Department of Plant Ecology and Ecosystems Research

Ecology of treelines


Forest patches built by *Polylepis* trees in the Andes form the highest forests of the world (up to 5200 m asl.).


Southern beech (*Nothofagus pumilio*) treeline at 1650 m asl. in East Patagonia (Mt Tronador, Argentina).

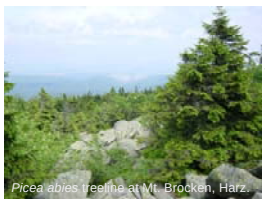

Treeline built by *Comarostaphylis arbutoides* (Ericaceea) in Costa Rica (3350m asl.).

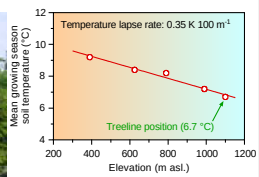

Treeline at the mediterranean Mont Ventoux (Southern France) *Pinus uncinata* stands (1750m asl.).

Background

Treelines are very conspicuous natural vegetation boundaries, and the causes and dynamics of treeline formation are among the most long-standing research topics in ecology. Treelines are under tight climatic controls, but they are also subject to intense human land use. Treelines are thus responsive to global change, and interest in treeline research has intensified in recent years. We study cold "alpine" treelines in high-elevation environments of European mountains, in the Andes, on oceanic islands and in the equatorial mountains of East Africa. Other projects focus on the dry "steppe treelines" of northern Mongolia and southern Patagonia, were forests border to semi-arid steppe vegetation.

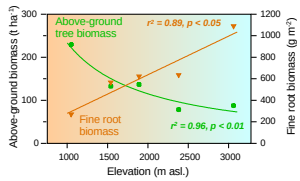
Research


Picea abies treeline at Mt. Brocken, Harz.



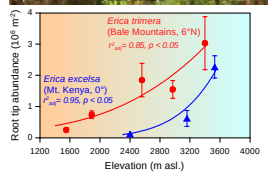
Most alpine treelines are characterised by adverse thermal growth conditions such as low soil temperature.


Alpine treeline South Ecuador (3100 m asl.)



Aboveground tree growth declines towards the alpine treeline, while belowground biomass increases.


Hagenia abyssinica trees near the afro-alpine treeline at Mt. Kenya.

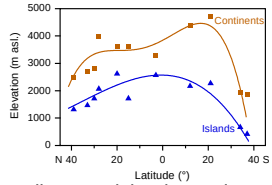


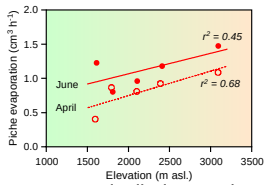
Strong elevational increase in root tip numbers at *Erica* treelines of tropical East Africa (Ethiopia, Kenya).


Erica trimera treeline.


Elephants near the treeline.

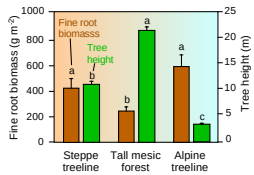
Afro-alpine treelines are often affected by fire and mammals (elephants).



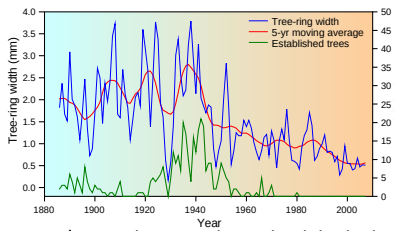


Treelines on islands are located at systematically lower elevations than those on continents. Some islands show climates of increasingly drier conditions at higher elevations (e.g. Tenerife).


Alpine and steppe *Nothofagus pumilio* treeline.



In S Patagonia, alpine and steppe treelines occur in close proximity. Trees at both treeline types respond similarly by increasing the root system, while the tree height declines.




Mongolian forest-steppe treeline of *Larix sibirica*.

Global-warming effects on the Mongolian steppe treeline are studied with tree-ring analyses and ecophysiological measurements.

Major projects: Hertel - ANDEN ETC. "funded by BMBF and DFG"
"The forest-steppe border in Mongolia" & "Global warming effects on Larix sibirica" - funded by DFG

Key results

- Alpine Treelines: Climatic measurements suggest temperature and moisture constraints to tree growth. In contrast to current theories about carbon allocation problems, trees at all studied treelines invest heavily in their fine root systems which are much more extensive than in stands at lower alititudes.
- Dry Treelines: Drought stress and herbivory by insects and small mammals prevent the trees in the Mongolian forest-steppe ecotone from encroaching onto grasslands. Late 20th century warming far above the global average reduces growth and regeneration in Mongolia's main tree species, *Larix sibirica*, but there is pronounced regional variation.