Session 5. Forest health: effects of air pollution, forest pests and pathogens

Summary report

Participants noted a variety of recent impacts on forest ecosystems that could be attributed to climate change.

- Ozone pollution continues to pose a significant threat in the Northern Hemisphere. Important abiotic forests stressors include increasing concentrations of tropospheric ozone and carbon dioxide and elevated levels of atmospheric nitrogen deposition. Increased ozone concentrations and nitrogen deposition disrupt the ratio of above and below ground biomass leading to increased susceptibility to drought thereby accelerating drought stress and exposing forests to increased insect outbreaks and wildfire.
- In Europe, data on deposition of sulphate, nitrate, and ammonium of the years 2000-2005 show marked spatial patterns and temporal trends. Sulphate has decreased in monitoring plots but sulphate, nitrate and ammonium deposition were found to still exceed critical loads at many forest sites.
- Climate change can affect forest pests and the damage they cause by: impacting their development, survival, reproduction and spread; altering host defences and susceptibility; and indirectly impacting ecological relationships such as changing the abundance of competitors, parasites and predators. A shift in geographic range (higher altitudes and latitudes) is being observed for many forest insects. Some insect emergence occur earlier in the spring and last longer.
- Increasing susceptibility of trees and forests to pathogens and insects because of climate change are present and expected to continue. In several papers, including ones presented by FAO and IUFRO Division 7, the current forest health changes caused by interactive effects of combination of stressors in various geographic areas as well as projections of the future expected changes in forest health have been compiled.
- In North America, forest fragmentation continues to affect forest health and function. Insect impacts in Canada are increasing. Aspen defoliators, gypsy moth, spruce budworm, and mountain pine beetle are all increasing in Canada. The current outbreak of the mountain pine beetle (*Dendroctonus ponderosae*) in British Columbia is the largest ever recorded. The epidemic has been attributed to a large expanse of even aged single species forest which has been exacerbated by fire protection practices and climate. Logging of pine of this general area is relatively recent. Even though many trees are killed, lodgepole pine continues to dominate the area and ¾ of stands attacked by the beetle usually does not need to be replanted. Logging and replanting in older age classes of trees may be reasonable but not for younger stands where merchantable wood is slight. Doing nothing for some age classes is often the best management practice.
- A variety of exotic invasive insects are increasing in Mexico. Lodgepole pine forests in the interior western US are severely infested by mountain pine beetle at higher elevations than expected. Favourable winter conditions are increasing insect outbreaks. Gypsy moth and other invasive species are continuing to spread into previously uninfested forests throughout the eastern US. *Phytophthora ramorum* is killing trees in California and Oregon but mortality is not apparent outside of those states.
- Recently, *Ips typographus* can realize two years of life cycle in one year in Poland and the Czech Republic. There are already thousands of hectares of dead spruce. The risk of outbreak in Norway spruce is more dangerous. Most bark beetles have predatory mites which keep populations in balance.
- Current large bark beetle outbreaks in temperate forests serve as carbon sources.
- In Ukrainian forests, the number, duration and severity of insect defoliator outbreaks have generally not changed over the last few decades with the exception of gypsy moth that has decreased and the European pine sawfly that has increased. The incidence of defoliators is highest in east Ukraine where pines have recently been planted in historically unforested land.
- Based on research on the spruce beetle in Slovakia, climate change is predicted to increase number of beetle generations and increase tree mortality across the range of Norway spruce.

- An example was given of pine processionary moth that expanded its range (altitude and latitude), as a result of increasing winter temperatures. Expansion has been documented in several studies in Italy and France.
- In subtropical Africa severe outbreaks of the fungus *Botryosphaeria* sp. on *Grevillea robusta* is increasing in severity and mortality with a drying climate. Many tree species are affected. Especially alarming is the attack on different *Eucalyptus* sp.
- Ash shoot dieback (*Chalara fraxinea*) is a new disease to Scandinavia from central Europe.
- The largest outbreak in history was recently recorded in Sweden of *Gremmeniella abientina* on *Pinus sylvestris* and *P. contorta*. Pre-outbreak weather is characterized by a cold and wet growing season followed by a mild and long winter period followed by another wet growing season. This fungus kills stressed trees.

Some of the future impacts on forests as identified in the session include the following.

- By 2050, 50 percent of forests may be affected by potentially phytotoxic ozone concentrations. Large increases in tropospheric ozone are projected, particularly in Asia.
- There will likely be an expansion of the range of the mountain pine beetle (*Dendroctonus ponderosae*) into Canada's boreal forest with climate change.
- Aspen and other ozone sensitive plants will continue to be affected by ozone deposition in North America.
- High insect mediated organic matter (insect frass/greenfall) inputs might enhance soil decomposition activity resulting in an elevated production of CO_2. Thus insect mass outbreaks might turn forests from carbon sinks to carbon sources.
- Highly coevolved relationships between insects and diseases and their hosts are expected to be disrupted. Host range expansion and contractions will cause crashes of some local populations of both hosts and their pests. Secondary pests may become more important in the future.
- Southern Europe diseases are predicted to move into boreal forests of Europe.
- Positive effects of climatic change include the expansion of tree species distribution and increased growth.
- Predicted mild winters and wet summers are likely to increase fungal disease outbreaks in Sweden.

While a number of examples were brought forth relating changes in climate and pest outbreaks, participants stressed that foresters need to be cautious about using climate change as an overall explanation for insect and disease outbreaks.

In discussing the future impacts of climate change on people and institutions, participants noted the following.

- Some climate change impacts may actually be positive such as lower snow accumulation that may reduce the winter survival of some forest pests.
- Economic assessment of mountain pine beetle infested stands in Canada find that replanting stands is not necessarily a good investment. Instead the study suggested that leaving the stand alone to develop after the beetle attack may be better. This is subject to change if wood demand or prices increase in the future.
- Society has assumed extreme expectations from forests and there may be a need to adjust our expectations of forest outputs as a result of climate change impacts, expected or unexpected.
- Extensive tree mortality from pest outbreaks has created awareness with the public and policy-makers to the importance of climate change.

Participants noted the following as potential management actions needed to adapt to climate change.

- There is a need to fill knowledge gaps related to natural enemies of forest pests under climate change scenarios. This includes research on the biology, ecology, and management of the complex suite of natural enemies (fungi, nematodes, mites and insects) and their relative abundance and nature of their association with forest pests.
- In declining spruce stands managers may have to plant other species.
- Studies show *Pinus contorta* is more resistant to *G. abietina* (European strain) than *P. sylvestris* in Europe. Plantations of *P. contorta* are currently restricted in Sweden but this policy may need to be reconsidered.
- The introduction of non-native species should be based on scientific knowledge, conducting pest risk assessments whenever possible because they can be very susceptible to pests if they are stressed in their new range.
- Biodiversified ecosystems are more resilient in a world of climate change. Better guidelines that are forward looking need to be developed. There is also a need for guidelines addressing large undiversified landscapes (such as pine in Canada) that are at risk and will continue to be so without management input.
- It was questioned how we can prepare to switch forests from one dominant tree species (Norway spruce) to another better suited species and how we can "buy time" through forest management to make the switch smoothly.

The following items were noted by participants through presentations and discussions in regards to policy needs.

- A global effort to conduct forest monitoring and research related to pollutant deposition needs to be designed to look at multiple pressures and interactions. These efforts are needed to assess risk to forests products and ecosystem services as well as opportunities to enhance forest products and ecosystem services. Air pollutant problems that started at the local level developed to have a global impact. Therefore well designed monitoring networks are required.
- Further legally binding protocols on air pollution abatement strategies are needed.
- North America and Europe need to harmonize forest monitoring and databases and efforts should be made to include the needs of developing countries.
- Methods to use lichens as air pollution severity indicators in forests need to be developed.
- More research and management on ameliorating forest pest damage is needed. There is a data gap especially with pest parasites and predators. The response by pest species that are regulated by natural enemies are not as easy to predict as those regulated by host-plant relationships.
- Focusing on single stress factors may lead to improper policy development.
- Governments tend to favour funding forest health modelling (short-term) rather than monitoring (long-term and expensive). There is a need for a balance of both options. Partnerships for monitoring need to cross political boundaries. Selection of appropriate indicators used in monitoring is difficult. Developing countries often have no capacity for forest monitoring. Multi-national or international monitoring efforts can be improved or developed.
- Invasive species networks need to be expanded and linked with one another. Existing databases and information need to be widely shared.
- Remote sensing techniques need to be improved to detect decline and dieback symptoms earlier.
- Vulnerability assessments should focus on monitoring high risk areas.