regeneration offers a direct and immediate opportunity to manipulate species or stand composition. The mixture of adaptive species or provenances better secures the resilience of a for-

est stand, since mixed stands remain less affected by pests and diseases than monocultures.

Thinning and tending offer means to promote target species composition, stand stability, quality and structure, as well as enhancing the growth of crop trees.

Late stand development stages are generally highly vulnerable to major disturbance factors such as windthrow, bark beetles and fungal

diseases. Adaptive harvesting should aim at reducing susceptibilities by minimizing stand edges exposed to prevailing winds or intense exposure to direct sun, for example. Silvicultural techniques and harvesting machinery must be adapted to the local conditions, keeping damage to soil, remaining trees and regeneration at a minimum level to preserve stand resilience.



Antti Saraja / Leuku

Rotation periods could be shortened in boreal environments as a response to accelerated growth. It would also mitigate the disturbance risk and lower the risk of financial losses due to disasters.

Maintaining or improving the inherent adaptive capacity of trees and forest ecosystems is important to facilitate natural adaptation to climate change, especially in the long term.

Socio-economic adaptive capacity is dependent on political stability, economic conditions and national and international policies as well as legal frameworks, educational systems and land owner structures.

Landscape level adaptation options focus on management planning and forest protection.

A diverse landscape structure increases the resilience of forest ecosystems. In developing alternative management strategies, forest planning is used to aggregate stand-scale management options to a concerted application at the landscape level.

A key approach in risk management is the diversification of tree species mixtures and management approaches between neighbour-

ing forest stands or within a forestry district. This approach increases adaptive capacity and acts as an internal insurance by improving the overall resilience of forests to climate change. As there is uncertainty about the timing of changing species or provenances in forest regeneration, more conservative and more rapid adaptation strategies can be applied simultaneously in different forest stands of a management unit. A landscape-level mosaic of forest types can be created to reduce fire risk, including species with reduced flammability, with pri-

Quick access to forests is important to minimise disturbance impacts. Upgrading infrastructure is a key element in climate change adaptation.



Ignacio López Vicens / CTFC

ority given to those forest types that have the ability to regenerate after fire.

Policy-level measures support increasing forest ecosystem resilience and manage disturbances.

Policy-level measures to adapt to climate change should support forest ecosystem resilience. To enable the choice of seeds well adapted to future climate conditions, national legislation should allow the use of neighbouring southern provenance in the mixing of seedlings at the

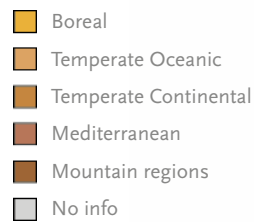
nursery stage in order to increase the diversity of reproductive material.

Climate change threatens the survival of those species that are unable to migrate to new suitable habitats in fragmented ecosystems. Reducing forest fragmentation through afforestation and by establishing connecting corridors between densely forested regions helps to maintain forest biodiversity and supports the natural adaptive capacity of the ecosystems.

Climate change is expected to increase disturbances in European forests. Coping with

disturbance events like pest outbreaks or forest fires will require good access to stands.

As human capital is a prerequisite to the local implementation of climate change adaptation, new insurance concepts, for example, should be developed to distribute risks. Risk management in forestry needs to be supported by educational efforts such as in-depth training courses that focus on identifying and preventing risks and mitigating their damage.



Projected climate change impacts vary in different bioclimatic regions.

Regional differences in projected climate change impacts

An increase in temperature will have a positive impact on forest growth in less water-limited areas and a negative impact in water-limited regions.

Boreal

- Enhanced forest growth
- Reduced winter hardening
- Increased abiotic damages

Temperate Oceanic

- Changes in storm, insect and pathogen disturbance regimes
- Shifts in tree species compositions

Temperate Continental

- Vulnerability of trees to frost increasing
- Forest fire risk increases
- Risk of pest outbreaks increases

Mediterranean

- Drought stress increasing
- Forest fires become a bigger threat
- Threat of desertification and soil loss

Mountainous regions

- Tree line shifts upward
- Forest fire risk increases



Prescribed burning can help reduce fuel loads and decrease the risk of catastrophic fires.

Selection of adaptation measures in different bioclimatic regions

In all bioclimatic regions

- Adjust thinning and harvesting to the changing growth of forests.
- Select well-adapted tree species or provenances at regeneration and favour them at the tending and thinning stages.

Boreal

- Better harvesting techniques on non-frozen soils

Temperate Oceanic

- Adapt the management to an increased disturbance risk

Temperate Continental

- Improve fire risk management and adjust afforestation techniques

Mediterranean

- Fuel management and the modification of stand structure to reduce fire risk

Mountainous regions

- Promote small-scale management and maintain the forest cover to secure its protective function against natural hazards and erosion



Wiktor Bubniak / www.fotolia.com

Vulnerability is the degree to which individuals, groups and systems on different geographical levels and locations are able to cope with and adapt to climate change, variability and extremes.

Regional assessments of vulnerability and adaptive capacity are crucial.

The understanding of adaptive capacity and regional vulnerability to climate change in European forests is poorly developed and thus requires more focused research efforts.

The Mediterranean region is highly vulnerable to climate change because impacts of climate change there are the most obvious in Europe and extensive forest management does not support immediate response to the impacts. As considerable risks also occur in all other regions, the assessment of regional vulnerability to climate change, including quantified risks and opportunities, constitutes a clear need for research.

Potential climate change impacts on various ecosystem goods and services other than wood production are not yet well understood. The identification of vulnerable ecosystem goods and services, which are NOT likely to be supported through either inherent adaptive capacity of the ecosystems or planned adaptation from the forest sector actors will be an important task for policy making.

Forests have an important protection function, especially against soil erosion and declining water quality.

From the current understanding, it appears that special attention must be directed towards less productive forests and woodlands in southern Europe to secure the protective and social functions (e.g. soil protection and recreational use) of these areas under climate change.



Planned adaptation to climate change requires that forest managers are well informed about the likely threats in their forests and that they know how to best modify traditional management practises.

The awareness of forest owners and practitioners improve the implementation of adaptation measures.

Real adaptation to climate change occurs at the local level and by local actors in the forest. The awareness and knowledge of forest owners and practitioners on the impacts of climate change on forests as well as on adaptation measures is important. For this reason, policy support,

resources for education, training of and the dissemination of knowledge to key actors are needed.

There will be a continuous challenge to provide scientific knowledge in a form that local managers and policy makers can also utilize. The

remaining uncertainties about the full extent of climate change impacts, the adaptive capacity and the suitability of the adaptation measures create a need for the monitoring of impacts and the evaluation of adaptation responses

It is time to act and implement flexible strategies



No-one can offer precise forecasts of future climate conditions – not today and not tomorrow. Uncertainty is something we need to consider in future forest management even with the most advanced climate models. We cannot wait for ‘better forecasts’, we must make a decision to adapt the management strategies in response to our improved understanding of impacts and observed forest responses to the changing environmental conditions. Successful adaptation requires flexible adaptive management systems, especially in the follow-up of disturbance events.

Policies at international, national and regional levels must all aim to improve the adaptive capacity of society. Forest owners’ and practitioners’ key role must be acknowledged.

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