

Session 1. Physiological responses of trees to climate

Summary report

Participants considered a number of recent changes in forest ecosystems and discussed whether they could be attributed to climate change. They considered the following evidence in particular.

- The European droughts of 1976 and 2003 gave the opportunity to investigate some aspects of temperate tree response. Some forest tree species that were studied, such as common oak, appeared to be more resilient to drought impacts along an environmental gradient than others, such as Norway spruce, which had the highest negative growth response and recovered slowest. Beech showed a good stress tolerance after one year of drought and, albeit not considering root production maintained net growth through a loss of trunk wood and an elevated fructification. Compared to other tree species, annual mortality of beech was rare.
- In a review of papers published over the last 20 years, 30 papers describe the responses of wood properties in woody species. Most papers agree that increased carbon dioxide increases stem wood production and affects wood chemical composition, particularly increases in soluble carbohydrates. Wood cell structure experienced only minor changes. The combined effect of CO₂ and O₃ was noted to result in increased stem production in aspen. The effects of elevated temperature on wood properties were noted to be the least explored.
- Forest herbs along a latitude gradient found accumulated temperature explained much of the variation in seed production and viability. Results demonstrate that the impact of climate warming on the sexual reproductive traits of forest herbs will be most positive for spring blooming plants and negative for late summer blooming species.

Participants discussed the future impacts of climate change on forests, people and institutions and noted the following.

- Decreasing snow cover and increasing winter temperatures impact fine root dynamics through (mild) drought and frost. In the short term, fine root mortality is compensated for the root loss. Increased C and N will increase the carbon sink strength of Norway spruce fine root systems.
- Some tree species may be physiologically able to cope better with climate change stressors than others. Spruce for example may not cope and adapt on sites where it is introduced whereas native spruce sites may not be as much at risk.
- Climate change is expected to extend growing seasons. As a result the net primary production in temperate and boreal forests is likely to respond with increased photosynthesis. Increased production may net increase economics for tree harvest.

Some possible adaptation measures or management actions, including institutional change, identified by session participants included the following.

- Adaptive forest management may design dispersal corridors, assist migration to improve recruitment of herbaceous plants vulnerable to decreased reproduction when climate warms.
- A strong positive correlation between leaf area to sapwood area ratio and water availability has been observed for several different tree species worldwide. In the jarrah forest of Australia a significant decrease in leaf area to sapwood area ratio may show the jarrah forest ecosystem adapts to water stress by decreasing their leaf area relative to their sapwood area. Reduction in leaf area relative to sapwood area is an important adaptation for dry forests.
- Earlier greening of some tree species may put them at risk to frost damage.

- Soil temperature increases may speed up mineralization which affects nutrient availability related to increased production.

Participants noted the importance of including basic physiological indicators or variables into forest monitoring and assessment. An example would be leaf area: sapwood ratio as a way to indicate physiological stresses that could be moderated with management change. An expert panel of scientists could be formed to create a short list of indicators.