



Mountain forest growth response to climate change in the Northern Limestone Alps

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Mountain forests offer a range of socio-economic and ecological services, such as protection from soil erosion and natural hazards (e.g. flooding, debris flow, rock falls and avalanches). However, the functions of these ecosystems can be significantly impacted by climate change. In particular, warmer temperature and an increased intensity and frequency of drought events may seriously impact the vitality of trees, but there are considerable uncertainties how the mountain forest tree species in the Northern Limestone Alps will respond to a changing climate. More detailed knowledge about the sensitivity and tolerance of native mountain forest tree species is required for a future-oriented forest management.

The aim of this dendroecological study is to assess the suitability of the most important mountain forest tree species spruce, fir, larch and beech, under changing climatic conditions in the Bavarian and Austrian Northern Limestone Alps. For this purpose, a comprehensive and unique tree-ring network was compiled consisting of ~1,200 trees. With a total of 50 studied sites, the investigation area covers a region of the Northern Limestone Alps with a west-east extension of 250 km and an altitudinal gradient of 1,200 m (~500-1,700 m asl). Growth responses to drought events and the long-term impact of the recent temperature shift through analyses along elevational transects were evaluated.

Spruce is identified as the most drought-sensitive species at the lower elevations. Fir shows a high drought tolerance and is well suited with regard to climate change. Larch shows no clear pattern, and beech seems unaffected at lower elevations albeit a strong dependence on site factors can be observed.

In summary, this study shows no negative long-term effects of current climate change on mountain forest tree growth in the Northern Limestone Alps. However, drought vulnerability was found in spruce below 1,200 m asl, and due to the predicted increase in frequency of extreme drought events, it is recommended to promote other native tree species (especially fir) in the spruce dominated Northern Limestone Alps. This would increase the stability of the mountain forests and also prevent bark beetle attacks and wind throw. Ecosystem functions resilient to current climate change, are thus likely to be found in a natural mixed mountain forest consisting of spruce, fir and beech in montane elevations, and spruce together with larch in the subalpine belt.