

Mountain Regions

Potential impacts of climate change on forest goods and services

Climate characteristics

Mountainous regions are characterized by steep elevation (altitude), resulting in a large diversity of ecotones, also called transition areas, and complex climatic patterns. Climate projections are therefore more uncertain in mountain regions compared to areas with more uniform landscapes. In mountainous regions, warming exceeds the average continental trend.

Sensitivity to climate change

Higher air temperature. An increase in temperature has the potential to extend the growing season and enhance tree growth in mountain areas. The number of tree species able to survive at higher elevations will increase due to increased competitiveness of broadleaved species under warmer conditions. It is also expected that the tree line will move upwards as a response to warming. The duration of snow cover is expected to decrease by several weeks for each °C of temperature increase in the Alps.

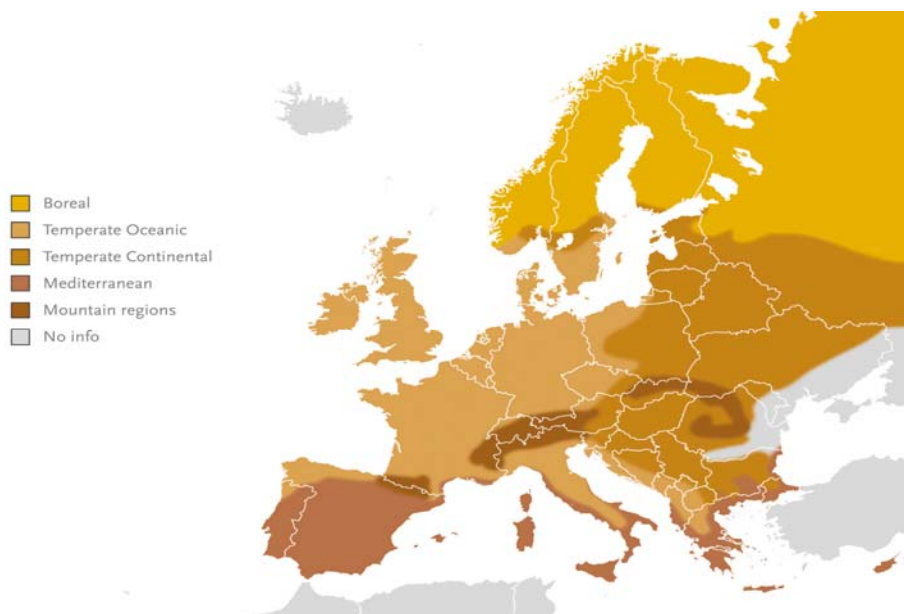
Precipitation (rainfall) is a limiting factor for forest productivity in the foothills of mountain ranges as well as in inner alpine dry valleys. Changes in the precipitation regime (amount, and also the seasonal distribution) in combination with increasing temperature may have a negative effect on forest growth and subsequently cause tree mortality. Growth of Scots pine, downy oak and Norway spruce in the Alps, beech in the lowlands of the Pyrenees, and Norway spruce in the lowlands of the



Mountain forest in Montafon Valley, Austria. Photo: M. Maroschek

Carpathians are already negatively affected by drought stress.

Abiotic risks (non-living factors which affect ecosystems, like wind patterns, precipitation, temperature). Mortality from forest fires could gain importance. In addition, windstorms might increase in the European Alps under future climate conditions. Through increased drought, the risk for forest fires will increase. Forest fires will be of particular importance in the Pyrenees.



Projected climate change impacts vary in different bioclimatic regions.

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Biotic disturbances (changes in living organisms). An increase in bark beetle infestations of Norway spruce stands (a group of similar trees) has already taken place, triggered by storm damage events and favoured by the increasing temperatures. The severity of fungal diseases in mountainous regions is strongly affected by changes in temperature and precipitation, especially the amount of snowfall and duration of snow cover.

Potential impacts on forest goods and services

Wood production. At higher elevations growth of current forests will increase as a result of the extended growing season, as long as the sites are not limited in water availability. Secondary coniferous forests at low elevation sites will suffer from decreased productivity and some conifer species may become unsuitable as a crop species.

Biodiversity. Actual species and habitat diversity will be strongly determined by changing disturbance regimes and management activities. Species-rich broadleaved forest communities will increase their potential area in the Alps and Carpathians.

Water retention and provision of clear drinking water.

Frequent and large-scale disturbances in mountain forests may negatively impact on water protection, due to reduced ability to dampen run-off peaks. Runoff is a term used to describe the water from rain or snowmelt that flows over the land surface and is not absorbed into the ground, instead flowing into streams or other surface waters.

Protective function against natural hazards. Different aspects influence the protective function of forests against natural hazards such as avalanches, debris flows, flooding, landslides and rock fall. In general, an increase in forest cover in an alpine zone (a zone at the highest level) and a subalpine zone (a zone immediately below the tree line) enhances protective functions, due to prevention of erosion, run-off dampening, reduction of avalanches, etc.



Currently highly productive Norway spruce dominated forests might encounter intensified bark beetle disturbance under climate change, calling for alternative management strategies. Photo: M. Maroschek

Adaptation options

- Adjust thinning and harvesting to the changing growth of forests.
- Select well-adapted tree species or new plants that are genetically similar to those that might have grown in the area previously, and favour them at the tending and thinning stages.
- Promote small-scale management and maintain the forest cover to secure its protective function against natural hazards and erosion.

The project **MOdels for AdapTIVE forest management (MOTIVE)** is a large-scale integrated project (project number 226544) in the 7th Framework Programme of the EU that develops tools to support decision-making in forestry in response to climate and land use change. It encompasses 20 partners from 14 European countries. It has an overall budget of almost 9 million euros, from which 7 million will be paid as EU contribution. The project is coordinated by the Forest Research Institute of Baden-Württemberg with duration of 4 years