



Sectoral Climate Change Impacts and Adaptation Responses:

Forestry

Forest management, products and productivity are closely linked with and dependent on climatic conditions. Forests not only provide a range of products and resources with great economic value, but also play a key role in climate change mitigation and adaptation. For example, mitigation measures include afforestation, forest management, carbon storage, and the use of wood as a substitute for other materials. Forests can influence adaptation positively by the way in which they regulate the climate, protect against landslides and avalanches, reduce flood risks, protect against soil erosion and degradation. The sector's capacity to adapt to climate change is key to ensuring the future sustainability and competitiveness of forestry in Europe.

This factsheet presents an overview of the main climate change impacts and adaptation options available to policy-makers and practitioners in the forestry sector.

Climate change impacts on the forestry sector

Rising CO₂ levels, higher temperatures, changes in precipitation patterns, and an increase in the frequency of extreme weather events will have significant effects on vegetation periods, vegetation growth, vegetation conditions, tree distribution and forest ecosystems. These effects depend on the range and severity of impacts in the different regions of Europe. The main expected risks and impacts resulting from climatic change are:

- **Increase of biotic risk:** Outbreaks of pests and/or diseases;
- **More frequent risks of fire events:** Increase of wildfire risk, especially in the Mediterranean region;
- **More damaging storms:** Changes in wind, water and soil regimes;

- **More frequent extreme weather events:** Droughts and floods may increase tree mortality;
- **Changes in growth rates:** Tree growth slowing down in Southern Europe, and may grow faster under humid Northern conditions;
- **Changes in phenology:** All climate change related irregularities will affect the start and end of the growing season as well as bud burst, flowering, leaf fall etc.
- **Changes in wood quality:** Overall wood quality may decrease as a result of an irregular tree growth rate from one year to another.

Figure 1 highlights observed and projected climate change impacts on forestry in Europe by biogeographical region.



Figure 1: Observed and projected climate change impacts in the forestry sector in the different regions of Europe (Source: EEA 2016)

Adaptation responses and options for the forestry sector

The various adaptation options available to forest managers can be categorised broadly at stand, forest landscape and sector levels. These levels are equally important to effectively and efficiently adapt to climate change and are crucial to holistically tackle related impacts in the sector. The measures at stand and forest level can be further enhanced by broader measures at sector level that address: infrastructure and transport; nurseries, forest tree breeding and other relevant research; and integration of adaptation in risk management and policy.

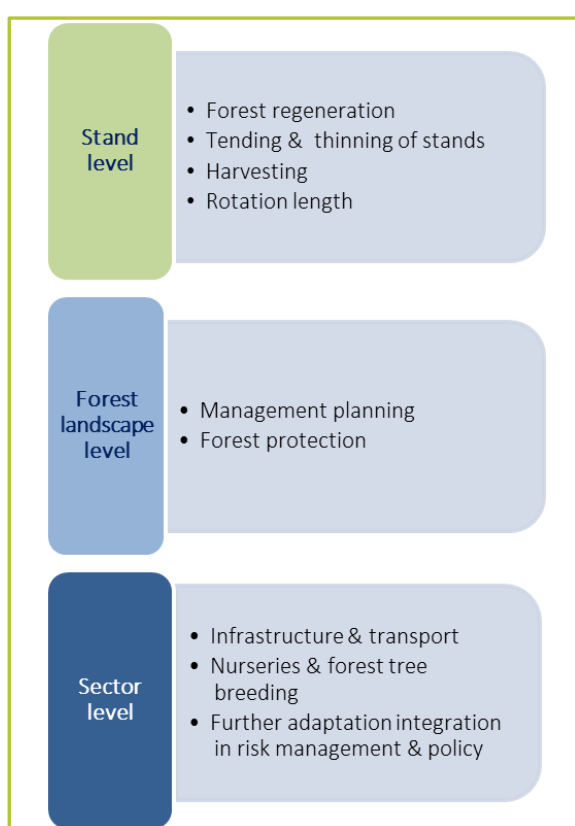


Figure 2: Typology of adaptation measures at stand, landscape and sector level (Source: Adapted from Lindner et al. 2008)

In addition, a range of **supporting measures** can encourage and aid practitioners in their adaptation actions:

- **Forest decision support systems** are tools for supporting adaptive forest management under conditions of climate change. Co-operation of scientists, decision-makers and stakeholders will lead to a more comprehensive understanding of the complex problems.
- **Urban and peri-urban agriculture and forestry (UPAF)** enhances food security for the urban poor, 'greens' the city and improves the urban climate, while also stimulating the productive reuse of urban organic wastes and while reducing the urban energy footprint.

An important condition for the ecological stability, resilience and adaptation of forests is their biodiversity. The diversity of genes, species, and ecosystems confers on forests the ability to withstand external pressures, and the capacity to adapt to changing conditions.

Box 1: Climate-ADAPT: The European Climate Adaptation Platform

Climate-ADAPT is the European Climate Adaptation Platform. It contains a vast database of sources and information about: climate change impacts, vulnerabilities and risks in different countries, regions and sectors; adaptation options, national strategies and case studies. It also allows users to share their own information and find useful links to other adaptation networks and databases. Climate-ADAPT has a dedicated Forestry sector page which contains the most relevant information about climate change and adaptation in the sector, including relevant EU policies, research initiatives and funding.

In practice, the following examples of adaptation measures can be undertaken in the forestry sector:

Table 1: Overview of adaptation measures available to respond to climate change impacts on water resource and flood management

Type of measures		Adaptation measures
Stand level	Forest regeneration	<ul style="list-style-type: none"> Natural regeneration: for example, by increasing diversity, maintaining population size, or by maintaining reproductive potential and fecundity; Seeding and planting e.g. selecting and introducing better adapted reproductive material.
	Changes in the tending and thinning of stands	<ul style="list-style-type: none"> Modification of frequency and intensity of tending and thinning practices.
	Harvesting	<ul style="list-style-type: none"> Modification of harvesting activities e.g. by harvesting at smaller scales or at a different frequency.
	Rotation length	<ul style="list-style-type: none"> Reducing the rotation length as a preventive measure in stands with high disturbance risks to allow an adaptation to faster growth associated with higher temperatures in cool environments and with high inputs of atmospheric nitrogen.
Forest landscape level	Forest management planning	<ul style="list-style-type: none"> Management planning at the landscape level; Reactive management (responding after impacts occur); Proactive management (active anticipation and management actions).
	Forest protection	<ul style="list-style-type: none"> Biotic damages: silvicultural strategies; pest and disease management; Abiotic damages: forest fire protection by using e.g. forest fire prevention and warning systems; wind damage management and snow management; Biodiversity restoration and protection: Protection of primary forests and restoration of managed or degraded forest ecosystems by supporting all fully functional units of plants, animals, micro-organisms, and fungi in the ecosystem to allow for natural resilience to climate change impacts
Sector level	Infrastructure and transport	<ul style="list-style-type: none"> Irrigation systems; Road networks and maintenance; Machine technology; Storage facilities.
	Nurseries and forest tree breeding	<ul style="list-style-type: none"> Increase and maintain diversity of reproductive material; Review regulations for the use of locally adapted plant material.
	Further adaptation integration in risk management and policy	<ul style="list-style-type: none"> Flexible planning frameworks; Vulnerability and risk assessment; Reduction of the forest fragmentation; Diversification of tree species.

The information in this factsheet is based on the following sources:

Brang, P., Breznikar, A., Hanewinkel, M., Jandl, R. and B. Maier (2013) Managing Alpine Forests in a Changing Climate, in Management Strategies to Adapt Alpine Space Forests to Climate Change Risks, edited by Cerbu, G.A., Hanewinkel, M., Gerosa, G., and R. Jandl, available at <http://www.intechopen.com/books/editor/management-strategies-to-adapt-alpine-space-forests-to-climate-change-risks>

Dubbeling, M. (no date) Urban and peri-urban agriculture and forestry as a strategy for climate change adaptation and mitigation, available at <https://sustainabledevelopment.un.org/topics/forests/documents>

EEA (2016) Climate change, impacts and vulnerability in Europe 2016, An indicator-based report, available at <http://www.eea.europa.eu/publications/climate-change-impacts-and-vulnerability-2016>

European Forestry Institute (2013) Policy brief 9: Climate Change in European Forests: How to Adapt, available at <http://www.efi.int/portal/2847>

European Forestry Institute (2011) Policy brief 6: Climate Change Impacts and Adaptation in European Forests, available at http://www.efi.int/portal/virtual_library/publications/policy_briefs/6/

IPCC (2014) Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects, available at <http://www.ipcc.ch/report/ar5/wg2/>

IPCC (2014) Climate, Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects, available at <http://www.ipcc.ch/report/ar5/wg2/>

Lindner et al. (2008) Impacts of climate change on European Forests and Options for Adaptation. Report for DG Agriculture, available at https://ec.europa.eu/agriculture/sites/agriculture/files/external-studies/2008/euro-forests/full_report_en.pdf

Orazio, C., Stojnic, S., Stojanović, D., Gartzia, N. and S. Hayes (2012) The influence of climate change on European forests and the forest sector, Rok-FOR project, available at http://www.efiatlantic.efi.int/files/attachments/efiatlantic/2012_rokfor/efi_rokfor_climate_change_a4_210113.pdf

Thompson, I., Mackey, B., McNulty, S. and A. Mosseler (2009) Forest resilience, biodiversity, and climate change. A synthesis of the biodiversity/resilience/stability relationship in forest ecosystems. Secretariat of the Convention on Biological Diversity, Montreal. Technical Series no. 43, available at <https://www.cbd.int/doc/publications/cbd-ts-43-en.pdf>

Useful sources for further information

- EU climate change policy - DG Climate Action: http://ec.europa.eu/clima/policies/adaptation/index_en.htm
- EU Forest Strategy: for forests and the forest-based sector COM(2013) 659 final;
- European Innovation Partnership (EIP) Agriculture: <http://ec.europa.eu/eip/agriculture/>
- Data services – Copernicus Climate Change Services: <https://climate.copernicus.eu/>
- SUBER - Integrative Management for an improved adaptation of cork oak forests to climate change: <http://lifesuber.eu>
- ENERBIOSCRUB – Sustainable Management of shrub formations for energy purposes: <http://enerbioscrub.ciemat.es>
- MOTIVE – MOdels for adapTIVE forest management: <http://motive-project.net/>
- RokFOR - Sustainable forest management providing renewable energy, sustainable construction and bio-based products: http://www.efiatlantic.efi.int/portal/networking/rokfor_european_project/
- AFORCE network: <http://www.reseau-aforce.fr/>




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More information on Climate-ADAPT:
Website: <http://climate-adapt.eea.europa.eu/>
Newsletter: <http://climate-adapt.eea.europa.eu/newsletter>

Useful resources:

European Commission Climate Action website and social media:

-  ec.europa.eu/clima
-  facebook.com/EUClimateAction
-  twitter.com/EUClimateAction
-  youtube.com/EUClimateAction
-  pinterest.com/EUClimateAction