

IUFRO Research Group 7.01.00

“Impacts of Air Pollution and Climate Change on Forest Ecosystems”

2010 Annual Report

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Identified Important Scientific Issues

New monitoring strategies. There is still considerable uncertainty how air pollution affects forest ecosystems despite various national and international efforts aimed at monitoring air pollution and health of forests. While these monitoring programs provide large amounts of data, these data often do not fit the conceptual and statistical requirements for detecting status and trends of forest health, nor for the cause–effect relationships. Therefore re-inventing of monitoring strategies is necessary because it has become apparent that the effects of air pollution and climate change on forest ecosystems are complex, dynamic and interactive. Under such circumstances, harmonization and quality assurance of the applied methods for detection, monitoring and evaluation is of highest importance.

Understanding of ozone phytotoxic potential. Considering the expected increase of the global average surface temperature and the simultaneous alteration in precipitation patterns the air pollution effects on forests, in particular of the ground-level ozone, are changing. Cumulative ozone uptake provides a biologically relevant estimate of ozone risk to vegetation. There is the ongoing initiative to develop a modeling approach that could be applied to estimate and map effective stomatal ozone flux to major vegetation types across Europe to understand future risks to forest ecosystems.

Deposition of N and S. Another aspect of a better understanding of chemical environment in forest ecosystems is development of reliable methodologies for estimation of atmospheric deposition of nitrogenous (N) and sulfurous (S) pollutants across the landscape. This information is needed to develop critical loads for pollutant effects and to determine areas of critical load (CL) exceedances, particularly in areas outside of Europe and in the Mediterranean-type ecosystems. Critical loads are needed along with long term monitoring in order to more effectively evaluate trends in ecosystem condition and potential recovery in areas where little work has been done and also in areas that have been more studied, largely because of the dynamic nature of pollution exposures. A key example of this dynamic includes Europe and North America where S deposition has decreased dramatically but N deposition has been relatively stable. However, at the same time NO_x component of N deposition has decreased while NH_x has become a much greater relative importance. Another key dynamic that warrants increased study is the effects of atmospheric deposition on ecosystems in rapidly developing areas such as in parts of Asia. Ecosystem response to such dynamics in air pollution inputs is a

theme of great importance. Deposition of dust and its role in nutrient cycling and ecosystem functioning is another growing area of interest.

Water in forests. Forest water interaction is gaining importance each year as part of the climate change concern. Forests help mitigating the adverse effects of climate change related to water quality, regime and quality issues with management tools. One of the major research topics is a management of water resources in forests and the surrounding areas. The other important research topic is an adaptation of natural ecosystems to changing climatic conditions. Any change in evapo-transpiration and soil moisture content could potentially affect forest health.

Mechanisms of air pollution effects. Mechanistic understanding of the effects of air pollutants on forest trees and ecosystems (natural, managed, tree plantations), is needed for developing a concept of risk assessment on a mechanistic basis. Consequently there is a need to:

Improve understanding of structural and functional stress response on a scale ranging from a single tree (i.e. relating molecular regulation to biochemical/physiological processes), through a forest stand, ecosystem, landscape up to the regional & global level.

- Emphasize process-based understanding of abiotic and biotic interactions, i.e., between pollutants and climatic and edaphic factors, including competitors, pathogens/endophytes, herbivores and soil microorganisms/mycorrhizae in fostering the mechanistic basis.
- Examine “mechanisms of action” of pollutants and in plant performance for capacities for “indicator development” and usability for differential stress diagnosis.
- Direct awareness in research to pollution as a component of climate change and impact factor on global resource cycling, with consequences for carbon sequestration of forest ecosystems, production efficiency of renewable, biogenic resources, and post-Kyoto policies.
- Focus on the industrially developing regions in East Asia, South America and Africa because of the expected exacerbation of environmental problems there. Accordingly, research regarding cause-effect based understanding of regional and global “mechanisms of action” and fostering of “indicator development”.

Genetics. In studying genetic aspects of the changing environmental conditions, major focus is the combined analysis of genetic, physiological and morphological variation in order to identify genes controlling important traits and their reactions to environmental change. New technologies such as large scale sequencing and marker development facilitate the assessment of molecular variation at multiple sites. The identification of “adaptive” genes and their allelic variation is progressing in tree species. Results underline the complexity of responses involving numerous interacting loci, each with a specific contribution. Sample sizes of hundreds of individuals appear to be necessary in order to identify genes involved in the adaptation of tree populations to changing environments, and thus to better understand preconditions for survival under heterogeneous field conditions. As part of an interdisciplinary concept, ecosystem genetics is a major challenge for current and future research.

Modeling of soil processes & modeling of forest responses. There is a lack of sufficient knowledge of soil processes governing nutrient cycles, and how these processes respond to

changes in climate and air pollution. In particular, most models simulate the future without taking into account some key nutrients, such as P, Mn, or even S. The role of soil microbial biodiversity is still only superficially understood and that lack of knowledge results in models inability to incorporate these processes. This may lead to flaws in what the models predict in their present form. There is also a lack of an integration of processes above and below ground and only a handful of models take account of feedbacks within forest ecosystems. However, such feedbacks are crucial in understanding the development of the ecosystems as a whole, particularly in light of the changing environmental conditions. Because of the complexity of forest ecosystems, it is imperative to identify a set of overarching and clear indicators that mirror the state of the ecosystems. Development of integrated indicators is crucial for a holistic understanding of forest functioning and improved usability of the existing and newly developed models.

Social and political dependencies. Air pollution and climate change issues are intrinsically trans-disciplinary and policy-related. Bridging science and policy is of highest importance for the forestry science since the newly developing problems are now mainly political, especially in the developing countries where the potential forest-mediated effects on the local society are of most concern, and where regulations to protect forests still need to be developed. There is a need for an improved dialogue between the traditional forest scientists and the social & political scientists. Such active dialogue and collaboration are essential for developing the scientifically, socially and politically accepted strategies for future management and utilization of forests. Closer collaboration with IUFRO Division 6 "Social, Economic, Information, and Policy Sciences" and Task Force on "Forest policy-science interface" is envisioned.

Organization of Scientific Meetings and Sessions

The main meeting for IUFRO RG 7.01.00 was a traditional 24th biannual meeting under a title "Adaptation of Forest Ecosystems to Air Pollution and Climate Change" that was held from 22 to 26th of March 2010 in Antalya, Turkey. More than 150 participants from 35 countries participated in the meeting which consisted of 8 scientific sessions organized by the 8 Working Parties of RG 7.01, 64 oral presentations, and 49 posters. Details regarding the meeting can be found at <http://www.iufro.org/science/divisions/division-7/70000/70100/activities/>.

The IUFRO RG 7.01 had also active participation in the IUFRO World Congress (as requested - not reported here).

In addition, there were 3 meetings in which the RG. 7.01 scientists took an active organizational and scientific role (taken from the IUFRO Webpage):

- **People, Forests and the Environment: Coexisting in Harmony;** Casablanca, Morocco; 25-27 May 2010. Units involved: 4.02.01, 8.00.00, 7.01.00, 1.00.00.
Conference homepage: <http://sylvamonde.110mb.com/welcome.htm>
Conference report: <http://www.iufro.org/download/file/5661/1767/casablanca10-report.doc/>
Picture: <http://www.iufro.org/download/file/5662/1767/casablanca10-picture.jpg/>
- **Mixed and Pure Forests in a Changing World 2010;** Vila Real, Portugal; 6-8 October 2010. Units involved: 1.00.00, 4.00.00, 7.01.00. [Conference homepage](#)

- **Fourth International Conference on Plant and Environmental Pollution;** Lucknow, India; 8-11 December 2010.
Conference homepage: <http://isebindia.com/icpep-4/icpep-4.html>

Other meetings co-organized by the RG. 7.01 scientists:

FOCUS Project coordinating critical loads development across the United States and submission of critical loads data in response to the call for data from The Working Group on Effects and National Focal Centres of the International Cooperative Programme on Modelling and Mapping, Denver, Colorado, April 2010.

ICP-Forests/FutMon Training Course on the Assessment of Ozone Visible Injury, Valencia, Spain, September 2010 (UNECE/ICP-Forests).

ICP-Forests Programme Coordinating Group Meeting, Rome, Italy, October 2010 (UNECE/ICP-Forests).

National Atmospheric Deposition Program (NADP) Annual Conference, Truckee, California, USA, November 2010.

International Conference “Forest ecosystem genomics and adaptation”, San Lorenzo de El Escorial (Madrid), Spain, June 9 - 11, 2010 (www.ecosystemgenomics2010.fgua.es). Session G2 “Evolutionary responses under climate change” was chaired by Gerhard Müller-Starck, Coordinator IUFRO 7.01.04.

COST FP601 Forest Management and Water Cycle. Antalya-Turkey

7.01.01. FutMon Task Force Meeting, Tampere, Finland, February 2010 (UNECE/ICP-Forests).

ICP-Forests Task Force Meeting, Garmisch-Partenkirchen, Germany, May 2010 (UNECE/ICP-Forests).

Selected Publications (in addition to abstracts published after the IUFRO World Congress Report):

Bytnerowicz, A., Cayan, D., Riggan, P., Schilling, S., Dawson, P., Tyree, M., Wolden, L., Tissell, R., Preisler, H. (2010) Analysis of the effects of combustion emissions and Santa Ana winds on ambient ozone during the October 2007 southern California wildfires. *Atmos. Environ.*, 44, 678-687.

Bytnerowicz, A., Fraczek, W., Schilling, S., Alexander, D. (2010) Spatial and temporal distribution of ambient nitric acid and ammonia in the Athabasca Oil Sands Region, Alberta. *J. Limnol.*, 69 (Suppl. 1), 11-21, 2010 - DOI: 10.3274/JL10-69-S1-03.

Cisneros, R., Bytnerowicz, A., Schweizer, D., Zhong, S., Traina, S., Bennett, D. H. (2010) Ozone, nitric acid, and ammonia air pollution is unhealthy for people and ecosystems in southern Sierra Nevada, California. *Environ. Pollut.*, in press.

Fenn, M., E. B. Allen, S. B. Weiss, S. Jovan, L. H. Geiser, G. S. Tonnesen, R. F. Johnson, L. E. Rao, B. S. Gimeno, F. Yuan, T. Meixner, A. Bytnerowicz (2010) Nitrogen critical loads and management alternatives for N-impacted ecosystems in California. *J. Environ. Manag.*, in press.

Lorenz, M., Clarke, N., Paoletti, E., Bytnerowicz, A., Grulke, N., Lukina, N. Sase, H., Staelens, J. (2010) Air pollution impacts on forests in changing climate. In: G. Mery et al. (eds). *Forest and Society – Responding to Global Drivers of Change*. IUFRO World Series, Vol.25, International Union of Forest Research Organizations, Vienna, Austria, 55-74.

Paoletti E, Schaub M, Matyssek R, Wieser G, Augustaitis A, Bastrup-Birk AM, Bytnerowicz A, Günthardt-Goerg MS, Müller-Starck G, Serengil Y (2010) Advances of air pollution science: from forest decline to multiple-stress effects on forest ecosystem services. *Environmental Pollution* 158:1986–1989.

Schaub M, Emberson L, Ferretti M (2010) Changes in climate and air pollution - new directions in forest monitoring, research and modeling. Session D-09 during [XXIII IUFRO World Congress](#), 23-28 August 2010, Seoul, Korea. *International Forestry Review*, Vol. 12(5), 233-235.

Schaub M, Matyssek R, Wieser G (2010) Preface to the special section of the IUFRO conference on air pollution and climate change effects on forest ecosystems. *Environmental Pollution* 158:1985.

Abstracts of the 2010 International Conference “Forest ecosystem genomics and adaptation in El Escorial, a book of abstracts was published (www.ecosystemgenomics2010.fgua.es).

Meetings Planned in 2011

IUFRO Enlarged Board Meeting, Vienna, Austria, February 23-25, 2011

FOCUS Project participants will be meeting in Denver, Colorado in February 2011 to prepare data for submission in response to the call for data.

Development of the Critical Loads Strategy for national Critical Loads monitoring on the USDA Forest Service Experimental Forest & Ranges Network, Riverside, CA, USA, May 2011.

Annual Air Pollution Workshop, Ft. McMurray, Alberta, Canada, May 2011.

COST FP0903 “Climate Change and Forest Mitigation and Adaptation in a Polluted Environment”, Prague, Czech Republic, June 2011.

The 8th IALE World Congress, August 2011, Beijing, China.