Air pollution, climate change and forest ecosystems:

evidence for effects, adaptation, and mitigation

6th ICP Forests Scientific Conference

16-17 May 2017 - Bucharest/Romania

Abstracts

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Edited by Walter Seidling and Marco Ferretti

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Foreword

Forests are an immense resource for our planet. They provide wood and non-wood products, and many other services and social and spiritual goods for human societies. They host a considerable proportion of the world's biodiversity, protect soil and water resources and are involved in the regulation of atmospheric and climatic processes.

The International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) operates under the UNECE Convention on Long-Range Transboundary Air Pollution (CLRTAP) since 1985. ICP Forests monitors forest condition and environmental factors across large parts of European forests. Data obtained from the monitoring activity are used by a large number of scientists investigating various research questions relevant for policy, forest management, and science. On average, more than 15 projects per year making use of ICP Forests data have been launched since 2011.

The 6th ICP Forests Scientific Conference focuses on the effects of air pollution and climate change. Investigating relationships between air pollution and climatic change on one side, and effects on forests on the other side is the most important aim for the ICP Forests. Scientific Conferences are essential in this respect: they promote research and co-operation among scientists, favour advances in understanding of forest ecosystem response to environmental drivers and therefore helps to fulfill the tasks under the CLRTAP.

ICP Forests Scientific Conferences provide an annual platform bringing together monitoring experts, field researchers, modellers, and resource managers. Scientific Conferences address scientists and experts from the ICP Forests community, the wider UNECE community and their partners and stakeholders, as well as all interested scientists and experts from related fields. We especially welcome researchers using ICP Forests data in their projects, evaluations, and modelling exercises.

Although generally open to contributions in the field of air pollution and climate effects on forests, the main topics of the conference reflected by the submitted papers can be grouped in two main categories:

- Impacts of atmospheric chemistry and deposition on forest soils and ecosystems (with particular emphasis on nitrogen deposition).
- Assessment and monitoring of the responses of trees and forest vegetation to air pollution and climate.

These two categories were used to identify the sessions for the 2017 ICP Forests Scientific Conference.

Looking forward to inspiring presentations, we wish to all fruitful and enthusiastic discussions.

The Programme Committee

Marco Ferretti, Walter Seidling, Ovidiu Badea

Programme

16 May 2017 Excursion together with participants of ICP Forests Task Force Meeting

17 May 2017 6th ICP Forests Scientific Conference

08:00-09:00 Registration

09:00- 9:15 Opening. Chair: Walter Seidling

09:00-09:10 Welcome Address by host country: **Puiu Lucian Georgescu**
Secretary of State, Romanian Ministry of Research and Innovation

09:10-09:15 Opening address by Scientific Committee of ICP Forests: **Marco Ferretti**

09:15-10:45 Session 1: Atmospheric chemistry and related ecosystem processes – part 1. Chair: Bruno De Vos

09:15-09:45 **Keynote. N. König et al.**: *Evaluation of soil acidification at long-term monitoring sites over the last 50 years and effects of liming.*

09:45-10:00 **M. Greve et al**.: Use of long term element budgets to identify driving sources for soil acidification and to monitor the effects of forest liming.

10:00-10:15 **P. Michopoulos et al**.: The use of lead isotopes to quantify anthropogenic pollution in soil of a mountainous fir ecosystem.

10:15-10:30 **N. Clarke et al**.: Effects of sea salt episodes on heavy metal concentrations in soil solution and needles at Norwegian Level II plots.

10:30-10:45 **P. Rademacher et al.:** Nutrition of fast growing tree species and effects of land use change on agricultural soils.

10:45-11:15 Coffee break

11:15-13:00 Session 1: Atmospheric chemistry and related ecosystem processes – part 2. Chair: Päivi Merilä

11:15-11:45 **Keynote. R. Guerrieri et al.:** *Combining multiple isotopes and metagenomic to delineate the role of canopy nitrification at ICP Forest sites.*

11:45-12:00 **M. Schaap et al.:** Atmospheric nitrogen deposition to terrestrial ecosystems across Germany.

12:00-12:15 **S. Raspe et al.**: Nitrogen budget of Bavarian Level II plots from 25 years of measurement.

12:15-12:30 **H. García Gómez et al.**: Atmospheric concentration and deposition of reactive nitrogen in Spanish forests of *Quercus ilex*: relevant results.

12:30-12:45 **E. Remy et al.**: Nitrogen cycling and sequestration in temperate forest edges.

12:45-13:00 **W. Werner et al.**: The magnitude of ozone fluxes in German forests – does latitude matter?

13:45-13:45 Lunch

14:00-15:45 Session 3: Response of forest vegetation: indicators, assessment and monitoring – part 1. Chair: Tom Levanič

14:00-14:30 **Keynote. R. Sousa-Silva et al.**: *Does tree diversity matter for defoliation trends of oak and beech?*

14:30-14:45 **E. Solly et al**.: Does regional drought intensity trigger mortality patterns of Scots pine in inner-Alpine dry valleys of Switzerland?

14:45-15:00 **N. Brown et al.:** Climate, deposition and soil type are strong predisposition factors to acute oak decline in England and Wales.

15:00-15:15 **I. Popa et al.**: Stem diameter variability inferred from band girth and point dendrometers in ICP Forests Level II in Romania.

15:15-15:30 **E. Gottardini et al.:** Leaf traits: a tool to assess forest health and vitality.

15:30-15:45 **C. Bégin et al.:** Boron and other nutrients dynamics in tree-rings as indicators of forest disturbances in the Lower Athabasca Oil Sands region, Northeastern Alberta, Canada.

15:45-16:45 Flash presentations, poster session, coffee break

16:45-17:45 Session 4: Response of forest vegetation: indicators, assessment and monitoring – part 2. Chair: Nenad Potočić

16:45-17:00 **M. Zhiyanski et al.**: Assessment and mapping the dynamics of health status and soil properties in forest ecosystems from central Balkan region.

17:00-17:15 **A. Nussbaumer et al.:** Mast behaviour in European forest tree species.

17:15-17:30 **M. Salemaa et al.:** Importance of bryophytes and their cyanobacteria in boreal forest N-budget.

17:30-17:45 **V. Araminienė et al.:** Development of forest vegetation under ozone exposure in Lithuania: study of visible ozone injury.

17:45 - 18:00 Final remarks and conclusion. Chair: Karin Hansen

Poster Session (leading authors in alphabetical order)

E.N. Apostol et al: Spring phenology in relation to global warming in Quercus species.

I. Barbu et al.: Influence of relief on the chemical characteristics of snowfall in the northern Carpathians.

A.L. Ciuvát et al.: Foliar nutrition of Norway spruce (Picea abies [L.] Karst), European beech (Fagus sylvatica L.) and sessile oak (Quercus petraea) from ICP Forests intensive monitoring network in the Romanian Carpathian Mountains.

M. Curca et al.: Trends in the atmospheric deposition in three representative forest ecosystems in Southern Romania.

L. Dinca et al.: Temporal variability of soil moisture at different soil depths from six years of records in three Romanian Level II monitoring plots.

Z. Galić et al.: Extreme temperature events in black walnut stands in January 2017.

V. Gulca et al.: Course syllabus “The impact of climate change on forest”.

H. Jochheim & P. Brunet-Navarro: Mitigation potential of forest management and wood products use – Simulation study for intensive monitoring plots of Brandenburg, Germany.

M. Markovic and S. Rajkovic: Injuries to living trees at the sample plots in central Serbia.

S. Neagu: Carpathian forests’ vitality and potential vulnerabilities.

S. Rajković and M. Marković: Biofungicides in order to prevent ecoproblems.

A. Thimonier et al.: Interaction of biotic processes with nutrient cycling and tree growth in an oak-hornbeam forest stand in Switzerland.

L. Ukonmaanaho et al.: Linkages between riparian zone and stream water DOC concentration and quality in relation to land use.

Poster presentation

Spring phenology in relation to global warming in *Quercus* species

Ecaterina Nicoleta Apostol, Cristian Sidor

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Phenological models can serve to quantify how meteorological conditions drive vegetation phenology. In some species, leaf budburst is initiated after a sufficiently cold period, followed by a sufficiently warm period. In other cases, photoperiod, or water access, plays a more dominant role in phenology. When properly parameterized and validated using extant data, phenological models provide a mechanistic approach to assessing the sensitivity of a population's phenology to environmental change. It also provides a user-friendly environment for managing input-output to construct a phenological model, fit a phenological model and make simulations. A set of 35-year time series of temperature for 1,522 points over the area of interest utilising ECMWF ERA-Interim reanalysis data base and BBCH 11 (first visible leaf stalk) for *Q. robur* unfolding phenological data were used. PMP 5.5 Phenological Model was fitted and tested. The goal of the study was to run the model in order to make future predictions for the timing of flushing of trees using external data. Our results show a local adaptation of the timing of flowering to local climate conditions.

Keywords: Quercus, phenology, phenological model, climate change

Development of forest vegetation under ozone exposure in Lithuania: study of visible ozone injury

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Tropospheric ozone is considered as a factor which has an impact on degradation of forest vegetation. The level of ozone concentration varies among European countries. Lithuania is located in the Northern part of Europe, having relatively low mean ozone concentration. However, negative ozone effects on forest vegetation are also registered in Central and Northern Europe, including Lithuania.

The aim of this study was to estimate the impact of tropospheric ozone concentration and meteorological conditions on main vegetation species of Lithuanian forests. Visible foliar injury was assessed in the Light Exposed Sampling Sites (LESS), installed nearby the Forest Monitoring Level II plots during the 2007–2015 period. Ozone concentrations were measured at two monitoring stations located in the western and eastern parts of Lithuania. Meteorological data were obtained from a network of 35 meteorological stations throughout Lithuania.

Since 2007, mean ozone concentration in the Eastern part of Lithuania ranged between 25–34 ppb during the April–September period. Meanwhile, during the same period, ozone concentration was significantly higher in the Western part of the country and it varied between a range of 32–37 ppb. The data analyses showed a slightly decreasing trend of annual mean tropospheric ozone concentration during the vegetation season. However, this study demonstrates a positive correlation between ozone concentration in August and a number of plants with visible ozone injury on leaves. Meanwhile, an increasing trend of ozone concentration was found in August during the 2007–2015 period. Visible foliar injury symptoms caused by ozone were observed on 0-4 species per site annually in nine LESS. *Rubus idaeus*, *Frangula alnus*, *Corylus avellana* and *Fraxinus excelsior* were among the species frequently showing ozone injury. The results of the study showed a constantly increasing number of ozone injured plants during the observation period.

Poster presentation

Influence of relief on the chemical characteristics of snowfall in the northern Carpathians

Ion Barbu, Marius Curca, Iacoban Carmen

National Research and Development Institute for Silviculture Marin Dracea, Romania

For a better knowledge of the sources of variability of pollutants and transfer of depositions in forest ecosystems, the authors show many case studies relevant for the understanding of the influence of relief and orographical precipitation on the content of pollutant ions in snowfalls. For the explaining of the forest decline at the border of the Carpathians, the authors formulated a new hypothesis. A database containing results of the chemical analysis of snowfall of different origins of air masses causing precipitation in the Carpathians was built in the framework of the atmospheric deposition monitoring program. Based on data analysis, the authors explain the influence of the mountainous area, located in zones exposed to pollutants originating at a large distance in Central Europe, in the context of air masses circulation. The influence of local conditions such as precipitation rate and type (rain, snow), wind direction, altitude, slope orientation and slope inclination etc. on the chemical parameters of precipitations are described.

A model of pollutant impact on the soil and roots in the spring in the snowmelt time is also proposed. For a better understanding of the ecological and toxicological impacts of snowmelt in biological systems, the authors describe the role of spatial gradients as key factors for the understanding of the variability of pollutant fluxes and the behavior of ecosystems under the pollutants' impact in mountainous areas.

The data presented permit a better modeling of the distribution of pollutants and atmospheric depositions in mountainous areas for the assessment of the relations between atmospheric deposition and crown condition in forests.

Boron and other nutrients dynamics in tree-rings as indicators of forest disturbances in the Lower Athabasca Oil Sands region, Northeastern Alberta, Canada

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Oil sands (OS) extraction in northeastern Alberta generates important quantities of NOx and SO_2 emissions that can lead to several negative effects on forest ecosystems including the potential for soil acidification. Mining processes, tailing pond treatments and heavy transport in mining areas are also considered important sources of air contaminants that have the potential to impair the nutrient balance of trees. In this study, we analysed micronutrients (B, Fe, Zn, Na, Cu) and macronutrients (Ca, Mg, Mn, K) in the tree-ring series of jack pine (*Pinus banksiana*) and spruce (*Picea glauca* and *Picea mariana*) trees growing at different distances from the heart of mining operations. Based on tree-ring records, our aims is to provide historical perspective on the nutritional status of forest ecosystems and to identify temporal changes in tree-ring chemistry that can be attributed to OS activities.

One of the key findings of this research is the immediate response of boron (B) in woody tissues of all studied species to mining operations. During the pre-mining period (prior to 1967) [B] variations in tree-rings of the three species covary with other elements such as Na and Fe and are likely controlled by environmental factors. After 1970, [B] increases and strongly departs from trends of other elements with a gradient depending on species and distance from OS activities. Finally, [B] trend at proximal sites nicely reproduces the historical pattern of industrial emissions.

Even if B specific emissions remain poorly documented in the OS region, the high [B] in top organic soil horizons at all sites confirm the atmospheric source for B. Rarely investigated in dendrogeochemical studies, B in the tree-rings, along with other associated nutrients, appears to be an excellent biogeochemical indicator of disturbances in nutritional status of forests in the vicinity of Alberta OS mining activities.

Climate, deposition and soil type are strong predisposition factors to acute oak decline in England and Wales

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**Presenting author*

Acute Oak Decline (AOD) affects both native oak species (*Quercus robur* and *Q. petraea*) in England and Wales and is of great concern as Oaks represent the largest component of native broadleaf woodland in the United Kingdom. Affected trees have characteristic stem symptoms, dark coloured liquid runs out from cracks between the bark plates and necrotic lesions are present in the phloem tissue. The symptoms are found in conjunction with galleries of the two-spotted oak bupresid (*Agrilus biguttatus*) and specific necrogenic bacterial species isolated from lesion areas. Similar symptoms have been described across Europe and form part of a wider oak decline complex which can establish following exposure to environmental predisposition factors, such as drought.

In order to understand the occurrence of oak decline it is necessary to not only investigate the impact of biotic agents and their interactions, but rather consider the whole system beginning with the links to environmental factors. A survey with more than 500 locations has been used to map AOD occurrence with soil type, climatic factors and deposition (nitrogen, sulphur and base cations) using GAM models. The presence of AOD in England and Wales is significantly influenced by rainfall, air temperature, and elevation, as well as nitrogen, sulphur and base cation deposition. Preliminary analysis highlighted differences between soil types and soil moisture, however these now need to be investigated at smaller scales, e.g. at site and tree level. This knowledge underpins risk mapping and will help develop best practice management advice.

This spatial study reemphasises the importance of predisposition factors in the Oak decline syndrome. Such spatial mapping and modelling could be applied to ICP Forests survey data to derive information on predisposition factors across tree species at both national and European scales.

Poster presentation

Foliar nutrition of Norway spruce (*Picea abies* [L.] Karst), European beech (*Fagus sylvatica* L.) and sessile oak (*Quercus petraea*) from ICP Forests intensive monitoring network in the Romanian Carpathian Mountains

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Monitoring forest health in Romania started in 1990 and was carried out in permanent sampling plots. Among studied variables (e.g. biometric, defoliation, soil properties) foliar nutrients content highlights qualitative and quantitative data used ultimately in assessing the health of trees and offers reliable parameters to determine the general state of the ecosystems. The aim of the research was to characterize the nutritional status of trees in relation to the content of the absolute foliar mineral element (per unit of dry biomass) and cationic reports between nutrient contents that can reflect potential imbalances.

Determination of nutrient contents followed the ICP Forests recommended methodology and was achieved by oxidation of the organic matter and solubilization of the residue. Overall, the levels of foliar nutrition for Norway spruce and sessile oak are normal, while beech on the other hand showed a deficit in the supply of nitrogen and potassium, which latest results show is counterbalanced by an increased supply of calcium and phosphorus, which in turn leads to a balanced nutrition.

Keywords: foliar, mineral nutrition, spruce, beech, sessile oak

Effects of sea salt episodes on heavy metal concentrations in soil solution and needles at Norwegian Level II plots

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Sea salt episodes, common at sites with a strong oceanic influence, are known to have a short-term acidifying effect on ecosystems, which might lead to leaching of aluminium and heavy metals through ion exchange and decomplexation processes. We studied effects of sea salt inputs on soil solution and needle chemistry at coastal and near-coastal Level II Norway spruce sites in Norway (Nedstrand and Birkenes) and compared these with more inland sites (Hurdal and Osen). Preliminary results suggest that very high sea salt inputs may be associated with higher concentrations than normal of heavy metals as well as aluminium in soil solution. Effects on heavy metal concentrations in current-year needles were not found.

Poster presentation

Trends in the atmospheric deposition in three representative forest ecosystem in Southern Romania

Marius Curca, Ion Barbu, Iacoban Carmen

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Monitoring deposition measurement started in Romania in the period 1985 – 1987 with analysis of snow samples collected in the Northern regions of country affected by Silver fir decline (Barbu I.,1991). After 1996 the atmospheric deposition measurement were conducted in 7 forest ecosystem following the recommendation of ICP Forests Programme. All plots were located in natural and semi natural forests. Sampling was done in the open field, under the canopy and in soil- soil solution- at different depth (10, 20, 40 and 60cm), every two weeks in the growing period and monthly in the cold period. For the common period 1998 – 2012 the fluxes and the trend of fluxes for sulfur and nitrogen were calculated at different levels in forest ecosystem. In the open field, in all the plots the trend of $S\text{-}SO_4$ shows an obvious reduction from 15-20 kg/ha/year in 1998 to 3-5 kg/ha/year. For nitrate ($N\text{-}NO_3$) and ammonia ($N\text{-}NH_4$) the trends are not very clear, showing a reduction from 5-10 kg/ha/year in 1998 to 1-2 kg/ha/year in 2012. With the reduction of emissions, the flux of atmospheric deposition reduced more clear in the open field and under the canopy. In the soil solution the accumulation of pollutants (sulfur) in the previous years shows pics (mainly in the drought periods) at different depth in soils with impacts in the pH of soil solution and root – mycorrhiza symbiosis function.

Temporal variability of soil moisture at different soil depths from six years of records in three Romanian Level II monitoring plots

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Soil humidity was continuously recorded in three intensive Level II monitoring plots from Romania (Predeal, Fundata and Stalpeni). The analysis started in 2010 and took into account the ICP methodology. As such, special sensors were placed at 3 levels of soil depths: 20 cm, 40 cm and 70 cm and even though the stands are different as typology (silver fir, beech and sesille oak), the soil is the same for all three plots: eutric cambosoil.

The soil sensors have recorded different humidity values. However, they aren't significantly influencing the quality of the results. The differences increase however as the sensors go further into the soil.

The soil's humidity is influenced by certain factors such as: rock type, soil texture. For example, the calcareous rock from Fundata leads to the recording of a lower humidity at the depth of 70 cm. On the other hand, the highest humidity recorded for Predeal, at the depths of 40 and 70 cm is caused by the soil's texture (silt loam).

The maximum soil humidity is recorded in the equilibrium periods between P (precipitations) and ETP (evapo-transpiration), followed by the period where P exceeds ETP, the period with medium P/ETP deficit and lastly by periods with a strong P/ETP deficit. The humidity level at the P/ETP exceeding is slower than the one from the P/ETP equilibrium due to the fact that, during winter, precipitations hardly reach the soil (the snow melts during spring, which leads to higher humidity soil values).

There aren't any significant correlations between soil humidity and atmospheric precipitations (monthly values). But the correlation coefficient decreases from the surface towards the depth of the soil, proving that precipitations have a more influence on the humidity from the first soil centimeters.

Extreme temperature events in black walnut stands in January 2017

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The aim of this paper are to shown the extreme temperature events in black walnut stands in January 2017. Data on microclimate indicators (temperature) were collected from January 2010 to January 2017. Climatological data are analyzed on the basis of annual report of the Hydrometeorological Service of Republic of Serbia.

The highest mean annual air temperature in black walnut stands was recorded in 2014. During the growing season (April-September) the highest air temperature was recorded in 2012 (19.2ºC). Outside of growing season (January-March and October-December) the highest temperature was recorded in 2014. The coldest period of October – December was recorded in end of 2016 (4.9ºC). This period was colder from 1.6ºC (2011) to 3.3ºC (2013) comparing it with the investigated period. A similar trends are recorded in January 2017.

In the investigated period the average monthly temperature in January was the lowest in 2017. year (-5.0ºC). The monthly air temperture was highest in 2014. year (5.1ºC). Only one day in January was with temperature above 0ºC. In investigated period (2010-2016) we recorded in average 13 days with temperature above 0ºC. In December 2016 we recorded 20 days with temperature below 0ºC.

In period from 7-12th January the minimum temperature was from -17.0 to -19.5ºC. The average daily temperature in January in investigated period (2010-2016) didnt exceed -7.8ºC, but in January 2017 average daily air temperature in period from 7-12th January was from -11.1 to -13.1ºC.

The average deviation from minimum to maximum daily temperature was recorded in January 2015, and after that in January 2017.

* This study is results of project financed by Ministry of Education, Science and Technological development of Republic Serbia.

Keywords: black walnut, air temperature, extreme events

Atmospheric concentration and deposition of reactive nitrogen in Spanish forests of *Quercus ilex*: relevant results

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Atmospheric concentration and deposition of N pollutants were monitored in four Spanish holm oak forests with different edaphic and climatic conditions during two years (2011-2013). Concentrations of the main atmospheric pollutants (NO_2, NH_3, HNO_3 and O_3,) were measured using passive samplers in open areas and inside the forests. Atmospheric particulate matter was monitored in open areas. Bulk and throughfall deposition of dissolved N (NO_3^- and NH_4^+) were collected weekly using conventional precipitation collectors, and seasonally using ion exchange resin columns. Dry deposition was estimated by means of rinsing techniques combined with an inferential method and including stomatal conductance modelling. Concentration of N in soil water was measured weekly through suction caps. Additionally, C/N ratio was assessed seasonally in leaves, litterfall and topsoil.

Ozone was the only atmospheric pollutant showing concentration high enough to directly affect vegetation, but gaseous N compounds may be contributing to ecosystem eutrophication through atmospheric deposition. The results showed that collection methods based on ion-exchange resins for bulk and throughfall deposition measurements can be recommended for long-term studies, particularly in remote areas. Total deposition of inorganic N (9.3 - 30.4 kgN ha^{-1} $year^{-1}$) was dominated by the dry deposition of the oxidized forms (56% - 60%), pointing out to the great importance of measuring ambient nitric acid vapour in Mediterranean forests.

Throughfall did not result a good indicator of total N deposition in these forests, because of the existence of canopy uptake during part of the year, mainly in the form of ammonium. Loss of NO_3^- in soil water was detected when ephemeral atmospheric N inputs occurred during periods of low biological activity, in agreement with the Mediterranean asynchrony hypothesis. The results highlight the importance of the strong seasonality of the N fluxes in Mediterranean region for monitoring Mediterranean forests and estimating their critical loads.

Leaf traits: a tool to assess forest health and vitality

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A proper management of forests is crucial to ensure the sustainable provision of environmental, economic and social benefits, and Sustainable Forest Management (SFM) criteria and related indicators have been developed to monitor and report the status of European forests (FOREST EUROPE, 2015: State of Europe's Forests 2015). SFM criterion 2 considers forest ecosystem health and vitality.

Within the LIFE project FutureForCoppiceS (LIFE14 ENV/IT/000514; http://www.futureforcoppices.eu/it/), SFM criterion 2 has been implemented by means of both current [defoliation and damage (Eichhorn et al., 2016; Ferretti and Fisher, 2013)] and new [leaf traits: chlorophyll *a* fluorescence, chlorophyll content and leaf morphology (Pollastrini et al., 2016)] indicators. These indicators were applied on three European Forests Types (EFT) (Apennine-Corsican mountainous beech forest; Mediterranean evergreen oak forest; Turkey oak, Hungarian oak and sessile oak forest), on a total of 21 forest coppice stands in two Italian regions.

Data analysis are carried out in order to test (i) the relation between current indicators and new, quantitative eco-physiological indicators, for a potential interpretation of available forest health monitoring data under a functional perspective; and (ii) the ability of different management options to support forest health and vitality, as measured by current and new indicators.

Together with all the other outcomes of the project, the results will help to better interpret the value of SFM indicators and augment the understanding of the resilience and adaptive capacity of coppice forests. These are necessary to promote "climate smart forestry" in coppice forests.

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Use of long term element budgets to identify driving sources for soil acidification and to monitor the effects of forest liming

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Acid atmospheric deposition is decreasing since the 1980s, mainly due to reduced sulfur dioxide emissions. But the input of acidic nitrogen compounds remains still at a high level. In Rhineland-Palatinate (Germany), where a high percentage of the forest area is located on poor soils with low buffer capacity, liming actions were performed in order to compensate the negative consequences of the acid deposition. In 1988, three study areas with control plots and different liming treatments from 3 to 15 t dolomitic limestone ha^{-1} were established to monitor soil acidification and to investigate the effect of liming regarding acid compensation.

Input-output nutrient and acid-base budgets were created based on the 24 years of measurements of deposition and seepage water. A detailed sampling of the forest stand allowed the calculation of the incorporated nutrients into the biomass and the acid load due to biomass increment. Base cation release due to mineral weathering was estimated by the model PROFILE.

On all control plots, the acid input exceeds the buffer capacity by base cations of the forest ecosystems over the whole observation period. For on plot the main source of proton production is the N budget. On the other plots the release of stored SO_4^{2-} or the loss of organic acids contributes primarily to the acid load of this forest site.

The commonly applied dosage of 3 t ha^{-1} was sufficient to compensate the acid input. Tough nitrate and sulfate output increased after liming treatment in different intensities, leading to higher acid load of the ecosystem compared to the untreated control plot. But the higher acid load was compensated by the carbonates of the dolomitic limestone. The results show that liming is still required for forest stands on base poor soils to prevent further acidification and the destruction of clay minerals.

Key note presentation

Combining multiple isotopes and metagenomic to delineate the role of canopy nitrification at ICP Forest sites

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Forest canopies influence our climate through carbon, water and energy exchanges with the atmosphere. However, less investigated is whether and how tree canopies change the chemical composition of precipitation, with important implications on forest nutrient cycling. In a previous study, we provided for the first time unequivocal isotopic evidence that biological nitrification in tree canopies was responsible for significant changes in the amount of nitrate from rainfall to throughfall across two UK forests (*Guerrieri et al.* 2015). This finding strongly suggested that bacteria and/or Archaea species of the phyllosphere were responsible for transforming atmospheric N before it even reaches the soil. Despite epiphytes representing an important component of tree canopies (*Kemball et al.* 2014), attention has been mostly directed to their role as pathogens, while we still do not know whether and how they affect nutrient cycling. Here we give an overview of the recently EU funded project – NITRIPHYLL – within the MSCA programme. The project aims to i) quantify biological canopy nitrification in tree canopies using $\delta^{15}N$, $\delta^{18}O$ and $\delta^{17}O$ in forest water and ii) characterize microbial communities harboured in tree canopies for two of the most dominant species in EU (*Fagus sylvatica* L. and *Pinus sylvestris* L.) using metagenomic tecniques. We consider 11 sites included in the ICP forest network, chosen along a climate and nitrogen deposition gradient (*Waldner et al.* 2014). We will present preliminary results regarding the microbial diversity in forest canopies and water samples (rainfall and throughfall) at some of the investigated ICP sites. In particular we will characterize the composition of epiphyfitic phyllosphere microbial communities and explore differences between the two investigated species for the relative abundance of bacterial and Archaea classes and - within them – identifying those species related to N cycling.

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Waldner P et al. (2014). Detection of temporal trends in atmospheric deposition of inorganic nitrogen and sulphate to forests in Europe. Atmospheric Environment, 95: 363-374

Poster presentation

Course syllabus “The impact of climate change on forest”

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This research consisted in designing of basic, advanced and specialized syllabuses for the course “The impact of climate change on forest” in context of the International Project 543946 TEMPUS-1-2013-1-ES-TEMPUS-JPHES “Support for Vocational Training in Sustainable Forestry — SUSFOR” 2013–2016. To attain this objective we first describe some of the emerging international issues relating to the impact of climate change on forest. Then we assess the Lifelong learning (LLL) system in different regions of the world. Also, we analyze degree curriculums and syllabuses from faculties of environment and natural resources. Finally, we propose the *basic module* “The impact of climate change on forest” to develop management practices to enhance forest carbon sequestration for the mitigation of climate change. The target group consists of land owners and everyone – from those who are in employment and seek self –fulfillment in learning to those in phases of ‘non-paid’ work, those who wish to use education to re-engineer their lives and their careers to people in their third age (to foster talent and more accommodating to weak learners); companies’ workers, anybody interested, forest owners, forest trainers, forest workers, vocational students.

Poster presentation

Mitigation potential of forest management and wood products use – Simulation study for intensive monitoring plots of Brandenburg, Germany

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Forest ecosystems store large carbon stocks in vegetation, coarse woody debris, and soil. The use of wood products may contribute to the mitigation of climate change by prolonging the carbon storage in harvested wood, and by substituting energy-intensive materials and fossil fuels. We present results of a simulation study for intensive monitoring forest sites of Brandenburg (Germany) to explore the mitigation potential of forest management taking into account wood products use. Two management strategies aiming at maximising yield vs. maximising carbon storage, varying in thinning intensity, harvest fraction, and rotation length, were compared with the business as usual scenario (BaU). Forest growth and carbon storage in forest ecosystems were simulated using a modified version of BIOME-BGC, extended by a management module. The carbon storage of harvested wood products including an assessment of its substitution potential was simulated using the wood product model CASTLE_WPM. On average, the 'storage strategy' increased the potential carbon sequestration of the forest sector by 32 t C ha^{-1}, compared to BaU. But taking into account the substitution effects, the advantage of the 'storage strategy' was overcompensated after 57 years. On the other hand, the lower sequestration potential of the 'yield strategy' of -31 t C ha^{-1} lasts for 177 years until over-compensated by substitution effects.

Evaluation of soil acidification at long-term monitoring sites over the last 50 years and effects of liming

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On 39 Level II plots and other long-term monitoring sites in Northwest Germany soil inventories have been conducted at 10 year intervals since 1995 according to the ICP Forests manual. Additionally, on most of these plots soil inventories previously to 1995 were performed spanning a period of up to 30 years, but, mostly with less intensive sampling with respect to depth intervals and spatial replicates. Altogether there are time series of almost 50 years available for the characterization of the acid-base status of forest soils.

In a first step the comparability and homogeneity of the time series was checked using depth functions of cation exchange capacity (CEC), organic carbon (C_{org}) and the ratio CEC/C_{org}. Afterwards, temporal trends of base saturation, $pH_{(CaCl2)}$, stocks of exchangeable Ca and Al and C_{org} as indicators for the acid-base status were evaluated as a function of soil depth. Stock changes were compared to budgets of the respective elements calculated from the major input-output fluxes.

At acid sensitive sites an ongoing soil acidification, as indicated by a decrease of base saturation and a loss of exchangeable Ca, was observed up to the beginning of this millennium; since around 2005 no significant trend could be detected. On some sites the observed stock changes of exchangeable Ca are in the same order of magnitude as respective Ca budgets. The $pH_{(CaCl2)}$ follows no clear trends.

The ongoing acidification observed at many un-limed sites was partially reversed at limed plots. Base saturation, pH, and the stocks of exchangeable Ca increased in the upper soil dependent on the lime dosage. A decomposition of the organic layer and an enrichment of C_{org} in the upper soil layers also occurred as well as an at least temporary $pH_{(CaCl2)}$ increase after liming.

The observed temporal trends confirm the results of the second German National Forest Soil Inventory.

Poster presentation

Injuries to living trees at the sample plots in central Serbia

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Results of the monitoring of injuries at 130 sample plots in the grid 16x16 kilometers, which has been continuously conducted in Serbia since 2003, presents in the paper. The causes of the injuries on the trees can be the consequence of the activity of the series of the adverse agents and owning to it the research of the most significant agents of the injuries was made. All injuries were classified in the paper by species and types of agents. The occurrence of the mass desiccation of oak forests is to a great extent result of the presence of the agents of powdery mildew. As the example of the use of the data from the database, the spatial arrangement of the plots with the pedunculate oak (which is our most sensitive species) was determined, as well as the infection of them by the powdery mildew. The strongest attack was reported during 2005 and 2006, when 79.3 % and 77.6% of the observed trees was infected. The critical month for the occurrence of the intensive infections by the powdery mildew in Serbia is the first half of July, which is important for the creation of the programmes aimed at the protection.

Keywords: injuries, defoliation, chlorosis

The use of lead isotopes to quantify anthropogenic pollution in soil of a mountainous fir ecosystem

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The lead concentrations and the isotope ratios $^{206}Pb/^{207}Pb$ were determined in soil samples from a mountainous forest ecosystem of fir to quantify the anthropogenic pollution by lead. The highest lead concentrations found in the FH horizon (38 mg/kg) were lower than those in the organic horizons of European forests. The values of $^{206}Pb/^{207}Pb$ ranged from 1.160 in the surface L horizon to 1.194 in the 20-40 cm mineral soil layer. Considering that lead contained in the 40-80 cm soil layer constituted geogenic lead and pollution was derived from petrol enriched with lead, the percentage of anthropogenic lead found in soils ranged from 53% in the L horizon to 2.1% in the 20-40 cm mineral layer. This percentage is a little lower than that found in the forests of industrialized countries. The results would be much more accurate if the metallurgic use of lead in the area was known taking into account that petrol was not the only source of lead emission.

Saether, O.M., G., Aberg, and E., Steinnes. 2011. Lead isotope distribution in podzolic soil profiles on different types of bedrock in a formerly glaciated terrain (Oslo, Norway). Appl. Geochim. 26: 5345-5249.

Itoh, Y., K., Noguchi, M., Takahashi, T.M., Okamoto, and S., Yoshinaga S. 2007. Estimation of lead sources in a Japanese cedar ecosystem using stable isotope analysis. Appl. Geochem. 22: 1223-1228.

Poster presentation

Carpathian forests' vitality and potential vulnerabilities

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Forest policies are built upon reliable data, our present day knowledge and ancillary wisdom of the *trial and error* learning principles. From a scientist point of view, more than often, there is a huge gap, both in space and time, between the latest findings in forest sciences and real world practice.

The aim is to find a common ground for the managerial and science paradigms to come together, and the optimum solution is most likely the *risk assessment tools,* and we propose as a case study: the Carpathian forests' vitality viewed from the perspective of potential vulnerabilities and risks.

The main objective of this paper is to outline the Carpathian forest health status over their entire range, along the Carpathian countries and policies gradients. The preliminary hypotheses are linked to the significance of the main driving forces of the forest health parameters (e.g. biotic factors, meteorological parameters, air pollution), in the circumstances of post-communist economic difficulties and policies shifts, on behalf of a fragile balancing game aimed at observing both sustainability and conservation of the natural and cultural heritages ((Gurung *et al.*, 2009; Kozak *et al.*, 2013; Chapron *et al.*, 2014).

Understanding the natural ecosystems' vitality (e.g. forests) is paramount to its management, as the consequences of previous and current malpractice may affect the long-term future. The concept of forest health is elusive, and in the search of a pertinent definition one might consider the forest as being 'healthy' under the assumption of the capability of withstanding its internal structure and functions in relation to the changing environment.

The crown condition dynamics over the mountain range will be assessed considering the biotic, abiotic and anthropogenic disturbances, using data from ICP-Forests network (16x16km grid and level II). The results will be discussed in terms of specific conditions of vegetation, air pollution, climate, preliminary results signaling a potential growth loss ranging between 15-75%.

The potential vulnerabilities are identified based on scientific literature analysis and shaped as a function of probability and intensity of damaging factors upon the forest condition, and the outcomes are discussed in relation to the sustainability of management policies, underlining the exposed regions.

Chapron, G., Kaczensky, P., Linnell, J.D.C., et al., 2014, Recovery of large carnivores in Europe's modern human-dominated landscapes, Science, 346 (6216), 10.1126/science.1257553, pp. 1517-1519.

Gurung, A.B., Bokwa, A., Chełmicki, W., et al., 2009, Global Change Research in the Carpathian Mountain Region, Mountain Research and Development, 29 (3), http://dx.doi.org/10.1659/mrd.1105, pp. 282-288.

Kozak, J., Katarzyna, O., Bytnerowicz, A., et al., 2013, The Carpathians: Integrating Nature and Society Towards Sustainability, Springer, p. 720.

Mast behaviour in European forest tree species

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Mast behaviour of forest tree species plays an important role in forest ecosystems, their management and their services. Alterations in mast year (MY) occurrence can have an impact on e.g. seed production, timber production and on the overall carbon sequestration in forest ecosystems. The objective of this study was to better understand (i) the underlying drivers and (ii) spatio-temporal patterns of mast synchronization (Nussbaumer et al. 2016, Nussbaumer et al. in review). The parameter fruiting from the ICP Forests Crown Condition Survey and additional long-term datasets from Europe were evaluated.

The impact of weather conditions in the two years previous to MY and in spring of MY was tested with a binary regression model, and fructification and MY synchrony was tested for spatial and temporal patterns.

(i) For beech, the most distinct weather pattern for MY in Europe was a cold and wet spring and warm summer in the year preceding the MY, followed by a second cold and wet spring in the actual MY. In spruce, a warm and wet summer in the year preceding the MY, followed by a warm and wet spring in the actual MY, was the clearest weather pattern. In oak and pine, patterns were diverse and more regionally scattered.

(ii) Beech and spruce showed high within-plot fructification synchrony while oak species and pine had weaker synchrony. Beech mast frequency increased in most regions, whereas the other species showed mixed or no trends. All species except pine showed strong intra-species MY synchrony, but only in Bavaria and Switzerland between-species synchrony was present. The results in beech and spruce supported the economy of scale, predator satiation and resource allocation hypotheses, while oak species and pine supported the large seed and the accessory costs hypotheses.

Nussbaumer, A.; Waldner, P.; Etzold, S.; Gessler, A.; Benham, S. et al. (2016). Patterns of mast fruiting of common beech, sessile and common oak, Norway spruce and Scots pine in Central and Northern Europe. For. Ecol. Manage. 363: 237-251.

Nussbaumer, A.; Waldner, P.; Apuhtin, V.; Aytar, F.; Bardulis, A. et al. (in review). Weather cues for mast fruiting in common beech, sessile and common oak, Norway spruce and Scots pine in Europe. For. Ecol. Manage.

Stem diameter variability inferred from band girth and point dendrometers in ICP Forests Level II in Romania

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Comparative analysis of stem diameter variability derived from permanent band girth and continuous point dendrometers was done in two core plots from Romanian ICP level II. Two species were analyzed: sessile oak and Norway spruce. Different growth data can be derived from these two types of dendrometers due to measurement frequency and precision. Seasonal dynamics of radial increment were modelled using logistic functions. In all studied plots the values recorded on permanent band girth regarding the onset and maximum growth are confirmed by the data recorded on continuous point dendrometers. Changes in tree stem diameter include both irreversible woody stem growth and reversible circumference changes related to water status. Point dendrometers permits evaluation of daily cycle of stem diameter variability comparing with band girth were only general growth trend can be derived. For both data sets correlation with daily and periodic climate data has performed.

Nutrition of fast growing tree species and effects of land use change on agricultural soils

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The ongoing emission of CO_2 and global warming due to burning of fossil fuels give new impulses to replace fossil raw materials by renewable biomass as sustainable alternative. Short rotation plantations (SRP) of fast-growing tree species are becoming an additional component in energy and material supply chains. Besides aspects of energy and material use the storage of carbon in trees and soils of SRP is an additional benefit stabilizing climatic and environmental conditions.

Typically fertilizer and organic residue application ensure a sufficient nutrient supply of agricultural crops. Land use change from intensively managed annual crop to wood production generally does not require fertilization. In case of biomass production on forest sites the amount of nutrient export with harvest is low as mainly logs with a low concentration of nutrients are used and branches and twigs with higher concentrations are left on site. Because of the high growth rates of trees in SRP systems and the use of smaller trees with bark and twigs, the export of nutrients is increased in SRP compared to traditional forestry.

The present investigation tries to assess the sustainability of current management practice on SRP. Thus the storage of plant-available nutrients in soils and organic layers is compared with nutrients accumulated in the biomass that is exported every 3–4 years due to harvest.

With low ratios of nutrient content in the soil to nutrient content in the harvested biomass, addition of fertilizer in the form of recycled ashes from wood combustors was found to be beneficial for tree growth. The addition of ash as well as the input of detrimental elements, such as heavy metals or an excess of nutrients, affect the nutrient status of the soil and thus need to be included in the nutrient balance to ensure the sustainability of such management practices.

Poster presentation

Biofungicides in order to prevent ecoproblems

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Many beneficial fungi and bacteria have been isolated from the soil and tested in laboratories as to their ability to control plant pathogens. Recently, some of the more promising of these beneficial fungi and bacteria have been further developed and marketed to plant growers as an alternative to traditional chemical-based fungicides. There are four different mechanisms by which beneficial or biocontrol agents interact with other microorganisms. Most biocontrol agents apply only one of these four mechanisms; however, some may employ more than one. In this papers were referred to the plant pathogen as the target organism. The first of mechanisms are direct competition. The second one is antibiosis when the biocontrol agent produces a chemical compound such as an antibiotic or some type of toxin that kills or has some sort of detrimental effect on the target organism. Antibiosis is one of the most effective methods of controlling microorganisms. Predation or parasitism is the third part of mechanism. In this case, the biocontrol agent attacks and feeds directly on the target organism, or the agent produces some sort of toxin that kills the target organism and then feeds on the dead target. And the fourth mechanism is induced resistance of the host plant. Scientists have known for decades that once a plant is infected with a pathogenic microorganism, infection triggers some sort of biochemical reaction in the infected host plant that helps keep it from being infected with further pathogens (super infection). The infected plant becomes more "resistant" to other infections. Plants do not have immune systems to protect them from infection as we do; however, they do have physiological and biochemical systems that help inhibit infection and spread of pathogens within tissues of the affected plant. Induced resistance is not highly understood and is currently a very exciting area of research throughout the scientific community.

Aim of this work is a better understanding of the current crop of beneficial organisms (biofungicides) -- how they work and, most importantly, their advantages and disadvantages when compared to traditional chemical fungicides.

Keywords: biofungicides, mechanism of interaction, plant

Nitrogen budget of Bavarian Level II plots from 25 years of measurement

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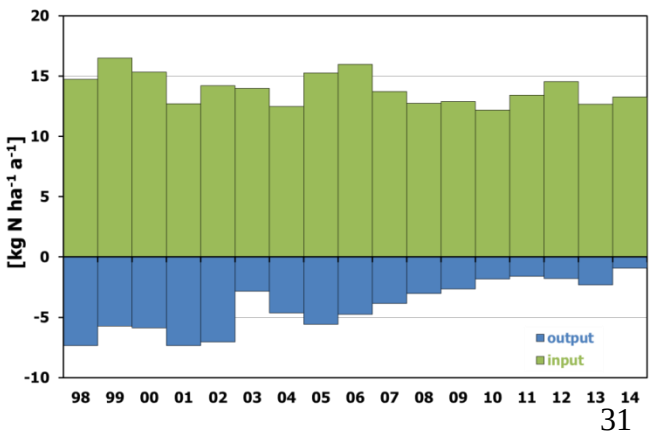
Comparing the of nitrogen stock data from all soil layers (up to 60 cm depth) between the first and the second German forest soil inventory an annual loss of 33.5 kg N ha^{-1} a^{-1} was calculated for not limed soils for hole Germany in average during the two decades (Andreae et al., 2016). To verify these findings the intensive monitoring data on biogeochemical nitrogen cycle from 22 level II plots in Bavaria were evaluated for the same period of observation. Input of nitrogen with deposition varies between 6 and more than 30 kg ha^{-1} a^{-1} and exceeded critical load on 70% of the plots. Most of these plots are not limed and show very low nitrogen concentration in seepage water. Nitrogen output was calculated with water flux from the water budget model LWF-Brook90. Time series of foliage nitrogen content and cycling by litterfall indicated the development of nutrition. Nitrogen uptake was calculated similar to the critical load approach using the measured growth data. Results show that nitrogen input exceeded nitrogen output considerably (see Figure). In average of all Bavarian level II plots nitrogen input was 14.2 kg ha^{-1} a^{-1} whereas output was 4.0 kg ha^{-1} a^{-1}. Assuming an uptake of 10 kg ha^{-1} a^{-1} nitrogen stock of the forest soils should be more or less constant if denitrification could be neglected. An annual loss of more than 30 kg N ha^{-1} a^{-1} could not be verified at any of the Bavarian Level II plots.

Andreae, H., Eickenscheidt, N., Evers, J., Grüneberg, E., Ziche, D., Ahrends, B., Höhle, J., Nagel, H.-D., Wellbrock, N. 2016: Stickstoffstatus und dessen zeitliche Veränderung in Waldböden. In: Wellbrock, N., Bolte, A., Flessa, H. (eds.): Dynamik und räumliche Muster forstlicher Standorte in Deutschland. Ergebnisse der Bodenzustandserhebung im Wald 2006 bis 2008. Braunschweig: Johann Heinrich von Thünen-Institut, Thünen Rep. 43, 135-180.



Nitrogen deposition (input) and leaching with seepage water (output), average of all Bavarian Level II plots from 1998 to 2014.

Nitrogen cycling and sequestration in temperate forest edges

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Forest edges are increasingly important landscape features worldwide, but they have largely been ignored in assessments of forest ecosystem functioning. Compared to interior forest zones, edges suffer increased nitrogen (N) input through atmospheric deposition, but it is still unclear how elevated atmospheric N deposition specifically affects N and carbon (C) stocks and cycling at temperate forest edges.

The specific aims of this study were (i) to assess the edge effect on N stocks, C stocks and sequestration and (ii) to determine which processes of the forest N cycle differ between forest edge and interior. All experiments have been performed in forests in Belgium (oak and pine) and Denmark (spruce) of which N in- and outputs were previously characterised. Aboveground (wood) and belowground (roots, mineral soil) N and C stocks are increased at the forest edge. A fully automated measuring system, consisting of static and dynamic measuring chambers, measured lower NO emission and increased CH_4 uptake at the forest edge, while there was no edge effect on N_2O fluxes. A pool dilution experiment (adding ^{15}N to the mineral soil) showed that mineralization rates were higher at the warmer forest edges, while nitrification was not affected by edge proximity. The microbial community, steering these soil processes was mapped via two *state-of-the-art* techniques: phospholipid fatty acid (PLFA) and aminosugar extraction. Biomass of Gram positive bacteria was increased at the forest edges. A ^{15}N tracer study showed that the forest interior retained more N in the litter layer, while N was stored in deeper soil layers at the edge. Litter decomposition and nutrient release were assessed via the litterbag technique and were increased at the edge compared to the interior.

Our results indicate the importance of incorporating forest edges in programs monitoring N and C on a landscape scale.

Importance of bryophytes and their cyanobacteria in boreal forest N-budget

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Bryophytes cover a substantial part of the forest floor in boreal region. In nitrogen limited northern forests biological nitrogen (N_2) fixation of bryophyte-associated cyanobacteria is an important source of new N. In this study we estimated the N stock of bryophyte layer and the N input rates by N_2 fixation of bryophyte-cyanobacteria associations and by N deposition at the ecosystem level. We studied 12 intensively monitored forest ecosystem plots (ICP Forests Level II) along a latitudinal gradient in Finland during 2009–2013. The total biomass and N stock of the green part of bryophytes varied 600–1500 kg ha^{-1} and 5–20 kg ha^{-1}, respectively. N_2 fixation rate associated to bryophytes increased towards north and was at highest 1–2 kg N ha^{-1} $year^{-1}$ (based on the bryophyte biomass in the monitoring plots). This N input was at the same level as the N deposition in northern Finland (1.5 kg N ha^{-1} $year^{-1}$). In comparison, the annual return of N to the nutrient cycle via needle litterfall and other tree litter is ca. 5 kg N ha^{-1}. In southern Finland the N_2 fixation showed very low rates probably because of inhibition of cyanobacterial activity by the anthropogenic N deposition. The moisture level of bryophytes and light/temperature conditions strongly regulated the rate of N_2-fixing activity. The results showed that the bryophyte layer significantly contributes to the N budget of boreal forests and that the cyanobacteria associations are sensitive indicators of changes in N dynamics in these ecosystems.

Standard presentation

Atmospheric nitrogen deposition to terrestrial ecosystems across Germany

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Biodiversity is strongly affected by the deposition of nitrogen and sulfur on terrestrial ecosystems. Forests in North-Western Europe are strongly affected by this process. In order to reduce the impact of acidifying and eutrophying deposition on ecosystems, countries need an assessment of the current situation to know which areas and sources to target. Here we present new quantitative estimates of the deposition of atmospheric nitrogen to ecosystems across Germany. The methodology combines prognostic and empirical modelling to establish wet deposition fluxes and land use dependent dry and occult deposition fluxes. On average, the nitrogen deposition in Germany was estimated to be about 1000 eq ha^{-1} yr^{-1}. The deposition maps show considerable variability across the German territory with highest deposition on forest ecosystems in or near the main agricultural and industrial areas. Dry deposition over forests is higher than over other vegetation types because the deposition velocity increases with increased vertical roughness of the vegetation. The accumulated deposition over Germany of this study is systematically lower (27 %) than provided in earlier studies. The main reasons are an improved wet deposition estimation and the consolidation of improved process descriptions in the LOTOS-EUROS chemistry transport model. The presented deposition estimates show a better agreement with results obtained by integrated monitoring and deposition modelling by EMEP than the earlier results. Through comparison of the new deposition distributions with critical load maps it is estimated that 70% of the ecosystems in Germany receive too much nitrogen. The highest exceedances are found for Lower Saxony, Schleswig Holstein, North-Rhine-Westphalia.

Does regional drought intensity trigger mortality patterns of Scots pine in inner-Alpine dry valleys of Switzerland?

Emily Solly, Matthias Haeni, Christian Hug, Peter Waldner, Lorenz Walthert, Andreas Rigling, Flurin Sutter, Pierre Vollenweider, Frank Hagedorn, Arthur Gessler

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Waves with elevated Scots pine (*Pinus sylvestris* L.) mortality have been observed during the last decades in several inner-Alpine dry valleys in Switzerland, Italy and Austria. In these regions air temperature has shown strong increases during the last decades and drought periods have become more frequent. In autumn 2016, a new wave of high Scots pine mortality has been observed in forests surrounding Visp, Brig and Gampel-Bratsch (including a Level II plot) but not in further Western areas of the Rhone valley. We hypothesized that the hot and dry climatic conditions in 2015 and the very dry summer and fall seasons in 2016 were triggers of this episode of mortality.

Regional temperature and precipitation maps provide first indications that the region affected by the high mortality rate was exposed to drought in 2016. On the Level II plot of Visp, volumetric soil water content and soil matric potential were continuously studied since 2008. These measurements show a significantly lower water availability in late summer 2016 as compared to that observed during the same period of time in previous years. On this plot, visible symptoms of a significant increase in Scots pine mortality were observed since October 2016, i.e. just during/after this drought period.

Our preliminary results suggest that the intensity of local drought may well be a trigger of the Scots pine mortality in the inner-Alpine dry valleys. We plan to explore drought indices and vegetation parameters on the regional scale and to relate them to local tree mortality inventories and soil moisture data in other forest study sites in the Rhone valley. At the site of Visp we are furthermore interested in investigating how the increasing competition with neighbouring plant species (trees/shrubs) may influence the mortality of Scots pine in interaction with local soil conditions such as soil depth.

Does tree diversity matter for defoliation trends of oak and beech?

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Climate change and other human-driven environmental changes may affect the productivity and stability of forest ecosystems in the coming decades. These disturbances shape forests by influencing their composition, structure, and processes. Recently, evidence from multiple ecosystems suggests that increased biodiversity is associated with higher resistance to disturbances. Thus, we hypothesized that the maintenance of forest ecosystem vitality is enhanced by species diversity, in particular when longer periods are considered. More specifically, we compared the effects of forest diversity on defoliation at both stand and tree species level. To do so, we revisited the trends in defoliation on Belgian Level I and Level II monitoring plots, from 1990 to 2015, for three main European tree species: common beech, sessile oak and pedunculate oak, either growing in pure or mixed stands, which allowed us to test for species diversity and species identity effects in terms of forest defoliation response to disturbances. In the end, we compared the observed trends with data from adjacent countries.

The investigated species exhibited different patterns of defoliation. In Belgium, where the overall defoliation trend has increased steadily, sessile oak had the lowest mean defoliation. At European level, however, both *Quercus robur* and *Q. petraea* displayed higher mean defoliation than common beech. But the most striking result emerging from the data was that, over time, the effect of tree species diversity on total defoliation shifted from negative to positive. Defoliation was initially lower in stands with higher tree diversity. However, following a gradual but consistent shift, the trend is reversed around 2009, after which vitality increases with tree species richness. These findings seem to confirm the stress gradient hypothesis, stating that diversity effects on ecosystem performance get stronger with increasing stress.

Finally, these results are interpreted in terms of mixed plantation practice as a climate change adaptation strategy.

Poster presentation

Interaction of biotic processes with nutrient cycling and tree growth in an oak-hornbeam forest stand in Switzerland

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Throughfall and bulk deposition have been continuously measured as a means of assessing atmospheric deposition and its trends at 14 sites of the Swiss Long-term Forest Ecosystem Research (LWF) since 1995 or later. All LWF sites showed a decreasing trend in the throughfall deposition of inorganic nitrogen (N) over the last two decades except the Jussy site, an oak-hornbeam stand located on the Swiss Plateau. The N inputs to the forest floor during the last sampling years were almost twice as high as the average input during the preceding years (9.8 kg^{-1} ha^{-1} yr^{-1} on average during 2012-2015 vs 4.8 kg^{-1} ha^{-1} yr^{-1} in 2008-2011). The elevated N inputs were due to the increased deposition of N in the ammonium form (NH_4^+), while the input of N in the nitrate form (NO_3^-) has slightly decreased.

The site of Jussy is regularly infested by the winter moth, the caterpillars of which cause significant tree defoliation in spring. Annual crown condition surveys and insect counts on glue bands attached to selected trees indicate a higher degree of infestation during the recent years. We therefore assume that the elevated NH_4^+ inputs originate from frass. The particular setting of the Jussy site supports this assumption. It actually consists of two 1 ha subplots ca. 500 m apart, both within a larger forest area. The two subplots are thus expected to be subjected to a similar pollution climate. However, NH_4^+ deposition is particularly high on the subplot that shows higher caterpillar infestation.

The crown condition survey also reveals particularly high defoliation in the years 2004-2006, which are, however, only weakly reflected in higher NH_4^+ fluxes during these years. The particularly high defoliation visibly impacted annual radial tree growth as recorded by manual dendro-meter bands.

Poster presentation

Linkages between riparian zone and stream water DOC concentration and quality in relation to land use

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Increasing trends in dissolved organic carbon (DOC) concentrations in surface waters have been recently reported in northern Europe and North America. Many different processes have been proposed to explain increased DOC concentrations, e.g. recovery from acidification, eutrophication effects caused by nitrogen deposition, increased forest production, climate warming and land use change. The loss of terrestrial organic carbon (OC) to rivers has been estimated to be about 10% of the net ecosystem production on land. OC transport is closely connected to land use (vegetation and soil type), and is largely controlled by hydrological processes. In our study we studied how the concentrations and characteristics of DOC differ among different land use, riparian zones and stream water and assessed if the magnitude of these spatial changes were similar to reported temporal changes in DOC that have been attributed to climate change and reduced acid deposition loads. We studied the riparian zone of five different land use sites (2009-2011): birch and spruce forest, drained and pristine peatland and cultivated field. The sites, except spruce forest, were located in the Löyttyoja catchment, south Finland. The old-growth spruce forest was located in the 20 km North from Löyttyoja catchment, at Valkea-Kotinen (one of the Finnish ICP Forests plot locates at Valkea-Kotinen). Open area deposition was collected from Valkea-Kotinen and represents deposition at all studied sites. Throughfall was collected from the forested sites, soil water from mineral soil riparian zone, ground water from peat riparian zones, stream water, and spring water from the Löyttyoja catchment and lake water from Lake Pääjärvi, into which the stream flows. Both DOC concentration and quality were determined in addition of major nutrients and SO_4-S and NO_3-N concentrations. Preliminary results indicated that overall DOC concentrations in the riparian zone and stream water varied greatly between the different land uses.

The magnitude of ozone fluxes in German forests – does latitude matter?

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As an air pollutant, ground-level ozone is still of major concern for European forests due to its effects on forest vegetation and associated reduction in plant growth. To assess the potential risk for exposed vegetation, different approaches may be used.

In comparison to the standard, concentration-based AOT40 approach (Accumulated O_3 concentrations over a threshold of 40 ppb), ozone flux calculations need a substantially higher amount of input parameters, as global radiation, temperature, vapor pressure deficit, wind speed, total water potential, air pressure and ozone concentration. However, these are not measured on the required hourly basis in many forest stands over long time.

To evaluate the risk of ozone fluxes, Critical Levels (CL), defined as biomass loss, are essential. At the moment, CL for Central European tree species are likely uncertain, because of the low amount of underlying data points and the narrow juvenile age distribution of sample trees in the CL determination. To avoid youth effects in dose response relationships, it is necessary to perform epidemiological studies or FACE experiments. For an epidemiological approach, a gradient in ozone flux would be beneficial. Due to an existing climate gradient from north to south and varying ozone concentrations in different years, Germany represents an appropriate region to investigate ozone flux gradients. The exploration for gradients in ozone flux according to meteorological parameters and air pollution will be the first step for an effective epidemiological study. Therefore, actual and former ICP Forest Level II plots with hourly data of ozone and meteorological parameters are identified and ozone fluxes are finally calculated with the DO_3SE model for the years 2002 to 2005.

The magnitude of ozone flux, the date of exceedance of CL, geographic topology and air pollution factors were taken into account to interpret the spatial results.

Standard presentation

Assessment and mapping the dynamics of health status and soil properties in forest ecosystems from central Balkan region

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A mapping and assessment of the dynamics in forest ecosystems condition focusing on health status and soil properties is demanded regarding biodiversity and sustainable management strategies. In order to fulfil the task the data for different indicators collected from ICP Forests Level I plots located in the central Balkan region were analysed for the period 1986 – 2016 and were discussed according to the DPSIR method. The primary focus was on the biophysical assessment of forest ecosystems and defining their condition in two time series. Based on the assessed condition and through the implementation of an innovative GIS approach, the dynamics of the capacity of forest ecosystems to supply relevant ecosystems services were discussed and mapped. The aim of the presentation will be the introduction of the approach and first experiences of ecosystem services – indicator development linking the existing dataset obtained by ICP Forests Level I network with ecosystem services concept. Bulgarian forests harbour a great diversity of natural conditions, which are suppliers of ecosystem services for the society. The last makes them significant in terms of study the dynamics of ES supply.

Acknowledgment: The study was realized under the TUNESinURB project (FM of EEA 2009-2014) and ICP Forests National Project (ExEA).

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The conference is hosted by

National Institute for Research and Development in Forestry (INCDS)
„Marin Drăcea"
B-dul Eroilor, no. 128
077190 Voluntari
Romania

www.icas.ro

Meeting venue

Novotel Bucharest City Centre Hotel
37B Calea Victoriei
Sector 1, Bucharest, Romania

Layout: Walter Seidling, Alexa Michel

Cover layout: Walter Seidling, Tanja Sanders

Printed in Romania by the National Institute for Research and Development in Forestry (INCDS) „Marin Drăcea" with the support of the LIFE project **MOTTLES** (LIFE15 ENV/IT/000183)

http://mottles.ipsp.cnr.it

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