

Adaptation of Forests and Forest Management to Changing Climate with Emphasis on Forest Health: A Review of Science, Policies and Practices

Umeå, Sweden
25-28 August 2008

Conference Report

Organized by

Swedish University of Agricultural Sciences (SLU)
Food and Agriculture Organization of the United Nations (FAO)
International Union of Forest Research Organizations (IUFRO)

Supporting organizations and sponsors

Canadian Forest Service
Food and Agriculture Organization of the United Nations
Swedish University of Agricultural Sciences
USDA Forest Service
United States Geological Survey
International Union of Forest Research Organizations
Royal Swedish Academy of Agriculture and Forestry
Seoul National University

Table of Contents:

Preface.....	p. i
Summary.....	p. ii
1. Introduction.....	p. 1
2. Impacts – past and future.....	p. 2
2.1 Forest ecosystems – goods and services.....	p. 2
2.2 People and livelihoods.....	p. 3
2.3 Science and institutions.....	p. 4
3. Adaptation needs.....	p. 6
3.1 Forest management practices.....	p. 6
3.2 New needs from science.....	p. 8
3.3 Policies and institutions for adaptation.....	p. 10
4. Conclusions.....	p. 14
Annex 1.....	p. 15
Annex 2.....	p. 16
Annex 3.....	p. 17
Annex 4.....	p. 18

Preface

In August 2008, about 330 forest researchers, managers and decision makers from over 50 countries met in Umeå to present and discuss ideas, facts and figures relating to the adaptation of forests and forestry to climate change. The conference focussed on the current impacts of climate change on the world's forests, and on the implications of these changes for forest management and conservation, and for livelihoods. Presentations and discussions emphasised current and projected impacts, as well as research, policies and practices that are needed to manage healthy, productive forests in order to meet future needs for the full range of forest goods and services. On each day, two or three senior scientists, managers or policy makers presented keynote addresses during the morning Plenary Sessions. These keynotes were followed by four to five concurrent technical sessions of voluntary oral presentations and discussions. One poster session per day followed and allowed participants to view posters associated with the technical sessions. The "Book of Abstracts and Preliminary Programme", FAO document K2985/E, contains the list of keynote speakers and the text of all accepted abstracts. An electronic version of the document is available on the conference web site at www.forestadaptation2008.net. Session summaries are also presented on the web site.

The present document distils from four days of conference, the points of major convergence among talks and discussions and the notable highlights. By necessity, it is general, as it aims to convey mostly the most significant messages. It also omits some points that, although important, were not covered by presentations during the conference. Details on specific topics are covered by the Book of Abstracts. A planned special issue of a scientific journal and of a technical journal will cover specific subjects in greater detail.

The ultimate aim of this report is to inform larger processes involved in the global climate change dialogue about issues of particular importance to forests, to the forest sector and to people that depend on it. The report will initially be used by the [Expert Panel on Adaptation of Forests to Climate Change](#), a joint initiative on science and technology of the [Collaborative Partnership on Forests](#) (CPF) who will use it within their effort to provide technical and strategic background to forums such as the UNFCCC COP 14 in Poznan, December 2008, and the United Nations Forum on Forests meeting in the spring of 2009. We also hope that the Conference Report will become a foundation document for other expert meetings planned to take place in Russia, Beijing and elsewhere.

The Organising Committee wishes to thank all those who contributed to the success of this meeting. Many are listed in Appendix 1. The Science Committee members reviewed the abstracts and helped maintain a high quality of the content. The Session Chairs were of course pivotal in the delivery of the sessions and the management of the post-session discussion periods. The rapporteurs were essential links between the sessions and the small group that was tasked to produce the final report, a small group composed of Jim Carle, Maxim Lobovikov, Björn Hanell, Andrey Kushlin, Dieter Schoene and Pierre Bernier. Sincere thanks are also extended to the other supporting staff, in particular Alberto DeLungo and Michèle Millanes of the Conference Secretariat at the FAO, and Camilla Persson of the Umeå Folkets Hus who managed issues related to registration and to the venue.

Additional information presented in the annexes is: Facts and figures on conference participation in Annex 2, IUFRO-SPDC workshop and financial support for developing country participants in Annex 3, and the conference programme in Annex 4.

Summary

Impacts

Forest health and livelihoods are affected by climate change: Observations of current impacts of climate-mediated events on forests complement the IPCC's Fourth Assessment Report and include diebacks and mass mortality and more subtle but no less significant changes in tree physiology, forest biodiversity, forest growth and productivity. Through its effects on forests, climate change is already affecting livelihoods of populations around the world. The impact of committed climate change on forests will likely accelerate over the course of this century.

Adaptation of forest management

Adaptation of forests and forestry is possible, but will likely involve a paradigm change: Current thinking and tools from the existing forestry repertoire may be useful to reduce risk but may not suffice. Planned forest adaptation must expand beyond existing structures, processes and bodies of knowledge, towards supplementary knowledge, new methods, and novel fields of expertise. Expectations and goals for management and conservation will need adjustment to new risks and realities.

Monitoring and risk assessments are crucial for adaptation: Periodic forest assessments incorporating indices related to forest health and productivity are major, effective tools for adaptation in forests of developed and developing countries, and are the basis of risk assessments. Adequate staffing, training and funds for and continuity of monitoring are prerequisites.

Risk and uncertainty in forest management and conservation will increase and affect revenues. Awareness and acceptance of climate change is necessary at the management and operational level. Models and techniques for decision under uncertainty must be incorporated in management and applied in practice, and incorporate the forest owner's attitude towards risk. The costs of risk in forestry will likely increase and affect net revenues.

Adaptation of forest science

Monitoring and risk assessment methodologies have to be improved: The challenge of monitoring is to produce results at time and spatial scales relevant to the establishment of baselines and to the detection of changes in the forest cover at reasonable cost. Risk assessments must improve the capacity to incorporate complex responses of vegetation to environmental changes such as thresholds.

Advanced tree breeding may offer only a partial solution to challenges posed by climate change: Past tree breeding programmes have raised productivity of certain species significantly, but new programmes may have to increasingly focus on resistance to climatic events. The prospects for developing resistance to new pests or diseases however, are not very positive.

The forest science sector must learn to deal with and communicate uncertainty: Capacity building for communicating and managing risk and uncertainty will involve crossing borders to other disciplines. Decision models that deal specifically with risk and uncertainty are available in many disciplines including the management science sector.

Adaptation of forest policies

Climate change adaptation starts with people: Behavioural change might be the most immediate target of planned adaptation in a traditionally conservative sector. Increased awareness about projected global and local climatic changes and their expected impacts on forests and other natural resources, and information on heightened risk and uncertainty are prerequisites.

Developing countries need to be better supported: The necessity for planned establishment or enhancement of institutions and infrastructure for adaptation is particularly urgent in developing countries, and is linked to improved livelihood. Without significant assistance, sustainable management and conservation, reductions of emissions from deforestation and forest degradation, and adaptation of forests will not be feasible in developing countries.

Adaptation means redefining the rules: Managing the fallout from large climate-mediated crisis shows that normal organisational structures are often too narrow in scope to deal with major crises. Efficient planned adaptation requires a significant broadening of thinking across institutional barriers, and the formation of multiple partnerships.

Many adaptation-mitigation synergies exist in the forestry sector: Forestry offers strong synergies between adaptation and mitigation actions. The current initiative to reduce emissions from deforestation and degradation in developing countries (REDD) with mitigation as a prime target, provides an example for developing countries. Another example would be optimising the mitigation potential of wood products through policies designed to increase their use and their post-use conversion to bio-energy.

Adaptation and mitigation must link national and local policies: Adaptation is a response to local circumstances and is therefore a local concern benefiting local populations, whereas mitigation is a response to a global concern and is often dealt with at the country scale. Synergies are best achieved when policies are coordinated so that national mitigation policies gain community acceptance because they also promote local adaptation.

Reducing other risks to forests is also an adaptation to climate change: Some climate change is inevitable, and so is its capacity to impact forests. Atmospheric pollution, illegal logging, degradation by unsustainable practices and the threat of invasive species, on the other hand, are partly manageable threats to the forest. Policies designed to curb the impacts of such threats or stressors on the forests contribute to adaptation of forests to climate change.

1. Context and perspective

The fourth scientific assessment by the Intergovernmental Panel on Climate Change (IPCC), has recently concluded that global climate change is very likely to be happening, and to be caused by human activities. Forests are intricately tied to climate change as sources of greenhouse gases, when they are destroyed, and as sinks for carbon, when they grow or expand. As large, extensively managed, long-lived ecosystems on less favourable sites, they respond sensitively to climatic changes and may become its victims, together with the people that depend on them.

Worldwide, more than 60 million indigenous forest dwellers depend fully on forests and their products; over 1 billion people in developing countries obtain food from trees and 70% of humanity depends on forests as their sole source of medicine. Forests contribute to human well-being with a palette of services that range from wealth to water to wildlife.

When looked at from a climate-change perspective, forests stand out as storehouses of carbon that hold roughly twice as much as the earth's atmosphere. In addition, forests contribute the bulk of a current sink for carbon that we know to function in the terrestrial ecosphere. Valued at today's prices in carbon markets, the globe's forests subsidize the world economy with roughly \$25US billion each year. Adapting forests, equates to adapting for people, supporting livelihoods, promoting food security and alleviating poverty.

In regard to the future, at least two powerful, positive feedback loops to catastrophic climate change might be generated from forests:

- Without the thermal insulation provided by forests and woody vegetation, boreal forest and tundra soils could rapidly release huge amounts of carbon dioxide and previously frozen methane, a very powerful greenhouse gas.
- Parts of the Amazon rainforests may die back from drought and fires, releasing about 180 Gt of C towards the end of this century.

This international conference focused on adapting forests because their health and vitality is already perturbed by climate change. Progressive change will likely affect most of today's forests; a species or silvicultural choice taken today will have consequences for decades and centuries; even a slight annual risk of fire or wind storm will add up to a virtual certainty over the long lifetime of a forested landscape.

In the past, it was the crisis of vanishing forests and decreasing wood supplies that spawned the concept of sustainable development. In the present, the climate change crisis is showing up through forests that are starting to be impacted, sometimes dramatically, by climate-mediated events. Current observations and projections provide a first estimation of the adaptation measures that will be needed to cope in forestry and, eventually, in all other sectors. Although our vision is blurred by risk and uncertainty, our actions on today's forests link our generation to the next. This is a reality that underscores the need to incorporate adaptation to climate change in our current management practices.

2 - Impacts – Past and Future

2.1 Forest ecosystems – goods and services

Forest health is being affected by climate change. On all continents, increased incidence, duration or severity of abiotic extremes like fire, wind storms and drought, and of insect and disease outbreaks have significantly impacted local forests and, in many cases have also affected the livelihoods of local populations. The overall picture emerging is one of abrupt negative impacts from a wide variety of causes linked to an altered climate regime, with more subtle, gradual impacts visible only in some locations and for some tree species. Impact of global changes on the growth of the natural forest appears to be variable by region.

Forest cover is also severely affected by deforestation and land conversion, at times directly or indirectly linked to climate change. Forested areas are being cleared to make way for often low-productivity crop production or livestock management, or, increasingly, are being converted to energy plantations. Use of wood for domestic energy is also reducing the forest cover in some developing countries.

Examples of impacts come from all continents: Temperate and boreal forests experience less snow, shorter frost periods and more extreme weather that increase the frequency, extent or severity of fires, windfall and landslides. These events may predispose large, homogeneous forests of these regions to outbreaks of insects, diseases and other pests of historical proportions or in unusual locations.

Tropical ecosystems have been subjected to increased temperatures and more extreme El Niño – Southern Oscillation (ENSO) events, including greater incidence and velocity of typhoons, heavy rainfalls and extreme drought, flooding and landslides. Plantations of Eucalypts and other exotic species are increasingly affected by insects and diseases. Deforestation and forest degradation are aggravated by vulnerable communities who use forests as a coping mechanism when facing crop and livestock failure as a result of climatic extremes. Lower river flow and higher storm surges are increasing the salinity of water in coastal fresh water wetlands in North America and in mangrove forests in Asia, leading to degradations of these environments.

In arid and semi arid lands, drought has increased tree mortality and has generated deforestation, forest degradation, desertification and losses of entire ecosystems in forest ecosystems that have low adaptive capacity. The impacts of climate change in many of these environments include sand storms, reduced irrigation water, lowered water tables, reduced agricultural productivity, spread of invasive species and unstable communities through migration and urbanization. As the productivity and production of agricultural land declines, many communities with low adaptive capacity encroach into the forests for grazing, fuelwood, food and illicit harvesting for revenue generation, further enhancing their degradation.

The future rate of impact is imprecise but may accelerate: Precise future impacts of climate change on forest health, growth and composition are difficult to assess, and use of the global or regional climate change scenarios can only yield approximate images of localized forest futures. Sub-regional projections are still rare and incomplete. In addition, complex interactions between biotic and abiotic factors preclude simple deterministic point estimates

in all but the simplest cases. Under most circumstances, the future states of the world cover a wide range of possible outcomes but with asymmetrical consequences. Growth may be stimulated by warmer seasons, longer growing seasons and CO₂-fertilisation in temperature-constrained ecosystems. However, stand-replacing calamities will generate abrupt, large and localised losses with large and immediate impacts on local populations, and possibly significant positive feedbacks to climate change mechanisms. Projections suggest an increase in extent and severity of such events.

Two other anthropogenic phenomena add uncertainty to long-term prediction of forest health, growth and composition. The first is air pollution, mostly through ground-level ozone, a strong phytotoxic agent that interacts with climate change impacts in many complex ways, and particulate nitrogenous pollutants, the source of nitrogen deposition that may enhance growth as presently appears to be the case in Europe, but may also cause nutrient imbalances. The second is invasive species that are often introduced via inter-continental trade. Such invasive pests have already altered many forest ecosystems worldwide.

2.2 People and livelihoods

Climate change is already affecting people and livelihoods: The impacts of climate change and of extreme weather events on communities are diverse and depend upon the unique governance, social, cultural, environmental and economic circumstances. In general, richer societies are more buffered from the more direct effects of climate change, making them less prone to suffer large direct negative impacts of climate-mediated forest losses on their health and welfare. By contrast, the poorest communities in developing and least developed countries depend on forests for low-cost economic services (food, fodder, fuelwood) and immediate environmental services (protection from erosion, streamflow regulation, etc...). Environmental changes also often lead to decreased agricultural productivity, leading these communities to increase their use of natural ecosystems such as forests as coping strategies, further exacerbating the degradation and loss of forests.

In developed countries, some communities whose livelihoods depend on forest-based industries, and who are physically located within forested landscapes, are already affected by climate-mediated forest disturbances. The increased incidence of forest fires in the boreal forests of Canada leads to threats to population safety, while the economic fallout of the large mountain pine beetle infestation in British Columbia will inevitably lead to a major restructuring of the forest-based industrial sector with consequences for the welfare of local populations. Climate change also impacts demand for nature-based tourism and recreational services and patterns in the Western USA, resulting in changes in economic benefits, some positive, others negative.

In developing countries, current impacts of climate change on the welfare of local populations are more pronounced. In Northern India for example, decreasing agricultural productivity caused by unpredictable rainfall, shrinking glaciers, water shortages and land degradation, exacerbated by continued population growth, has increased pressure on forest ecosystems to meet basic livelihoods needs. In tropical landscapes where climate change and extreme weather events increasingly occur more frequently and more severe, vulnerable groups encroach and overexploit forest ecosystems for wood, non-wood forest products, fuel, food, fodder, medicines and other products as coping strategies. The negative economic and human welfare impact of climate change can be the most severe in rural communities, particularly

when the community governance is not functioning properly and the benefits are not reaching individual families.

In Asia and Africa, a greater incidence of human – wildlife conflicts has been noted due to changed ecosystems, water access and feeding patterns of a wide range of animals. In tropical and dry forests, savannahs and grassland ecosystems, extreme weather events (drought, higher temperatures and wind) have increased the incidence and impact of fires, which has resulted in large negative impacts on the lives and livelihoods of communities.

The relationships between climate change, forests and people are very complex and the impacts on people and institutions are difficult to model or predict in future scenarios. However, current observations demonstrate that the effect of forest mortality on local populations will likely be very different in developed and in developing countries, and particularly in the least developed countries. In the former, forest mortality may have a local economic impact, but this impact can be at least partially mitigated through appropriate capital investments, re-training of workforce or mobility of the population. In developing countries, however, extreme climate-mediated events will increase the risk of forest dieback or mass mortality, but may also impact agricultural production and generate food security issues. Additional uses of the forests as part of coping strategies by local populations will lead to further forest degradation. Enhancing local welfare is therefore the key to adaptation and preventing local degradation of forests, particularly in areas where forests are vulnerable to climate change.

2.3 Science and institutions

Climate change enhances multilateral and cross-sector collaboration: Climate change has already impacted both science and institutions in many fields of environmental research, particularly in the fields of forest ecology and forest management in particular. The need to improve our capacity to predict the fate of carbon stocks and dynamics and project future climates has led to dramatic advances in understanding of the feedback loops between forest ecosystems and the atmosphere, along with a significant increase in the capacity to integrate research results over space and time. Research has also had to cross disciplines to increase its understanding, but has also had to interact much more intensively with policy makers. The Intergovernmental Panel on Climate Change has been crucial in this respect, providing a preferred conduit for the transmission of technical information to global policy makers. At the same time, it has heightening the awareness of the research community to the type of information needed by decision makers and has also managed to reach out quite effectively to the public. This unprecedented level of dialogue has also taken place within national administrations as countries around the world have had to vet the assessment reports and had to take a stance on climate change-related issues.

Climate change has also brought home more clearly than ever the need to tackle global issues in a multilateral manner, and has forced countries to operate in such an environment. Global institutions and global governance are slowly taking shape as the scale of the challenge, and the consequences of not tackling it globally, become clear and accepted. This trend is also filtering down to regional and national institutions through which forest management stewardship is determined and enforced.

At the local level, current challenges and new outlooks as to the value of wood as a reservoir of carbon and as a source of renewable energy is opening partnerships between public and private sectors, and among sectors within the public administrations. Some forest certification schemes, initially conceived as vehicles to promote locally sustainable forest management now incorporate global contributions to the water and carbon cycles as yardsticks of forest management quality. Forestry has rapidly moved from a local concern of providing a raw material to a local industry, to an activity with global environmental and livelihood perspectives. Opening of carbon markets, development of new trading tools, emergence of third party certifiers are opening the traditional forestry models to a new world of interactions across many disciplines and across many different institutions, at local, national and global scales. Such changes are expected to continue in the future.

3. Adaptation needs

3.1 Forest management practices

Adaptation of forests and of forestry is possible. Observations have shown that forests health is already being impacted by climate change or climate-driven events. Such events have caused localised mass mortality that impacts livelihoods in addition to providing a positive feedback to climate change. In the future, there will be three possible management approaches for adaptation to climate change: non-intervention; reactive adaptation, and planned adaptation¹. Most current management belongs to the first, or at best the second category, but we must increasingly move into the third category of planned adaptation. This would include traditional and novel actions to mitigate the effects of climate change on forests or capture opportunities, advance planning to mitigate the impact of climate change on communities and livelihoods, and, at the global scale, actions to reduce the future contribution of diebacks and deforestation to climate change.

An example of non-intervention is that of extractive forestry that is still practiced in many tropical forests. Examples of reactive adaptation are post-disturbance changes in industrial processes to increase wood salvage, post-disturbance changes in growth projections for the determination of allowable cuts, and post-disturbance development of socio-economic support programmes for affected localities.

Planned adaptation is a paradigm change in forest management: Planned adaptation, on the other hand, is a pro-active approach that permits a better use of resources and a potential overall reduction of climate change impacts. Planned adaptation may redefine how and why forestry is done and could be seen as a paradigm change, a move away from a sustainable forest management based on maintaining past patterns of use or possibly past forest conditions, and towards a management of uncertainty and a goal of sustainable livelihoods.

Planned adaptation involves multi-level and cross-sector approaches. At the community level, planned adaptation may include diversification of forest-based and non-forest based income sources, increased local governance of local forest resources and general capacity building for the detection and management of climate change impacts. Within the industrial forest sector, planned adaptation may include diversification of product line to incorporate bio-energy or other emerging forest values and pro-active use of wood products' low carbon footprint as a marketing tool. At the national and global level, planned adaptation may include a timely monitoring and reporting system and the development of tools for vulnerability assessments and adaptation planning. Management might also be increasingly required to look at the global implications of actions, as forests are part of global biogeochemical cycles.

Examples of stand-scale adaptation actions include implementation of practices that reduce vulnerability and increase resilience to extreme events at the expense of growth, such as the planting of a larger diversity of species and provenances, or of trees genetically improved for

¹ Unfortunately, definitions for various types of adaptation are inconsistently used within and between IPCC and UNFCCC. Particularly definitions and uses of the terms “autonomous adaptation” and “planned adaptation” are ambiguous. Autonomous adaptation may refer to adaptation to climate change that employs only the resources and methods within a system. At times, it designates non-deliberate or unconscious changes within a system due to external forces. Planned adaptation involves new resources and methods in a more fundamental change from past business-as-usual. Planned adaptation is always anticipatory, whereas autonomous adaptation can be anticipatory or reactive.

resistance to expected stressors, the introduction of structural diversity (uneven spacing, and age classes). Examples of landscape-scale adaptation options include the establishment of landscape-level targets of structural or age-class, of landscape connectivity for species movement, and of passive or active measures to minimize the potential impacts of fire, insects and diseases, and the increased afforestation and reforestation, and the rehabilitation of degraded forests. At the national scale, adaptation options may include *a priori* vulnerability assessments and preparations for increased use of salvage logging procedures.

Adaptation of management to climate change may also include implementation or maintenance of an overall management process where targets and results, as well as the effectiveness of options are revisited and assessed periodically against emerging issues and changing environmental conditions. Finally, one clear action and outcome of the scenario analysis is that forest management planning must move away from a deterministically-based approach in which the projections are assumed to follow simple trajectories over time, to approaches that embrace and incorporate uncertainty and the increased probability of extreme events.

Planned adaptation requires monitoring and assessment of impacts: Forest managers need to initiate or intensify monitoring and assessment of productive or protection functions. Monitoring at sub-national and national scales can provide early warning of forest diebacks and of pest and disease outbreaks, and provide managers with an improved capacity to manage uncertainty, coordinate early action, minimize damage, and assist adaptation. Damage assessments on the other hand, can be done *post facto* to determine impacts of diebacks and outbreak on socio-economic systems, influence policy decisions, and provide a link to decision-making processes. Many management actions could be taken to support this need. These include:

- Improving national, regional or operational forest health monitoring networks
- Harmonising inventory and reporting protocols of such networks,
- Expanding and linking invasive species networks

Most developed countries with significant forest cover already track tree growth and forest status, and have invasive species networks. Such investments should be maintained, but particular emphasis could be placed on the more vulnerable areas. Developing and least developed countries, on the other hand, may lack the resources and expertise to support adequate monitoring of forest health and damage assessments, leading to difficulties in providing adequate early response and performing appropriate actions for mitigating either the event or its impact on the socio-economic development. In such countries, planned adaptation must start with resource transfer from developed countries and capacity building.

Risk assessment is also a core component of planned adaptation: Within planned adaptation, vulnerability or risk assessments of the forest can be used to identify where proactive management of the risk is worthwhile, and where the response options in the current forest sector repertoire are insufficient. In the short term, current trends in the regime of abiotic and biotic events can be used as drivers for management actions for wood and non-wood forest products.

As an example, the recent wind storms and droughts in Europe are now drivers of planned adaptation in that region. Foresters have long known that spruce is more vulnerable to storm

or drought than hardwoods, and that even-aged stands are less resilient than uneven-aged stands, but have often failed to integrate realistic risk assessment into management decisions. They now increasingly enhance the stability of stands by silvicultural means that de-emphasize productivity. Drought is also a concern under future climate conditions. In one experiment, heavy thinning has improved resilience of Norway spruce stands, as measured by the faster recovery of basal area growth, following extreme droughts in 1976, 1992 and 2003, although such response may be local. More drastic changes in management, e.g. gradual shifts to drought-resistant introduced species might be necessary in planned adaptation.

Similarly, many forests in developing countries are presently at risk because of increases in the severity of drought events and associated biotic and abiotic disturbances. Appropriate risk assessments would help identify vulnerable forests and vulnerable communities and support the development and funding of appropriate adaptation actions.

Managing forest for protection and biodiversity requires special attention: Management of forest lands for the conservation of biodiversity and of the forest's protective functions must be based on assessments of risks to these protective functions and a cost-benefit analysis of the management investment. Proximity services such as protection of communities against slope failures, rock fall or avalanches are easily identifiable and are likely those that may generate the most direct management actions. The protection of the more indirect services such as contributions to global cycles and protection of biological biodiversity, likely requires land use planning and protection status as the most effective management tool, especially in developing countries. Appropriate plans for such areas must recognise potential changes in environmental conditions and include engagement of local communities, monitoring, and the consideration of innovative financing mechanisms.

3.2 New needs from science

"The significant problems we face cannot be solved at the same level of thinking we were at when we created them." (Albert Einstein)

Monitoring and risk assessment methodologies have to be improved: The transition from past to future climate will generate large-scale stresses on forests that will potentially translate into large-scale events of mass mortality as a result of abiotic or biotic factors. There is a clear consensus that monitoring is the key to proper application of adaptive practices to forest management in the face of on-going climate changes. This places two requirements on science. The first is the pursuit of better and cost-efficient methods of multi-scale monitoring systems for early detection of change in forest status and health. The second is the development, testing and improvements of risk assessments methods. Improved risk assessments are particularly important since, when matched to actual events, provide a powerful feedback mechanism for improvement of management plans and of global efforts to determine future positive and negative feedbacks to climate change. On the monitoring side, remote sensing is slowly coming of age as a global monitoring tool as frequency of coverage and resolution enable the capture of some ephemeral, small-scale phenomena. Remote sensing applications to forest health may enable early detection or at least mapping of areas with forest health problems, and may be particularly useful in areas lacking systematic ground surveys or as a stratification tool for subsequent ground surveys.

Risk assessments will have to learn how to incorporate the complexities of forest responses to stress. However, while many forest diebacks seem occur as site-specific thresholds for critical

species are crossed, other more complex stories of diebacks are emerging, underlining the complex and sometimes unpredictable nature of the interaction between site conditions and the trees' life cycle dynamics. And although the most large and apparent climatic changes are occurring at high latitudes, smaller climate changes in tropical environments may also have very large effects on vegetation because of the complex inter-dependence of organisms in such environments and of their usually narrow range of climatic suitability. Multiple interactions may lead to rapidly increasing incidences of large forest diebacks or mass mortality in the future. This poses a definite challenge to risk assessments.

Advanced tree breeding may offer only a partial solution to challenges posed by climate change. Increased climatic stresses may call for genetically improved trees that can capture the new growth potential, or better resist drought. Short rotations could be used with genetically improved stock for bioenergy or to reforest areas where previous species failed. Productivity gains and increased drought resistance already achieved suggest further possible gains. Matching provenances to new site conditions could be another goal.

The prospects for developing resistance to new pests or diseases, however, are not positive. After some 50 years of tree breeding, very few gains have been made in developing tree varieties that are resistant to existing pests and diseases. Gains have been made in some cases, but did not involve economically important species with major long-standing disease problems such as the Eastern white pine (*Pinus strobus*) or the American chestnut (*Castanea dentata*). Emerging forest health issues with tropical plantations *Eucalyptus* and other exotic species are also underlining the urgency of developing new approaches in forest genetics.

The forest science sector must learn to deal with and communicate uncertainty: In the face of incomplete knowledge, forest science must learn to provide scenarios and evaluate associated uncertainties so that informed policy decisions and management actions can be taken. Managers and policy makers must learn to accept and handle uncertainties and tailor actions that correspond to their attitude towards risk. Pilot projects, periodic re-assessments, insurance, and risk-spreading are methods by which uncertainties can be dealt with. Dealing with uncertainty and managing risk are not well developed concepts in forestry, and must therefore be brought in from fields in which they are commonly used, such as management science, econometrics, insurance and engineering.

There is also a need for modellers to engage more with stakeholders and outside expert groups to incorporate their judgement and attitude towards risk and to translate model results into language that is understood by key decision makers. Quantifying uncertainties as probability distributions in modelling would improve meaning of results, as uncertainty is currently rarely adequately incorporated into stochastic models.

Adaptation and mitigation research must include socio-economics: The root causes of climate change are linked to behavioural patterns of people, and its impacts become catastrophic to the extent that they affect populations. Impetus for change in the forest sector comes chiefly from socio-economic, not ecological crises, and it is only by linking the physical drivers to their socio-economic impacts that scientists can fully inform policy makers. Within the context of adaptation of the forest sector to climate change, this linkage can be done by elevating the importance of the social sciences in the evaluation of the adaptation capacities and assessment of risks for communities, land-uses and forest management to climate change. Ultimately, changes in land use and forest management practices can be best justified if they are linked to impacts on socio-economic indicators.

Science and technology in developing countries needs to be better supported: A message that stands out clearly from this conference is the large gap between developed and developing countries. Whereas the former push ahead with large multidisciplinary efforts aimed at refining risk assessments and at implementing adaptation and mitigation options, the latter are often faced with a serious lack of technical and governance capacity, resulting in a lack of local information on which to make climate change adaptation decisions and leadership to implement them. Compounding the problem are the serious and immediate issues of poverty and instability that make planned adaptation difficult, and the presence of vulnerable environments that make large and negative impacts on livelihoods locally unavoidable. Clearly climate change is an equity issue that has to be better addressed by the global community. Technical capacity building within these countries is a necessary component of adaptation of forests, forest management and forest-dependant communities to climate change. North-South relations need planned adaptation for the common good.

3.3 Policies and institutions for adaptation

Lessons from a crisis: Adaptation means redefining the rules: Governmental institutions, are structured to respond to the needs of society in times of average stresses, but may not be able to cope efficiently in the face of extreme or highly unusual challenges. In the particular case of forestry or related land-uses, there appears to be a general lack of governance, policies and legal frameworks to specifically deal with climate change adaptation. Adaptation to climate change is as much a cultural and intellectual challenge as it is an ecological one, requiring thinking and acting outside the traditional intellectual and institutional frames. In cases of extreme events with profound ecological and socio-economic impacts, efficient adaptation may require reaching beyond the normal management structures.

Lessons may be learned from current forest crises linked to climate. One of the most pre-eminent of these is in British Columbia, Canada, where 15M ha of lodgepole pine forests have been affected by the Mountain Pine Beetle. The current loss of about 500 M m³ of commercial wood, and projected loss of an additional 400 Mm³ over the next few years, will have a large impact on the livelihoods of all communities in the region where forest-based industries are the centre of the economy. Some of the messages learned from people at the heart of this issue are that:

- Catastrophic events can happen abruptly and overtake our knowledge
- Data is important, but often insufficient to change people's attitude
- Generating the appropriate adaptation responses involves revisiting all the rules
- Adaptation opportunities often lie where departmental expertise or jurisdictions overlap
- Successful mitigation of consequences requires the development of partnerships

An additional message is that, although reactive management is sometimes the only possible option, careful, planned adaptation is usually the most productive pathway. The challenge of planned adaptation, however, is to proceed with a change in forest management policy without having had the benefit of a crisis to overcome the natural inertia of forest management agencies, or the perceptions of the public.

Since land management orientations are based on national policies, these policies must therefore include climate change within the very fabric of management approaches. In developing countries, policies relating to adaptation of forest management to climate change need to be interlinked with rural development and agricultural policies that focus on people, poverty alleviation, food security and livelihoods issues in communities vulnerable to the negative impacts of climate change. Under such circumstances, income diversification may be the most appropriate climate change adaptation strategy, and may serve to protect forests from overuse in times of environmental crisis..

The management of an extreme crisis has taught land managers that adaptation of forests and forest management to climate change demands building bold new partnerships between the public, private and institutional sectors, and the communities at risk. Crisis management has also resulted in a division of forces between short-term response to mitigate the impacts, and long-term responses to decrease vulnerabilities. All this has meant increased collaboration within and between key land-user groups, a more prominent and proactive role for the private sector and more inter-agency engagement across sectors and institutions.

Many adaptation-mitigation synergies exist in the sector: Adaptation to climate change and mitigation of climate change are often thought of as separate concepts, the former being concerned with livelihood issues, while the latter addresses the global biophysical problem. However, both are strongly linked, and explicit recognition of this linkage may provide real win-win situations. In all countries, if properly planned and linked to local adaptation policies, afforestation and reforestation, curbing deforestation and managing forests sustainably as mitigation actions will often have beneficial side effects that may help local populations to better their livelihood and withstand climate change. Maintaining or creating forests generates many local benefits

Benefits from adaptation-mitigation synergies under climate change are particularly urgent in developing countries and could be drawn from agroforestry. Agroforestry practices sequester only modest amounts of carbon per ha, but can be introduced in almost unlimited combinations of trees, including bamboos and palms, with agricultural crops, garden products, grazing or fishponds on a huge area globally. Current crop-or grazing lands as well as millions of hectares of degraded lands could be amenable to this option. Agroforestry has the potential to contribute substantially and worldwide to global mitigation and local adaptation of rural societies.

In several aspects and in their overall effects, current efforts at introducing “Reducing emissions from deforestation in developing countries (REDD)” are defined from their original concept as mitigation activities. However, a more successful approach may be to view and promote REDD as an additional way to adapt forests, forest dependent people, rural communities and the developing countries themselves to expected impacts of climate change. REDD must not focus on “payoffs for not doing wrong” but instead on “incentives for doing right”, that is, initiating sustainable forest management and conservation. . Forests are “non-excludable” from national accounting of carbon stocks and changes in stocks, and all efforts at carbon removal or emission reduction using forests will face a high risk of being temporary without adequate adaptation. Deforestation and degradation can only be reduced and long-term adaptation undertaken, if forests are managed sustainably.

Adaptation and mitigation are community-level livelihood issues: The loss, fragmentation and degradation of the forest cover are strongly linked to economic, demographic and livelihood issues and can only be tackled efficiently if management actions explicitly recognise these competing influences. In this respect, one of the problems regarding the linkage between adaptation and mitigation is that potential benefits and responsibilities accrue to different levels of governance within a country. Adaptation is a response to local circumstances and is therefore a local concern benefiting local populations. Mitigation, on the other hand, is a response to a global concern and is often dealt with at the country scale. Thus, although mitigation through forestry-related actions takes place necessarily at local levels, the responsibility rests with national government so that benefits also accrue at that level. The challenge of mitigation policies is therefore to ensure that significant benefits from mitigation actions flow to communities, and the best manner may be to also ensure that mitigation actions also promote local adaptation to climate change.

Reforestation of privately-owned degraded agricultural lands has been offered as a good example where local economic considerations may prevent implementation of reforestation. Current owners who use such lands for raising livestock may prefer the economic flexibility offered by the livestock in uncertain times to the potentially larger gain made from the proceeds from realised afforestation credits at some later date. National policies aimed at promoting afforestation / reforestation must account for such issues.

Supportive policies towards adaptation at the local scale are therefore policies that generate local wealth and increase adaptive capacity, while promoting retention of the forest for the sustainable production of community benefits. These include the promotion of community based forest management, the development of agroforestry, the availability of microfinance, the training in NWFP management, marketing and manufacturing, and a greater role for women. Community plantings, village woodlots, shelterbelts, partnerships with private sector and public awareness campaigns through the media, children's education programmes and field demonstrations have also proven to be effective adaptation mechanisms to improve community and individual welfare. To be effective, these need to be supported by sound governance, strengthening institutions, greater participation (including the private sector) and education, greater accountability, reinforced monitoring and community access to benefits. Such policies are most urgently needed in countries with high population pressures, land use issues and vulnerability to drought and extreme weather events.

Industries can also benefit from the drive to mitigate climate change: Adaptation is not limited to communities, but also extends to industrial entities for which climate change is a new variable in their operating environment. In addition to the forest management aspects, adaptation of industries, or of the forest sector, to this new environment means an adaptation to the mitigation efforts, as industries position themselves with respect to this new market value.

Investments in wood production through improved silviculture in countries such as Sweden or through planted forests in many developed and developing countries provide mitigation of climate change and also represent adaptation by the forest sector. Moreover, companies can market wood-based products as low-emission alternatives to steel and concrete. Wood products can also be recycled as a source of bio-energy at the end of their life cycle, thereby adding market appeal to their image as environmentally sound products.

Developing the bio-energy market can also be used as an adaptation measure for areas that have suffered climate-related forest calamities. Burning wood is carbon neutral, save for the energy used for extraction, processing and distributing, and pro-bioenergy incentives in many countries are making production and shipment of wood pellets an attractive opportunity. In the US, the recently increased expenditures for fighting forest fires are a strong incentive for alternate use of timber as bio-fuel. In addition to traditional wood-based products, forest residues and purpose-grown energy forests can provide fuel for heat, energy and transport.

Finally, policies for diverting discarded solid wood materials from the traditional waste stream towards bio-energy facilities would have the double effect of reducing methane emissions from landfills (in landfills not equipped to capture such emissions) and producing carbon neutral energy. Coherent energy policies through the complete value chain of forest products will therefore play an increasingly important role in mitigating climate change.

Reducing other risks to forests is also an adaptation to climate change: We are on the path to a new global climate regime, and current global policy efforts can only slow down its rate of progress. Under such circumstances, reducing non-climate related stressors on the forests and forest communities could be seen as a measure of adaptation to the inevitable stresses linked to climate change. Three policy avenues are presented below.

In many developed countries, forests affected by chronic air pollution, in particular by ground-level ozone, are pre-disposed to suffer from environmental stresses such as drought or from pests and diseases. In addition, exposure to ozone prevents forests from benefiting from the CO₂ fertilisation effect. Policies to curb ozone pollution in developed countries would improve the health of forests, enhance their growth and decrease their vulnerability to climate-mediated events.

Illegal logging is particularly acute in forest-rich developing countries where local governance is insufficiently structured to support sustainable management. Illegal logging has negative environmental impacts, and impoverishes local communities by depriving them of forest-based revenues. Environmental certification has been embraced mostly by companies operating in countries with good forest stewardship but has not yet had a large impact on illegal logging. Policies to reduce illegal logging could be seen as planned adaptation of forest management as they would likely improve the sustainability of forest practices, generate additional revenues and raise the adaptive capacity of local populations.

Finally, invasive species are an ever present threat and are part of the larger phenomenon of global change. Invasive species are probably the largest uncertainty that hangs over every forest estate on all continents, and this threat is heightened by the ever-increasing inter-continental trade and by the gradual decline in climatic barriers in the northern countries. Policies and measures are already in place to minimize the risk of an invasion by alien pests and diseases, but additional policies to strengthen these measures are part of a planned adaptation response to global change in general, and to climate change.

4. Conclusion

In summary, there are a few take-home messages that emerged most strongly from this conference.

Forest health and forest ecosystems are already being impacted by climate change, and this impact will likely accelerate, with local and global negative consequences. Adaptation is possible, but we have to plan and act rapidly.

Adaptation needs and capacity differ dramatically between developed and developing countries. In developed countries, issues are of a more technical nature, and address concerns raised with respect to the forest and the forest industry. In developing countries, issues are often more immediate, at the community level, and are fuelled by conflicts between environmental and economic objectives. Supporting community forestry appears of high importance.

Reducing deforestation in developing countries is now on the global climate change agenda, but this it is not clear how internationally-negotiated programmes will affect the people whose livelihoods depend totally or partially on these lands and forests. Successful mitigation programmes must ensure that local poverty is not exacerbated, and should support adaptation.

Adaptation and mitigation can be co-managed into win-win solutions, as mitigation programmes can promote sustainable forestry which, in turn, should decrease the vulnerability of local populations to climate change.

There will never be enough information to bring certainty to decision making. In order to be relevant to the challenge at hand, science must therefore learn to move from “finding exact solutions to approximate problems” towards a greater capacity to “provide approximate solutions to exact problems”.

Annex 1: List of members of the Organising and Science Committees, and list and affiliation of session Chairs.

Organising Committee	Björn Hånell (SLU/IUFRO) Jim Carle (FAO) Göran Hallsby (SLU) Pierre Bernier (FAO / Natural Resources Canada)
Science Committee	Björn Hånell (SLU) Gillian Allard (FAO) Perry Brown (University of Montana, U.S.A.) Andrzej Bytnerowicz (U.S. Forest Service) Dave Cown, Scion (New Zealand) Manuel Guariguata (CIFOR, Indonesia) Hans Heinemann (Swiss Federal Institute of Technology) Werner Kurz (Natural Resources Canada) Bailian Li (North Carolina State University, U.S.A.) Alex Mosseler (Natural Resources Canada) Catherine Parks (U.S. Forest Service) John Parrotta (U.S. Forest Service, U.S.A.) José Antonio Prado (FAO) Robert Szaro (U.S. Geological Survey, U.S.A.) Margarida Tome (Technical University of Lisboa, Portugal)
Session Chairs (See Appendix 4 for session names)	S1: Jan-Erik Hällgren (SLU) S2: José Antonio Prado (FAO) S3: John Innes (University of British Columbia, Canada) S4: Heinrich Spiecker (University of Freiburg) and Kari Mielikäinen (Finnish Forest Research Institute) S5: Andrzej Bytnerowicz (U.S. Forest Service) and Gillian Allard (FAO) S6: Niels Elers Koch (Royal Veterinary and Agricultural University of Denmark) S7: Marcus Lindner (European Forest Institute) S8: Perry Brown (University of Montana, U.S.A.) S9: Hans Heinemann (Swiss Federal Institute of Technology) S10: Mark Johnston (Saskatchewan Research Council, Canada) and Tim Williamson (Natural Resources Canada) S11: Manuel Guariguata (CIFOR, Indonesia) S12: Kurt Johnsen (U.S. Forest Service) S13: Pierre Bernier (FAO) S14: Andrey Kushlin (World Bank) S15: Margarida Tomé (Technical University of Lisboa, Portugal), Tomas Lamas (SLU) and Ljusk Ola Eriksson (SLU) S16: Tomas Thuresson (HäradSkog AB, Sweden) S17: Werner Kurz (Natural Resources Canada) S18: Katsuhiko Takata (Akita Prefectural University, Japan)

Annex 2: Basic statistics on participation to the Conference

A2.1 Number of participants by country

Algeria	1	Finland	18	Pakistan	1
Argentina	2	France	1	Philippines	1
Armenia	1	Germany	17	Poland	3
Australia	3	Ghana	3	Portugal	3
Austria	9	Greece	1	Republic of Korea	10
Bangladesh	2	Guyana	1	Russia	8
Belgium	5	Hungary	2	Saint Vincent and the Grenadines	1
Bolivia	1	India	7	Sierra Leone	1
Brazil	1	Indonesia	9	Slovakia	2
Burkina Faso	3	Italy	15	South Africa	3
Cameroon	2	Japan	7	Spain	3
Canada	30	Kenya	2	Sudan	2
China	2	Latvia	1	Sweden	81
Colombia	1	Mexico	1	Switzerland	6
Costa Rica	5	Mongolia	1	Taiwan	1
Cote d'Ivoire	1	Morocco	1	Turkey	1
Czech Republic	3	Nepal	3	Ukraine	1
Denmark	5	Netherlands	4	United Kingdom	2
Estonia	1	New Zealand	2	United States	21
Ethiopia	1	Norway	5	TOTAL	331

A2.2 Classification of participants by countries aggregated according to the World Bank List of Economies

High income	255
Upper Middle Income	28
Lower Middle Income	19
Low Income	29

Annex 3: Pre-conference Workshop and financial support to participants

Prior to the conference, on 22-23 and 24 August, the IUFRO's Special Programme for Developing Countries (IUFRO-SPDC) with the support of the Swedish University of Agricultural Sciences (SLU) hosted a Pre-Conference Training Workshop on: "Adaptation of Forests to Climate Change: Working effectively at the Interface of Forest Science and Forest Policy". All 22 workshop participants were scientists or forest managers from developing country that received financial support to attend the workshop. Details on this workshop can be found on the IUFRO-SPDC web site: <http://www.iufro.org/science/special/spdc/>

The workshop was tied to the conference in a two-way partnership that enhanced both activities. One of the prerequisite for getting financial support was to have an accepted oral or poster contribution to the Conference. The SPDC thus relied on the conference review system to provide a list of prospective candidates for funding consideration. In return, the conference was enriched by the participation of these workshop participants.

In addition to the 22 participants to the IUFRO-SPDC workshop, other funds from SLU, FAO, and United States Geological Survey were used to support an additional 17 participants to attend the conference, for a total of 39 participants from 22 countries. The participants from developing countries made significant contributions to the conference. They were able to expose the larger group to the very different realities of forestry and climate change in developing countries.

Annex 4: Detailed conference programme (A preliminary listing of presentation by session is provided in the Book of Abstract).

Sunday 24 August 2008

16h00 – 18h00: Registration and poster installation

Monday 25 August

08h00 – 10h00: Registration, poster installation and coffee

10.00 – 12.00 hours: Opening and Keynote addresses (Chair: Björn Hånell, in Idun room)

- Ms. Lisa Sennerby Forsse - Rector, SLU
- Mr. Jan Heino - Assistant Director-General, Forestry Department, FAO
- Mr. Don K. Lee - President, IUFRO
- Ms. Abigail Kimbell - *Managing forests in an era of climate change: Perspectives from the U.S. Forest Service*
- Michael Wood - *Alternative Energy Cooperation between the U.S. and Sweden and the Search for Forest-based Solutions*
- Risto Seppälä - *Increasing Knowledge about Adaptation of Forests to Climate Change: An Expert Panel Approach*

12.00- 13.00 hours: Lunch

13.00 – 15.00 hours: Parallel technical sessions (Part 1)

- S1- Physiological Responses of Trees to Climate
- S3 - Impacts of Altered Regimes of Extreme Abiotic Events
- S10 - Climate Change and Forest Sector Adaptive Capacity
- S13 - Dieback and Mortality: Assessment and Early Warning

15.00 – 16.00 hours: Coffee break and **poster session**

16.00 – 17.00: Parallel technical sessions (Part 2)

- S1- Physiological Responses of Trees to Climate
- S3 - Impacts of Altered Regimes of Extreme Abiotic Events
- S10 - Climate Change and Forest Sector Adaptive Capacity
- S13 - Dieback and Mortality: Assessment and Early Warning

17.00 – 18.00 hours: Informal poster session

18.00 hours: Social and walking dinner party

Tuesday 26 August

08.00 – 09.30 hours: Keynote addresses (Chair: Jan Heino, in Idun room)

- Jacques Régnière - *Predicting insect continental distributions from the physiology of individuals.*
- Brent Larson - *Phytosanitary issues related to climate change, invasive alien species and trade: How to use the framework of the International Plant Protection Convention for the management of forest health.*
- Dieter Schoene - *Forest health and adaptation of forest management: Perspectives from the IPCC's Fourth Assessment Report (AR4)*

09.30 – 10.30 hours: Coffee break and **poster session**

10.30 – 12.00 hours: Parallel technical sessions (Part 1)

- S4 - Impacts of Climate Change on Forest Growth
- S5 - Forest Health: Air Pollution, Pathogens and Forest Pests
- S8 - Socio-Economic Functions and Livelihoods
- S15 - Scenarios and Modelling for Forest Management Planning

12.00- 13.00 hours: Lunch

13.00 – 14.30 hours: Parallel technical sessions (Part 2)

- S4 - Impacts of Climate Change on Forest Growth
- S5 - Forest Health: Air Pollution, Pathogens and Forest Pests
- S8 - Socio-Economic Functions and Livelihoods
- S15 - Scenarios and Modelling for Forest Management Planning

14.30 – 15.00 hours: Coffee break

15.00 – 17.00 hours: Parallel technical sessions (Part 3)

- S4 - Impacts of Climate Change on Forest Growth
- S5 - Forest Health: Air Pollution, Pathogens and Forest Pests
- S8 - Socio-Economic Functions and Livelihoods
- S15 - Scenarios and Modelling for Forest Management Planning

Wednesday 27 August

08.00 – 09.30 hours: Keynote addresses (Chair: Abigail Kimbell, in Idun Room)

- Doug Konkin - *Learning to deal with climate change and catastrophic forest disturbances*
- Balgis Osman Elasha – *Assessment of impacts and adaptation to climate change and the links to sustainable development in Africa*
- Nur Masripatin - *Mainstreaming Climate Change Adaptation Issues into Forest Policies and Management Practices: A Way to Bring Concepts into Actions*

09.30 – 10.30 hours: Coffee break and **poster session**

10.30 – 12.00 hours: Parallel technical sessions (Part 1)

- S2 - Climate-Induced Changes in Forest Ecosystems
- S6 - Silviculture and production of wood and non-wood forest goods
- S11 - Tropical Forests and Climate Change
- S14 - Forest Mortality and Dieback: Monitoring and Mitigation of Consequences
- S16 -The "Swedish Example" as a Tool for Global Carbon Mitigation

12.00- 13.00 hours: Lunch

13.00 – 13.30 hours: Keynote address

- Eskil Erlandsson - *Swedish Forest Policy in a changing World*

13.30 – 15.30 hours: Parallel technical sessions (Part 2)

- S2 - Climate-Induced Changes in Forest Ecosystems
- S6 - Silviculture and production of wood and non-wood forest goods
- S11 - Tropical Forests and Climate Change
- S14 - Forest Mortality and Dieback: Monitoring and Mitigation of Consequences
- S18 - Wood as Green Building Material (in Balder-Brage room)

16.00 hours: Bus departure for *Reception at SLU*

18.30 hours: Banquet

Thursday 28 August

08.00 – 09.30 hours: Keynote addresses (Chair: Peter Mayer, in Idun room)

- Malik Amin Aslam - *Carbon Market Development in Pakistan – Leveraging the innovative role of Forest Management*
- Catherine Potvin - *Reducing Emissions from Deforestation and Forest Degradation: International Negotiations and Technical Challenges*
- Hans R. Heinimann - *Precision Forestry - A Key Concept to Make Adaptive Management Operational?*

09.30 – 10.30 hours: Coffee break and **poster session**

10.30 – 12.00 hours: Parallel technical sessions (Part 1)

- S7 - Biodiversity, Conservation and Protective Functions of the Forest
- S9 - Innovative Management and Policy Approaches
- S12 - Genetic and Physiological Adaptation to a Changing Climate
- S17 - Opportunities for Combining Adaptation and Mitigation

12.00- 13.00 hours: Lunch

13.00 – 14.30 hours: Parallel technical sessions (Part 2)

- S7 - Biodiversity, Conservation and Protective Functions of the Forest
- S9 - Innovative Management and Policy Approaches
- S12 - Genetic and Physiological Adaptation to a Changing Climate
- S17 - Opportunities for Combining Adaptation and Mitigation

14.30 – 15.00 hours: Coffee Break

15.00 – 17.00 hours: Conclusion of the Conference: Poster awards, Summaries and Closure (in Idun room)