Department of Plant Ecology and Ecosystems Research

Temperate forests under Climate Change


Roof construction of a throughfall exclusion experiment in a mature beech-oak forest in NW Germany.


Open-top chamber facility for experimental reduction of air humidity around forest ground vegetation plants.

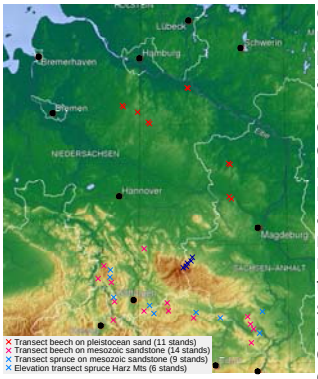

Study on effects of different degrees of soil drought and nitrogen deposition on beech saplings.


Raising temperatures already have led to increased attacks of spruce trees by bark beetles.

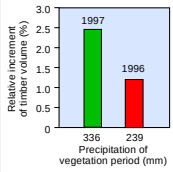
Background

Climate change scenarios for Central Europe predict higher precipitation in winter, but markedly drier and warmer summer periods. Hence, studies on the consequences of the altered growth conditions for forest trees are urgently needed to support the future forestry concepts. Results on the climate change response of tree species are ideally gathered by combining full-controlled plant experiments with tree saplings together with experimental approaches on adult trees in the field as well as by using space-for-time substitution transects (e.g. along natural rainfall gradients) as an alternative to long-term studies.

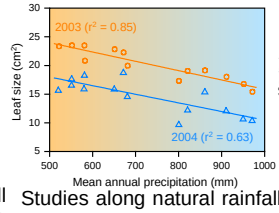
Research



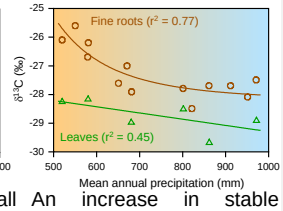
Currently, studies on the response of European beech (*Fagus sylvatica*) and Norway spruce (*Picea abies*) to different climate conditions are conducted along natural rainfall gradients in the lowlands of N Germany and in central German mid-elevation mountain regions. An elevation transect of spruce stands in the Harz Mts. allows for analysing effects of different temperatures on tree growth.



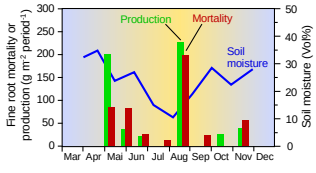
A reduced rainfall amount during the vegetation period often leads to significant reduction of the stem growth of trees (European beech, N Germany)



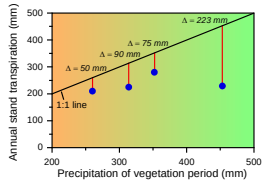
Studies along natural rainfall gradients sometimes reveal unforeseeable results: e.g. leaf size of beech trees clearly increases towards drier sites rather than it decreases as one would expect from textbook knowledge.



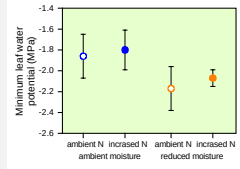
An increase in stable isotope $\delta^{13}C$ signature can be used as an indicator for reduced stomatal hydraulic conductivity as a result of drought stress on both leaf and fine root tissues (European beech).



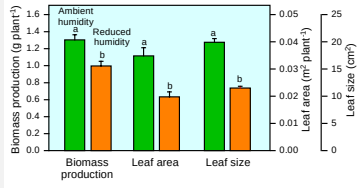
The fine roots (< 2 mm diameter) of trees often respond very sensible to the death of roots by severe soil drought by compensatory production of new roots (e.g. beech trees in the very dry summer in 1995).



Since beech stands appear not to differ markedly in their annual water consumption, stand transpiration at drier sites nearly equals rainfall in summer. These stands crucially rely on a soil water saturation in winter.



Like adult trees, beech saplings respond to reduced soil moisture by a decrease in leaf water pontential. Additional N availability seems to dampen this effect.



Not only reduced water availability, but also reduced air humidity has strong effects particularly on plants growing in the ground vegetation of forests (e.g. beech saplings). This phenomenon has mainly overlooked so far.

Major projects:"Biodiversity Manipulation in Rhizosphere and Soil" - Cluster of excellence "Functional Biodiversity Research"
"Growth and vitality of fine roots of Norway spruce - DFG Research Unit 562 "Soil Processes under altered climate"
"Ecophysiological responses of beech and spruce on drought stress" - KLIFF Lower Saxony "Research on adaptation strategies to climate change"

Key results

- Short-term responses and long-term adaptation mechanisms of trees to altered climate growth conditions are not necessarily equal. Hence, space-for-time transect studies may serve for identifying the amplitude of responses of tree species to changing climate factors.
- On the leaf level, trees respond primarely to drought stress with physiological adaptations that shall guarantee a sustainable water supply to the leaves. Carbon assimilation, in contrast, is often less affected by drought.
- On the root level, tree species often respond very rapidly to altered soil moisture conditions. In particular, the turnover of the fine roots appear to be markedly enhanced by higher degrees of soil drought.