

## **IUFRO Research Group 7.01.00 “Impacts of Air Pollution and Climate Change on Forest Ecosystems”**

### **2012 Annual Report**

#### **25<sup>th</sup> Biennial meeting for Specialists in Air Pollution Effects on Forest Ecosystems**

The entire RG participated in preparations and organizing its biennial meeting that took place in Kaunas, Lithuania on 18 – 26 May 2012. For the first time the meeting was organized as a joint international conference in collaboration with COST Action FP 0903 “Climate Change and Forest Mitigation and Adaptation in a Polluted Environment“, ENVeurope Project “Environmental quality and pressures assessment across Europe“, ICP Integrated Monitoring Programme, North American Air Pollution Workshop, and European Long-Term Ecosystem Research Network. The Kaunas conference was the first attempt of the IUFRO RG 7.01.00 to promote collaboration between the forestry scientists, managers and decision makers aiming at better understanding of the biological effects of air pollution and climate with an ultimate goal of improved health, sustainability and productivity of forests in the Baltic States and worldwide.

This conference entitled “Biological Reactions of Forests to Climate Change and Air Pollution” was held at Aleksandras Stulginskis University and was hosted by the WP 7.01.01 Deputy Coordinator, Algirdas Augustaitis and his wife Ingrida Augustaitiene. The conference gathered more than 200 scientists from 34 countries to share current state of knowledge and discuss scientific gaps in the understanding of the interaction of climate change and air pollution and their integrated and synergetic effects on forest ecosystems. The combination of diverse programs represented at this meeting provided a holistic view of the forest environment and greatly facilitated the important knowledge exchange needed to enhance sustainable management of forests today and in the future. More information about the conference can be found at: <http://www.iufro.org/science/divisions/division-7/70000/70100/activities/>



Figure 1. Conference participants during a field trip to the Curonian Spit National Park (photo: A. Bytnerowicz).

### **Invitational trip of RG 7.01.00 Coordinator, Andrzej Bytnerowicz, to China.**

Andrzej Bytnerowicz was invited by Shang He (RG 7.01.00 Deputy Coordinator) of the Research Institute of Forest Ecology, Environment and Protection, the Chinese Academy of Forestry in Beijing, to pay an official visit to China on November 10-18, 2012. Chen Zhan of the Chinese Academy of Forestry, Liu Qi-Jing of the Beijing Forestry University and Wang Huimin of the Chinese Academy of Sciences also helped organizing that visit which was sponsored by the Chinese State Administration of Foreign Experts Affairs.

Andrzej gave lectures on methodologies of large-scale air pollution monitoring, air pollution trends in North America and Europe, and interactive effects of air pollution and climate change on forests. The lectures were presented at the Chinese Academy of Forestry, Beijing Forestry University and the Chinese Academy of Sciences. He also visited the Qianyanzhou Ecological Station the Jiangxi Province to see restoration of the devastated lands and long-term ecological research conducted by the Chinese Academy of Sciences in subtropical forests. Restoration of lands has been done by rational utilization of land resources through conversion of the mono-crop farming system (paddy fields) to the diversified agricultural economy and development of the slope land agriculture. The main objectives of those efforts have been to alleviate poverty of the area and to improve its ecological environment. At the Qianyanzhou Station a state-of-science research on the climate change effects, including measurements of CO<sub>2</sub> and methane fluxes, has been conducted.

During numerous meetings with Chinese colleagues, collaborative research on the impacts of air pollution and climate change on forests in the United States and China was discussed. Future collaboration will focus on symptomatology of the deleterious effects of ozone on plants, impacts of N and S deposition on forests, evaluation of interactive impacts of air pollution and climate change on health and growth of forests in a context of changing climate.



Figure 2. Chen Zhan, Liu Qi-Jing, Andrzej Bytnerowicz and Shang He at the Beijing University of Forestry (photo: Jixin Cao).



Figure 3. Shang He, Andrzej Bytnerowicz and Wang Huimin in front of the Qianyanzhou Ecological Station in the Jiangxi Province.



Figure 4. Wang Huimin with oranges harvested at the Station groves (photo: A. Bytnerowicz).



Figure 5. Eddy covariance equipment at the Qianyanzhou Ecological Station (photo: A. Bytnerowicz).

### **Activities of Working Parties**

#### **WP 7.01.02 Mechanisms of Action and Indicator Development**

**Prepared by Rainer Matyssek (Coordinator), Alessandra R. Kozovits (DC), Gerhard Wieser (DC)**

The coordinator of WP 7.01.02, Rainer Matyssek (RM), was invited by the Brazilian *Probral* program to give seminars on the role of air pollution (focus on ozone,  $O_3$ ) as a component of climate change and to land-use impacts. The main organizers of his invitational trip were Sergio Pascholatti, Marisa Domingos, and Raquel Ghini (University of Sao Paulo and *Embrapa*, with campuses of Piracicaba and Campinas), Alessandra R. Kozovits (also deputy of 7.01.02, University of Ouro Preto) and Eduardo de Mattos (University of Rio de Janeiro). In his lectures, RM gave the northern-hemispheric perspective on consequences of C binding and storage capacities of forest trees and ecosystems, outlining global dimensions and needs for improved understanding in the southern hemisphere (in particular, Brazil), while stressing over-arching research challenges and perspectives towards global cooperation and integration. The Brazilian research community provided a strong feedback and supported ideas for research needs such as the  $O_3$  effects in rural landscapes and in relation to land-use changes. Discussions during the seminars emphasized serious land-use changes in the “*Iron Quadrangle*” region around Ouro Preto, where extensive open-cut mining has led to substantial accentuation of oxidative stress by ozone on semi-deciduous forest and Cerrado ecosystems through wet and dry heavy-metal deposition (Fig. 6).



Figures 6. Open-cut mining in the Iron Quadrangle region near Ouro Preto /Minas Gerais in SE (photo: R. Matyssek).

During his travel RM also took part in planning of the 2013 biennial conference of RG 7.01.00 “*Vegetation Response to Climate Change and Air Pollution – Unifying Evidence and Research across Northern and Southern Hemisphere*”, to be held in Ilheus, Bahia/Brazil during September 1 – 6, 2013 being hosted and organized by Alessandra R. Kozovits (<http://www.iufro2013.ufop.br/>). The 2013 Conference is envisioned to be conducive to the development of funding research programs in Brazil and other regions of the southern hemisphere.

In Europe, RM initiated and helped to develop scientific exchange and research cooperation on climate change effects on the water relations of forest trees and ecosystems. A remarkable example of this new line of research is the free-air humidification experiment with *Betula pubescens* conducted by Anu and Jaak Söber in Tartu /Estonia, in which enhanced summer fogginess and air humidity predicted in this region of the boreal zone in Northern Europe are simulated (Fig. 7).



Figure 7. Free-air humidification experiment of Anu and Jaak Söber near Tartu /Estonia (photo: R. Matyssek).

During that visit RM initiated a scientific exchange with two other climate change-related experiments conducted in Central Europe, where summer drought will be the key stressor in water relations. The new experiment “KROOF” (*K*ranzberg Forest *R*oof Experiment (Fig. 8) initiated by RM and colleagues in Freising/Germany will clarify species-specific mechanisms of tree decline and alterations in intra and inter-specific competition for water in a mixed beech/spruce forest (*Fagus sylvatica*/*Picea abies*) during prolonged periods of severe drought and recovery.



Figure 8. Kranzberg Forest Roof Experiment (KROOF) of Rainer Matyssek, Hans Pretzsch and Jean Charles Munch and teams near Freising /Germany (photos: K.-H. Häberle).

To this end, precipitation exclusion has been employed by means of automated, novel rain-closed roof constructions above trenched, hydraulically isolated stand catchments. KROOF will intensify existing research cooperation within a joint project coordinated by Gerhard Wieser (also deputy of 7.01.02) at Tschirgant in the region of Tyrol/Austria. Here, the drought tolerance of *Pinus sylvestris*, *Picea abies* and *Larix decidua* is currently explored along an edaphic gradient in soil moisture in the inner-alpine river Inn valley. Also this study is backed by a rain exclusion experiment (Fig. 9). The German-Austrian-Estonian cooperation is intended to be linked to a respective research in SE Brazil with its locally specific sub-tropical stress scenarios (partners: Alessandra R. Kozovits, Marisa Domingos).



Figure 9. Tschirgant Roof Experiment of Gerhard Wieser (photos: G. Wieser).

### **WP 7.01.03 Atmospheric Deposition, Soils and Nutrient Cycling** **Prepared by Mark Fenn, Coordinator**

Mark Fenn, coordinator of WP 7.01.03, along with Linda Geiser, Sarah Jovan and others, is a coauthor of a new synthesis study describing the use of epiphytic lichen tissue N concentration for predicting throughfall nitrogen deposition in forests of western North America. Monitoring deposition exposure in remote regions with this approach could be used to identify areas in exceedance of empirical CLs for N.

Members of WP 7.01.03 continue to participate in the FOCUS (Focal Center Utility Study for the United States) project of NADP's Critical Loads Atmospheric Deposition (CLAD) Science Committee. Mark Fenn and Linda Geiser are leading two of several FOCUS working groups with the objective of improving the methods currently used to determine empirical and modeled critical loads for eutrophication and acidification. FOCUS is also preparing to make an informal submission from the U.S. in response to the call for CL data as it relates to biodiversity by the UNECE Coordinating Center for Effects (CCE).

The U.S. Forest Service Air Resources Management program designed a web portal to guide air specialists through the evaluation of CLs for forest planning. Issues in designing this portal have included determining what deposition information to use for calculating CL exceedances, incorporating uncertainty in CL and deposition calculations, and deciding which

CLs to base air quality assessments on. Mark Fenn participated in developing and reviewing guidance documents on critical loads, CL exceedances, and target loads.

Mark Fenn is also coauthor of a recent paper tracing industrial emissions of sulfur in the boreal forests surrounding the Athabasca Oil Sands industrial activities in northern Alberta, Canada. High levels of S deposition occur in the region, but S exposures and deposition decrease rapidly beyond 20 km from the industrial zone.

Members of Division 7.01 coauthored a chapter on air quality for a scientific synthesis in support of forest management in the Sierra Nevada and southern Cascade ranges in California. In May 2012, Mark Fenn visited researchers in Spain and coordinated research efforts on Mediterranean ecosystems in Spain and California, USA. He presented a talk „Chronic Atmospheric N Deposition in Mediterranean Ecosystems: An Unnatural Ecological State of Affairs“ at Universitat Autònoma de Barcelona. Barcelona, Spain, on May 16, 2012.

#### **WP 7.01.04 Genetic Aspects**

##### **Prepared by Roman Longauer, Coordinator**

The primary focus of the WP continued to be on the molecular genetics and functional genomics aspects of forest trees' responses to pollution and climate change. Many genes and pathways responsive to climate change and air pollution in conifer and hardwood trees have been identified and characterized. The responsive genes and their sequences provide molecular markers for long-term monitoring of trees' response to stresses caused by climate change and air pollution.

A comparative hardwoods transcriptome analysis, underway at Pennsylvania State University, indicates that ozone stress triggers pathways similar to those caused by other known abiotic stressors (heat, drought etc). Consequently, trees became more susceptible to pest and disease attack because they experience increased stress due to climate change.

At the May 2012 RG 7.01.00 business meeting in Kaunas, Gerhard Müller-Starck resigned and proposed Roman Longauer to take up the coordination of the working party for the next 2 years. The WP deputy coordinators are Om Rajora, Elina Oksanen and Teodora O. Best. The WP7.01.04 would like to express sincere thanks and great appreciation for the superb coordinating work done by Gerhard Müller-Starck and looks forward to his further involvement in the future activities of the working group.

#### **WP 7.01.06 Social and Political Aspects**

This WP has been closed due to a lack of recent activities based on the unanimous decision reached at the 7.01.00 business meeting in Kaunas, Lithuania, in May 2012.

#### **WP 7.01.08 Hydroecology**

##### **Prepared by Yusuf Serengil, Coordinator**

2012 was a very active year for the IUFRO WP 7.01.08. The WP officers joined many IUFRO activities. One of these was collaboration with the WP 8.01.02 "Landscape Ecology". The WP 8.01.00 Coordinator joined the below mentioned Kahramanmaraş Conference and Yusuf Serengil attended the Landscape Ecology conference in Chile. Both WPs decided on organizing collaborative conferences and sessions for the future.

### Conference on Forest-Water Interactions with Respect to Air Pollution and Climate Change

The first IUFRO WP 7.01.08 “Hydroecology” meeting entitled “*Forest-Water Interactions with Respect to Air Pollution and Climate Change*” was held between 3-6<sup>th</sup> of September in Kahramanmaras, a southeastern city in Turkey. A COST 903 (Climate Change and Forest Mitigation and Adaptation in a Polluted Environment) WG4 meeting was also organized in parallel to this meeting to discuss “Knowledge Gaps Related to Forest –*Water Interaction with Respect to Air Pollution and Climate Change*”. Together with these two meetings the 4th National Watershed Management workshop of Turkey was organized (Fig. 10).



Figure 10. Opening ceremony

The objective of the IUFRO Hydroecology WG meeting was to establish a strong communication between hydrologists and ecologists to promote research on hydroecology in relation to the air pollution and climate change effects. The Landscape Ecology WP 8.01.02 and Multiple Stressors on Ecosystems WP 7.01.07 officers have attended the meeting to identify further collaboration possibilities between the WPs. Over 100 scientists attended the meeting from many European countries, US, Far East and Middle East. The technical field trip of the conference was realized towards discussing water stress and land degradation issues in semi-arid regions. During a field trip to the Nemrut Mountain, a land rehabilitation site at Adiyaman district presenting a good example of forestation was visited. The Kahramanmaras Conference was very successful in terms of attracting attention of many scientists from Turkey and other neighbouring countries to the IUFRO activities. A mailing group has been established to build up a large hydroecology group under the IUFRO auspices.



Figure 11. Conference field trip to Nemrut Mountain and its environment.

#### Other activities of the WP 7.01.08:

Organization of COST FP0903 meeting on “Knowledge Gaps Related to Forest – Water Interaction with Respect to Air Pollution and Climate Change”

Special Issue for the papers of the IUFRO conference in Kahramanmaras.

Attendance to the IUFRO 7.01. biennial meeting in Kaunas-Lithuania.

Attendance to IUFRO Regional Meeting in Nairobi-Kenya

Attendance to IUFRO 8.01.02 Landscape Ecology meeting in Concepcion-Chile

Attendance to UNFCCC COP 18 meeting in Doha-Qatar

Participation to the IPCC Wetlands Supplement Guideline as a Lead Author. I attended the IPCC Zimbabwe, and Ireland meetings for this study. Participation in the above meetings resulted in many presentations and publications.

#### **Selected Scientific Papers for RG 7.01.00 resulting from the 2012 activities**

Bytnerowicz, A., Burley, J. D., Cisneros, R., Preisler, H. K., Schilling, S., Schweizer, D., Ray, J., Dullen, D., Beck C. and Auble B.. 2013. Surface ozone at the Devils Postpile National Monument receptor site during low and high wildland fire years. *Atmospheric Environment*, 65, 129-141.

Bytnerowicz, A., Fenn, M. and Long, J. 2013. Air Quality. In: Bottoms, R. and Hayes, J., Team coordination and review. USDA Forest Service Pacific Southwest Research Station. Science Synthesis to support Forest Plan Revision in the Sierra Nevada and Southern Cascades. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 501 p.

Eialou, H.K., Sengonul, K., Gökbülak, F., Serengil, Y., Uygur, B., 2013. Effects of Forest Canopy Cover and Floor on Chemical Quality of Water in Broad Leaved and Coniferous Forests of Istanbul, Turkey. *Forest Ecology and Management*. 289,371-377.

Eigirdas M, Augustaitis A, Mozgeris, G, 2013. Predicting tree crown defoliation using color-infrared orthophoto maps. *iForest* 6: 23-29 [online 2013-01-14] URL: <http://www.sisef.it/iforest/contents?id=ifor0721-006>

Jansons A, Sisenis L, Neimane U, Rieksts-Riekstins J, 2013. Biomass production of young lodgepole pine (*Pinus contorta* var. *latifolia*) stands in Latvia. *iForest* 6: 10-14 [online 2013-01-14] URL: <http://www.sisef.it/iforest/contents?id=ifor0637-006>

Mozgeris G, Augustaitis A, 2013. Estimating crown defoliation of Scots pine (*Pinus sylvestris* L.) trees using small format digital aerial images. *iForest* 6: 15-22 [online 2013-01-14] URL: <http://www.sisef.it/iforest/contents?id=ifor0705-006>

- Proemse, B.C., Mayer, B., and Fenn, M.E. 2012. Tracing industrial sulfur emissions in atmospheric sulfate deposition in the Athabasca oil sands region, Alberta, Canada. *Applied Geochemistry* 27: 2425-2434.
- Serengil, Y., Erden, H., 2012. Durban Climate Deal and LULUCF. *International Journal of Environmental Studies*. Volume 69, 1, pages 169-171.
- Serengil, Y., Swank, W.T., Vose, J.M., 2012. Alterations on flow variability due to converting hardwood forests to pine. *iForest* (2012) 5: 44-49.
- Serengil, Y., İnan, M., Yurtseven, İ., Kılıç, Ü., Uygur, B., 2012. Stream corridors as indicators of watershed land use: A case study in Istanbul. *Revista Bosque*, 33, 3.
- Zverev, V., Kozlov, M.V., Zvereva, E.L. 2013. Changes in crown architecture as a strategy of mountain birch for survival in habitats disturbed by air pollution. *Science of the Total Environment*, 444, 212-223.

### Addendum

**COST Action FP0903 Climate Change and Forest Adaptation and Mitigation in a Polluted Environment** <http://cost-fp0903.ipp.cnr.it/>  
**Prepared by Elena Paoletti, RG 7.01.00 Deputy Coordinator**

The COST Action FP0903 explores themes that are relevant to the IUFRO RG 7.01. Some activities in 2012 were carried out in close collaboration between the two networks, such the organization of the international conferences in Kaunas and Karamanmaras.

Other FP0903 activities that are relevant to RG 7.01 are :

(i) A meta-database for highlighting available data and integrating the information about research and monitoring in Europe, also improving access to and coordination between different datasets, was developed and made available for free download at <http://cost-fp0903.ipp.cnr.it/Downloads/WG1%20metadatabase.xlsx>. Info about data sampling, processing, storing, evaluation of institutional embedding, funding and synthesis of data storage and accessibility, is now available. Details are in the following papers:

Danielewska A, Clarke N, Olejnik J, Hansen K, de Vries W, Lundin L, Tuovinen J, Fischer R, Urbaniak M, Paoletti E\_(2013). A meta-database comparison from various European Research and Monitoring Networks dedicated to forest sites. *iForest – Biogeosciences and Forestry* (early view) - doi: 10.3832/ifor0751-006

(i) A special section in *Trees* about future directions of integrating modelling and experimentation was edited and published (doi: 10.1007/s00468-012-0778-4). It included four papers. The deficit of interaction between experimenting and modeling astonishes, as intrinsically these two scientific domains are coupled in mutualistic ways. Merging of the two research domains is a must in view of the global and interrelated impacts of air pollution and climate change on forest ecosystems—so we wish this Special Section to give impetus to meeting this demand.

- Krause K, Providoli I, Currie WS, Bugmann H, Schleppi P (2012) Long-term tracing of whole catchment  $^{15}\text{N}$  additions in a mountain spruce forest: measurements and simulations with the TRACE model. *Trees*. doi:10.1007/s00468012-0737-0
- Wieser G, Matyssek R, Gotz B, Gruenhage L (2012) Branch cuvettes as means of ozone risk assessment in adult forest tree crowns: combining experimental and modelling capacities. *Trees* doi:10.1007/s00468-012-0715-6
- Gruenhage L, Matyssek R, Haberle K-H, Wieser G, Metzger U, Leuchner M, Menzel A, Dieler J, Pretzsch H, Grimmeisen W, Zimmermann L, Raspe S (2012) Flux-based ozone risk assessment for adult beech forests. *Trees* doi: 10.1007/s00468-012-0716-5
- zu Castell W, Ernst D (2012) Experimental omics data in tree research: facing complexity. *Trees* doi: 10.1007/s00468-012-0777-5
- (ii) A questionnaire for suggesting recommendations and key priorities for Supersites was developed and circulated. It summarised the development of existing European forest monitoring and research infrastructures, harmonisation of databases and knowledge about climate change and air pollution impact on forest ecosystems, and knowledge gap statements from 50 experts who answered a specific questionnaire. The statements are structured within the following subjects: The carbon cycle in forests (LULUCF accounting), forest health and vitality, forest biodiversity, extent of forest resources, availability of wood and forest biomass, protective functions of forests and socio-economic information about the forest sector (<http://cost-fp0903.ipp.cnr.it/index.php/events/supersite-survey.html>)
- (iii) Proceedings of the conference ‘Ozone, Climate Change and Forests’ held in Prague in June 2011, were peer-reviewed and published as follows:
- Díaz de Quijano M, Schaub M, Bassin S, Volk M, Peñuelas J (2012) Ozone visible symptoms and reduced root biomass in the subalpine species *Pinus uncinata* after two-years of free-air ozone fumigation. *Environmental Pollution*, 169: 250-257.
- Fares S, R. Weber, J.-H. Park, D. Gentner, J. Karlik, A.H. Goldstein (2012) Ozone deposition to an orange orchard: partitioning between stomatal and non-stomatal sinks. *Environmental Pollution*, 169: 258-266.
- Zapletal M J, Pretel , P. Chroust , P. Cudlín , M. Edwards-Jonášová , O. Urban , R. Pokorný , R. Czerný , I. Hunová (2012) The influence of climate change on stomatal ozone flux to a mountain Norway spruce forest. *Environmental Pollution*, 169: 267-273.
- Hunová I., Schreiberová M. 2012 Ambient ozone phytotoxic potential over the Czech forests as assessed by AOT40. *iForest* 5: 153-162.
- Sramek V. 2012 Monitoring of Ozone Effects on the Vitality and Increment of Norway Spruce and European Beech in the Central European Forests. *Journal of Environmental Monitoring*, 14 1696-1702.
- Gerosa G; Finco A; Marzuoli R; Ferretti M; Gottardini E 2012 Errors in ozone risk assessment using standard conditions for converting ozone concentrations obtained by

passive samplers in mountain regions. *Journal of Environmental Monitoring*, 14: 1703-1709.

Neiryneck J; Gielen B; Janssens I; Ceulemans R 2012 Insights in ozone deposition patterns from decade-long ozone flux measurements over a mixed temperate forest. *Journal of Environmental Monitoring*, 14: 1684-1695.