LRTAP
Long-range Transboundary Air Pollution

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Working Group on Effects
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ICP Forests

Book of abstracts

4th ICP Forests Scientific Conference

May 19th – 20th, 2015
Ljubljana, Slovenia

Long-term trends and effects of air pollution on forest ecosystems, their services, and sustainability

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Long-term trends and effects of air pollution on forest ecosystems, their services, and sustainability

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Foreword

Forests represent an immense resource for our planet. They provide a number of services (from the provision of wood and non-wood products, to the protection of biodiversity, habitats, water resources and the regulation of atmosphere and climate processes) and are just essential for human life on Earth.

The conference is aimed at scientists and experts from ICP Forests, the UNECE ICP community under the Working Group on Effects (WGE), partners and respective stakeholders, as well as all interested scientists and experts from related fields. Researchers engaged in projects, evaluations and modelling exercises based on ICP Forests data, or working in co-operation with ICP Forests are encouraged to present and discuss their work and results.

The 4th Scientific Conference of ICP Forests addresses the role of air pollution as primary or secondary stressor and its effects on tree growth, crown condition, biodiversity, ecosystem services, and the sustainability of forests. The main topics are:

- The temporal development (possibly with predictions) of air pollution effects on forests, including nitrogen deposition and ozone impacts, on different spatial scales
- The temporal and spatial development of forest performance indicators, forest ecosystem services, their sustainability and interactions with climate trends
- Integrative analyses and modelling exercises based on the above indicated data

For 30 years the International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) operating under the UNECE Convention on Long-Range Transboundary Air Pollution (CLRTAP) monitors forest condition (the amount and composition of foliage, tree growth, biodiversity) and environmental factors (e.g. soil and soil solution chemistry, deposition chemistry, air chemistry, meteorology) across Europe. The data is used by a large number of scientists investigating different policy relevant research questions.

The conference will provide an overview on the latest research in policy relevant fields, such as air pollution trends, trends of response variables and interactions with climate change, as well as on nutrient and water cycles, biodiversity, and forest condition. A comprehensive platform is offered for scientists to discuss scientific questions and share experiences. The conference provides an annual platform to bring together monitoring experts, researchers, and modellers. Data users will benefit from background information related to the data sets. Data providers will profit from an advanced insight into the latest statistical applications based on “their” data. Data users will be able to take advantage of getting in touch with data experts to discuss data availability and data quality as well as metadata. Both, data and evaluations provide a sound basis for future activities at all levels of integration and differentiation: spatial, temporal, and functional.

Programme

08:00-09:00	Registration	
	Opening addresses. Chair: Alexa Michel	
09:00 - 09:15	Host country	NN
09:15 - 09:20	ICP Forests, PCC	Walter Seidling
09:20 - 09:25	ICP Forests, Scientific Committee	Marco Ferretti

Session 1: Measuring and modelling air pollution trends and effects in Europe. Chair: Karin Hansen

09:25 - 09:45	**Key note: E.J.W. Wattel-Koekkoek et al.:** Changes over the past 25 years in rainwater and groundwater quality in nature areas in The Netherlands as a result of emission reduction policy
09:45 - 10:00	**Standard: N. König et al:** Comparability of analytical data as a basis of possible evaluation of European deposition, soil and foliage data
10:00 - 10:15	**Standard: J. Johnson et al.:** Contrasting responses of two Sitka spruce forest plots in Ireland to reductions in sulphur emissions: results of 20 years of monitoring
10:15 - 10:30	**Standard: K. Andreassen & W. Aas:** Effects of nitrogen deposition on growth of Norway spruce in Norway
10:30 - 10:35	**Short: A. Marchetto et al.:** Geo-statistical modelling of bulk deposition of inorganic nitrogen to Italian forests
10:35 - 10:40	**Short: S. Türtscher & T.W. Berger:** The change of forest soil conditions in beech stands (*Fagus sylvatica*) of the Vienna Woods within the last three decades due to declining deposition of atmospheric pollutants
11.40 - 11:00	**Coffee break**

Session 2: Measuring and modelling air pollution trends and effects in Europe (cont.). Chair: Nenad Potočić

11:00 - 11:20	**Key note: M. Schaub et al.:** 2000-2013 ozone trends across Europe
11:20 - 11:35	**Standard: C. Proietti et al.:** Ozone impacts on forest's productivity and health in Europe
11:35 - 11:50	**Standard: D. Silaghi et al.:** Radial growth response to ozone exposure and uptake of sessile oak (*Quercus petraea*) in Mihaesti Level II forest monitoring plot, Romania
11:50 - 12:05	**Standard: A. Saenger et al.:** Changes in nutrient and carbon stocks in French forest soils under decreasing atmospheric deposition
12:05 - 12:10	**Short: R. Novotný et al.:** Chemistry of forest soils and the deposition load in the Czech Republic within the last two decades
12:10 - 12:15	**Short: S. Neagu et al.:** Impact of weather conditions, atmospheric deposition and foliar nutrients in the Romanian intensive monitoring system
12:15 - 12:20	**Short: P. Michopoulos et al.:** Deposition and soil solution chemistry in two adjacent mountainous forest ecosystems in Greece
12:30 - 13:30	**Lunch**

Session 3: Forest response: health, diversity and growth.
Chair: Walter Seidling

13:30 - 13:50	**Key note: S. Nevalainen:** A trend analysis of the defoliation in boreal forests of Finland
13:50 - 14:05	**Standard: M. Ferretti et al.:** Defoliation reconsidered?
14:05 - 14:20	**Standard: D. Žlindra et al.:** Degradation of *Fagus sylvatica* on Trnovo plateau in southwest Slovenia
14:20 - 14:35	**Standard: M. Nicolas et al.:** Plant bio-indicators do not reflect temporal changes measured in forest soil pH and C/N ratio over 15 years
14:35 - 14:40	**Short: I. Berki et al.:** Retreating sessile oak forest with improving vitality – including tree mortality in vitality assessment
14:40 - 14:45	**Short: U. Vilhar et al.:** Tree phenology in relation to meteorological conditions and crown defoliation on intensive forest monitoring plots in Slovenia
14:45 - 14:50	**Short: M. Čater:** A 20-year overview of *Quercus robur* L. mortality and crown condition in Slovenia
14:50 - 14:55	**Short: E.I. Vanguelova:** Long-term trends and effects of air pollution on British forests and soils
15:00 - 16:10	Coffee and Poster session
	- Poster: Z. Galic: Soil properties on the Level I plots in lowland forests in Serbia **- Poster: T. Scheuschner:** Impact of air pollution and climate change on forest ecosystems in the Polish-Saxon border region **- Poster: W. Schröder:** Methodology to assess and map potential developments of forest ecosystems exposed to climate change and atmospheric nitrogen deposition by example of Germany **- Poster: S. Leca:** Intra-annual dynamics of stand basal area increment in four intensive monitoring plots (Level II) in Romania **- Poster: T.W. Berger & A. Muras:** Predicting recovery from Acid Rain using the micro-spatial heterogeneity of soil columns downhill the infiltration zone of beech stemflow **- Poster: L. Kutnar & K. Eler:** Use of ICP Forests methodology for assessment of species diversity and invasibility of (peri-) urban forests **- Poster: A. Príncipe:** Microclimate matters for the long-term natural regeneration potential of woodlands in semi-arid regions **- Poster: R. Gagić Serdar:** Monitoring within integrated pest management as essential precondition for sustainable governance of natural resources in Serbia – defoliation comparable analysis on ICP Forests plots during period 2009-2014

Session 4: New developments. Chair: Nathalie Cools

16:10 - 16:30	**Key note: G. Chirici et al.:** The use of ICP Forests Level I BIOSOIL-BIODIVERSITY plots for pan – European estimation of forest variables
16:30 - 16:45	**Standard: P. Merilä et al.:** Impacts of harvesting practice on base cation budgets of coniferous stands in Finland – a sustainability study
16:45 - 17:00	**Standard: M. Skudnik et al.:** Environmental factors explaining the N and δ15N values in the moss collected inside and outside canopy drip lines
17:00 - 17:15	**Standard: V. Mues et al.:** Forest Management Scenario Study with BiomeBGC at nine ICP Forests Plots
17:15 - 17:30	**Standard: K. Dolschak & T.W. Berger:** Modelling sulphur biogeochemistry of beech (*Fagus sylvatica*) stands at the Vienna Woods
17:30 - 17:35	**Short: J. Kattge et al.:** TRY – the global database of plant traits
17:35 - 17:40	**Short: L. Canini et al.:** Making forest monitoring cheaper and closer to society: The LIFE+ Project "SMART4Action**"**
17:40 - 17:45	**Short: D. Finžgar et al.:** LIFEGENMON - LIFE for European Forest Genetic Monitoring System: Development of a system for forest genetic monitoring
17:45 - 17:50	**Short: W. Schröder et al.:** Heavy metals and nitrogen concentrations in moss collected across Europe from 1990-2010: Meaningful for ICP Forests / Modelling and Mapping?
17:00 - 18:00	**Conclusive remarks:** Marco Ferretti
18:00	**Closing**

Abstracts

Standard presentation

Effects of nitrogen deposition on growth of Norway spruce in Norway

Kjell Andreassen[1] and Wenche Aas[2]

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In Norway soil nitrogen is often a nutrient limiting factor for growth of Norway spruce. However, will nitrogen deposition influence the growth? In this investigation the growth of Norway spruce (*Picea abies*) trees and nitrogen deposition was analysed at about 500 forest monitoring plots throughout Norway through 30 years from about 1980 to 2010. The growth was calculated from five year periodic measures of breast height diameters of all trees, and additional data from tree-ring series from increment cores of a subsample of trees. From the growth data a 'relative growth' variable was calculated, being the deviation in % between observed and expected growth rates from models. The expected growth was estimated from growth models based on site productivity, age and stand density at each plot. The plots were categorized into four age classes. The nitrogen deposition was estimated for each plot for the same five year period by geographical interpolation of deposition observations at monitoring stations made by the Norwegian Institute for Air Research. For the entire 30 year period we found a long term relationship between growth and nitrogen deposition, corresponding to a forest growth increase of 0.7% per kg total nitrogen deposition per hectare and year (R^2 = 0.13). This is in line with studies carried out on other data sets and for shorter time periods. This apparent fertilizing effect was most pronounced for the youngest forest, while the effect was weak for the oldest forest. The growth increase was most pronounced in the southernmost part of Norway, the region with the highest nitrogen deposition. However, the relationship between nitrogen deposition and growth varied considerably between the time periods. In two of the periods the relationship was slightly negative: these periods corresponded well with summer droughts occurring in the southernmost part of Norway. Drought, as well as other climatic factors, will also influence the short-term variations in forest growth and may obscure the fertilizing effect of nitrogen deposition in some periods. In conclusion, nitrogen deposition has most likely increased growth in Norway spruce in southern Norway. However, our study also shows that inferences from such correlative studies should be drawn with care if the growth period is shorter than 10-15 years because climatic factors produce temporal variations in the relationship between nitrogen deposition and forest growth.

Poster presentation

Predicting recovery from Acid Rain using the micro-spatial heterogeneity of soil columns downhill the infiltration zone of beech stemflow

Torsten W. Berger[1], Alexander Muras[1]

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Revisiting the Acid Rain topic is worthy, since in many regions mass balance estimates of sulfur are negative due to release of previously-stored sulfur, delaying the recovery of pH of soils and surface waters. Using the micro-spatial heterogeneity of soil columns downhill of a beech stem enables the study of reversibility of soil acidification as a function of historic acid loads (stem area received much higher deposition loads in the past than the between trees area) and time (a "false chronosequence" is expected, since increasing soil solution fluxes due to additional stemflow with decreasing distance from the stem cause a quicker steady state of soil sulfate pools in response to decreasing inputs). Changes of soil chemistry with increasing distance from the stem of selected beech trees in the Vienna Woods were measured by Sonderegger (1982) and Kazda (1983) in the 1980s. Three of these old sites soils were re-sampled (2010) and analyzed for pH, total contents of C, N, S and exchangeable cations.

Mean soil stores (forest floor and mineral soil down to 50 cm depth) at the three sites of C_{org} (76-116), N_{tot} (5-10) und S_{tot} (0,7-1,0; data in t ha^{-1}) showed no differences between the individual distances (27, 55, 100, 150 und 300 cm) downhill from the stem. However, the acid input of the last decades is currently documented by decreasing stores of Al_{exch} and Fe_{exch}, and increasing stores of Ca_{exch} and Mg_{exch}, respectively, from the base of the stem to the between trees area at 3 m distance.

In the 80s, soil pH (H_2O, KCl) near the stem was up to 3 units lower than distant from the stem, but now this gradient has flattened down. Consequently, soil pH close to the stem is currently higher, but at 1.5 to 3 m distances lower than in the 1980s. The best match with these pH trends was found for soil stores of Ca_{exch}. Comparing historic and recent pHs indicates that the acidification front-line moved down to deeper soil depths.

It is predicted that the top soil will recover from acid deposition, as shown for the infiltration zone of stemflow. However, in the between trees areas and especially in deeper soil horizons recovery may be highly delayed.

Kazda, M. (1983): Schwermetalleintrag in das Buchenwaldökosystem des Wienerwaldes. Diplomarbeit, Universität für Bodenkultur, Vienna.
Sonderegger, E. (1982): Bodenschädigung durch sauren Stammablauf in Buchenbeständen der Flyschzone. Diplomarbeit, Universität für Bodenkultur, Vienna.

Short presentation

Retreating sessile oak forest with improving vitality – including tree mortality in vitality assessment

Imre Berki[1], Ervin Rasztovits[1], Norbert Móricz[2], László Kolozs[3]

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[2]Forest Research Institute, National Agricultural Research and Innovation Centre, Sárvár
[3]National Food Chain Safety Office, Budapest

The drought induced vitality loss of sessile oak has been continuously observed in Hungary for more than three decades. Although stand density is an important indicator of the stand stability, the decreasing stand density as a consequence of drought induced mortality is not considered in most of the monitoring methods (e.g. ICP forest monitoring network). We introduced a novel health assessment method based on the vitality of the living trees and on the relative stand density, expressed as the ratio of the current density to the fully stocked density. Stands for the assessment were selected along a climatic transect from the humid region in SW-Hungary to the continental-semiarid region in NE-Hungary where no forest intervention was applied at least during the last two decades. The results showed that the calculated health status of the sessile oak stands are considerably below the ones measured by the ICP Forests, lying between 70-90% in SW Hungary and below 50% close to its xeric limit.

Short presentation

Making forest monitoring cheaper and closer to society: The LIFE+ Project "SMART4Action"

Laura Canini[1], Angela Farina[1], Aldo Marchetto[2], Giorgio Matteucci[2], Silvano Fares[3], Gianfranco Fabbio[3], Luca Salvati[3], Guia Cecchini[4], Filippo Bussotti[4], Marco Ferretti[5]

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[4]Università di Firenze, Italy
[5]TerraData Environmetrics, Italy

LIFE SMART4Action (Sustainable Monitoring And Reporting To Inform Forest- and. Environmental Awareness and Protection. LIFE13 ENV/IT/000813) intends to redesign forest monitoring and its information and reporting system in Italy. It is designed over the period September 2014 – March 2018 and will attempt to ensure financial sustainability to forest monitoring, despite budget restrictions, whilst maintaining scientific reliability. The project has two main goals:

- design a new system to reduce the current annual costs by 30%, while recognizing the importance of national and regional statistics on key variables linked to sustainable forest management and ecosystem services; and
- to improve communication with, and data transfer to, relevant stakeholders and citizens through a participatory process.

The analysis of the available data series of forest monitoring data will permit to optimize the number of plots, the frequency and the distribution of the activities, to maximize the information, and identify possible areas were monitoring and modeling can be fruitfully integrated.
To increase awareness about forest related issues and the importance of forest monitoring, SMART4Action will develop mechanisms to involve local people in plot management and basic monitoring for readily measurable variables, with local conferences and courses, synthetic result sheets at regional scale, and web-based and smartphone applications to obtain an active involvement of citizens. Present and historical monitoring data will also be shared on-line using geospatial standard services.
Here, we intend to present the project at its very beginning in order to explore the possibility of interaction and synergy with other on-going activities.

Short presentation

A 20-year overview of *Quercus robur* L. mortality and crown condition in Slovenia

Matjaž Čater[1]

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Pedunculate oak (*Quercus robur L.*) forests in Slovenia are experiencing widespread mortality. Changes in lowlands are reflected in decline of complete forest complexes, high mortality, uneven stand structure and associated forest regeneration problems. Prediction of the present-tree response in disturbed forest ecosystems may significantly contribute to better guideline policies for the silvicultural and forest management practice in the changing environment in both stressed and stabile forest ecosystems. Data from annual crown condition surveys for the 1995–2014 period from four permanent plots have been compared with parameters from hemispherical photo analysis and hydrometeorological data. Good agreement has been confirmed between crown defoliation and total openness; all parameters from the hemispherical photo analysis, which were corrected for winter period values, also indicated a better agreement. Mortality rate and crown defoliation correlated well with extreme drought events in 2003 and 2013. Pattern of agreement among compared parameters was different for the plots Krakovski gozd, Dobrava and some other plots. Mortality is influenced by the average air temperatures much more than by precipitation and groundwater table oscillations.

Keywords: pedunculate oak; mortality; drought; lowland forests; climate

Key note presentation

The use of ICP Forests Level I BIOSOIL-BIODIVERSITY plots for pan-European estimation of forest variables

Gherardo Chirici[1], Anna Barbati[2], Francesca Giannetti[1], Davide Travaglini[1], Roberto Canullo[3]

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This contribution is aimed at presenting the activities carried out in the framework of the UPSPEX ICP group for “Upscaling & Spatially explicit estimation of biophysical variables with remote sensing”.

UPSPEX is aimed at testing parametric and non-parametric techniques for predicting forest variables from satellite imagery and ground data acquired in the framework in order to test the possibility of spatially predicting pixel level estimates of forest variables at continental scale level.

The project is based on the use of the data collected in the framework of the biodiversity module of the BIOSOIL project in the ICP Forests Level I network. The field data were collected in 3,273 plots between 2007 and 2009.

This contribution first presents the analysis for the pre-elaboration of raw data and their comparison with the results presented by the JRC in the official report from 2011 (Durrant et al. 2011).

For each plot on the basis of tree level data several allometric equations were tested for calculating the biomass and growing stock volume plot level values. Plot level data are then aggregated on the basis of Horvitz-Thomson estimators for estimating country level estimates which are than compared with official estimates from National Forest Inventories.

The results obtained are the basis of the following phases of the project based on the integration with remotely sensed imagery which are currently undergoing.

Standard presentation

Modeling sulphur biogeochemistry of beech (*Fagus sylvatica*) stands at the Vienna Woods

Klaus Dolschak[1], Torsten W. Berger[2]

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[2]Department of Forest- and Soil Sciences, Institute of Forest Ecology, University of Natural Resources and Live Sciences (BOKU), Vienna, Austria

Forest ecosystems in Central Europe have received high loads of atmospheric sulphur during the last century. Several reasons led to a drastic decrease of deposition starting in the 1980s. Recent studies report only a weak response of the catchment S output to decreased atmospheric deposition. This discrepancy of S input and seepage S load is generally assigned to a net S release from the soil.

In this work we set up and apply a dynamical balance model which aims to identify the key mechanisms controlling the soil S budget. The model comprises a hydrological component controlling fluxes of solute SO_4. A sulphur dynamics module covers soil chemical processes as well as biotic S transformations.

We adjusted the model to 3 beech stands in the Vienna Woods which were intensively monitored for 2 years. The model succeeds to reproduce the current soil S pool, as well as an observed time series of SO_4 concentration in soil solution, allowing an assignation of fluctuations of solute sulphate to actual biogeochemical processes.

The model identifies the microbial interplay of S immobilization and mineralization as a major driver of the short time dynamics of solute SO_4 in the soil. A net S release, responsible for the observed output surplus, seems to be caused by the mineralization of more stable organosulfur, originating from plant biomass. The model depicts the monitored forest stands as a sink for atmospheric sulphur during the era of elevated SO_2 emission. In the late 1980s the system shifts from sink to source for the first time. Under current legislation emission the system approaches a new steady state (I=O), which is not reached entirely within the timeframe of the simulation (1700-2200).

Standard presentation

Defoliation reconsidered?

Marco Ferretti[1], Marco Calderisi[1], Elena Gottardini[2], and Manuel Nicolas[3]

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Since the 1980s defoliation (often assessed by means of crown transparency) is the most used indicator of tree condition adopted in Europe. It has been criticized for its subjectivity and scarce relation with meaningful endpoints. Here we collated the results of three different studies carried out in France and Italy to investigate the relationship between defoliation/ transparency and other measured indicators of tree growth and health.

In a first study, basal area increment (BAI) and mean defoliation of conifers and broadleaves in the French Level II network RENECOFOR were examined for the growing periods 1995-2004 (47 plots, 2008 trees) and 2000-2009 (63 plots, 3, 116 trees). A second, similar study was carried out on *Picea abies* (L.) Karts., in Trentino, Northern Italy, on 13 Level I plots and two growing periods, 2001-2005 (136 trees) and 2005-2009 (111 trees). The third study was carried out also in Trentino: nine *Picea abies* trees were randomly selected along an elevation gradient (900-1500 m asl) and examined for crown transparency, shoot length, needle weight, chlorophyll fluorescence, and stable isotopes in needles (δ 13C and δ 18O).

BAI resulted negatively and significantly related to defoliation at both the French and Italian plots, and growth reduction of 0.73-1.49% per unit increase of defoliation can be expected. The gradient study revealed that the response of trees to elevation is consistently and significantly recorded by the various indicators (e.g. reduced shoot length, needle weight, chlorophyll fluorescence, and increase of crown transparency).

We argue that, despite its "bad" reputation, defoliation can be considered as an effective indicator of forest health and vitality. Its role among the indicators of Sustainable Forest Management is justified, also in view of its long-term documentation in terms of QA/QC procedures at national/international level. These are strong arguments for supporting and promoting forest health monitoring networks.

Short presentation

LIFEGENMON - LIFE for European Forest Genetic Monitoring System: Development of a system for forest genetic monitoring

Domen Finžgar[1], Marjana Westergren[1], Barbara Fussi[2], Monika Konnert[2], Phil Aravanopoulos[3], Gregor Božič[1], Hojka Kraigher[1]

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According to the European Environmental Agency 2010 assessment, the overall forested area is rather stable but the variety of threats reducing forest biodiversity is increasing. These threats may adversely affect future adaptive potential and sustainability of European forests as well as set multiple forest ecosystem services at risk. Therefore, the latest state of the world's forest genetic resources report calls for urgent action to conserve and sustainably manage forest genetic resources (FGR). This is not an easy task and special tools, such as forest genetic monitoring (FGM) are needed to recognise the state and changes in FGR composition. Information on relevant changes of FGR adaptive and neutral genetic variation throughout time caused by management and conservation measures, can only be achieved through genetic monitoring. Genetic monitoring based on indicators and their verifiers can serve as an early warning system to assess a species response to environmental change at a long-term temporal scale.

While the already existing forest monitoring schemes aim at providing temporal and spatial overview of forest condition in relation to stress factors as well as understanding causes and effects of the condition of forest ecosystems, the gene level has so far been neglected on national and international levels. With the exception of a pilot study of the German FGM concept, it has not been implemented in practice to date.

The six-year LIFE + project LIFEGENMON, led by the Slovenian Forestry Institute, and supported by six partners from Germany, Greece and Slovenia, is intended to design, test and implement FGM on the transect from Bavaria to Greece, forming a regional implementation baseline for any future Pan-European forest genetic monitoring programme. The main objective is to contribute to the long-term conservation of forest adaptability.

Poster presentation / Short presentation

Monitoring within integrated pest management as essential precondition for sustainable governance of natural resources in Serbia - defoliation comparable analysis on ICP Forests plots during period 2009-2014

Renata Gagić Serdar[1], Tomislav Stefanović[1], Goran Češljar[1], Svetlana Bilibajkić[1], Radovan Nevenić[1], Ilija Đorđević[1], Zoran Poduška[1], Ljubinko Rakonjac[1]

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Integrated pest management (IPM) can play a key role in the reduction of damage in sustainable forestry practice development. Significant diversity of serious threats to forest ecosystems condition demands special governance instruments in goal of increasing productivity while an environmental contamination and health hazard needs to be reduced to a minimum. Forest research and policy development as partners should outstand contributing in IPM, notably in varietal resistance against pests, demanded by definition from the aspect of its suppression. Studies were conducted how it is required by planned preparations within ecosystem services such as ICP Forests bio-monitoring system. The National Focal Centre for forest monitoring in the Republic of Serbia, within the Institute of Forestry of the Republic of Serbia has been taking an active part in an international program of ICP Forests, with a tendencies of improving its working activities and harmonizing them with modern foreign approaches.

In order to determine forest ecosystem processes, it is necessary to carry out detailed research of ecological and socio-economic consequences of forest deterioration and to study the impacts of regional climate changes on forest communities. In the period from 2009 to 2014, observations were performed on permanent sample plots and data were necessary collected for all analysis. Plots are systematically arranged in either a 16 x 16 km or a 4 x 4 km grid system. The main parameters assessed on the sample plots are the degree of defoliation and discolouration as well as the extent of damage.

Research indicated forest vitality with defoliation occurrence, presenting certain regularities; especially those could be interpreted as a trend. The crown state elements fluctuations and the plant vitality parameters oscillating represented main important health indicators of Serbian forests in practice, from year to year.

Keywords: Integrated pest management, defoliation, ICP Forests sample Plots, crown condition monitoring, Serbia.

Poster presentation

Soil properties on the Level I plots in lowland forests in Serbia

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The aims of this study were to determined soil properties on the Level I plots in AP Vojvodina (northern part of Republic of Serbia). The research was done on 13 plots. We investigated the most important physical and chemical soil properties.

The textural class of the soils were from sand to silty loam. The contents of carbonates were in range of 1.41 to 17.03 %. The contents of carbon were in range from 0.65 to 8.92 %.

The contents of lead were from 22.81 mg kg^{-1} to 131.07 mg kg^{-1}. The contents of cadmium were 1.81 to 6.74 mg kg^{-1}. The contents of nickel were from 4.52 mg kg^{-1} to 37.64 mg kg^{-1}. The contents of zinc were from 36.31 to 150.19 mg kg^{-1}.

Keywords: soil properties, heavy metals, Level I

Standard presentation

Contrasting responses of two Sitka spruce forest plots in Ireland to reductions in sulphur emissions: results of 20 years of monitoring

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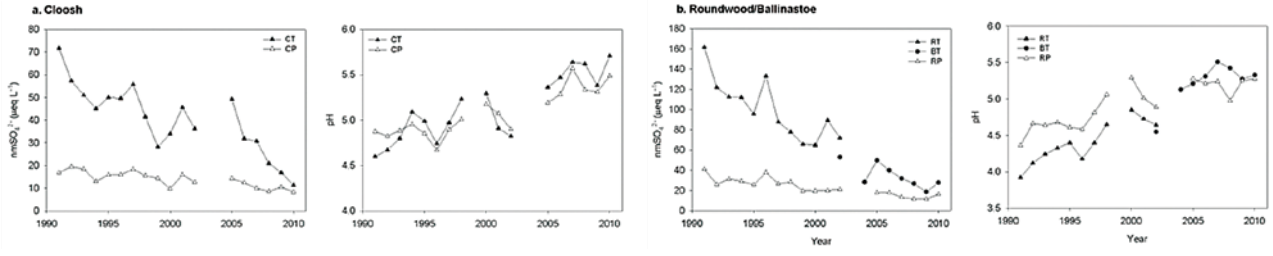
During the past two decades sulphur (S) emissions in Europe have declined substantially in leading to a large reduction in S deposition; however, the recovery of forest soils from acidification impacts has been mixed: many studies of soil water in forests report either slow or little recovery. In this study we evaluated the relationship between non marine sulphate ($nmSO_4^{2-}$) and nitrogen (N) deposition and soil water chemistry at two Sitka spruce stands with contrasting soil types and in the context of Ireland's temperate marine climate. The first stand (Cloosh) was planted on a low-lying Atlantic peat bog and located close to the west coast; Na^+, Cl^- and Mg^{2+} dominated deposition. The second site was located on a shallow peaty podzol soil along the east coast receiving much higher levels of anthropogenic S and N deposition. Significant declines in $nmSO_4^{2-}$ and acidity were observed in bulk precipitation and throughfall at both sites (Fig. 1). The decline in throughfall $nmSO_4^{2-}$ was significantly related to reductions in European sulphur dioxide (SO_2) emissions. At Roundwood, SO_4^{2-} declined significantly in humus, shallow and deep soil water. In deep soil water this was accompanied by a long-term increase in pH and a reduction in total aluminum (Altot). The recovery from acidification was delayed by high concentrations of NO_3^-, which strongly influenced acidity and Altot concentrations. At Cloosh, there was a significant decline in SO_4^{2-} in humus water, but long-term trends were not evident in shallow or deep soil water; SO_4^{2-} concentrations at these depths fluctuated in response to drought-events. The results highlight the value of long-term monitoring in assessing the impacts of emission reductions.



Time series of mean annual nm SO_4^{2-} and pH in bulk precipitation and throughfall at Cloosh (CP) and Roundwood (RP). Throughfall $nmSO_4^{2-}$ and pH for the site that replaced Roundwood-Ballinastoe (BT), are included for the period 2002–2010.

Johnson, J.A., Aherne, J., Cummins, T., 2013. Contrasting responses of two Sitka spruce forest plots in Ireland to reductions in sulphur emissions: results of 20 years of monitoring. Biogeochemistry, 1-23.

Short presentation

TRY – the global database of plant traits

Jens Kattge[1,8], Sandra Díaz[2], Sandra Lavorel[3], Colin Prentice[4,5], Paul Leadley[6], Gerhard Bönisch[1], Christian Wirth[7,8], and the TRY consortium

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Plant traits determine how primary producers respond to environmental factors, affect other trophic levels, influence ecosystem processes and services, and provide a link from species richness to ecosystem functional diversity. Plant traits thus are a key to understand and predict the adaptation of ecosystems to environmental changes. At the same time plant trait data are dispersed over a wide range of databases, many of these not publicly available. To overcome this deficiency we have developed a worldwide plant trait database, called TRY (www.try-db.org, Kattge et al. 2011). Its goal is the construction of a standard resource of plant trait data, while at the same time respecting intellectual data property.

So far the TRY initiative has united a wide range of the plant trait research community world-wide and gained an unprecedented buy-in of trait data: about 278 trait databases have contributed about 5.6 million trait entries for 100,000 plant species and 1,000 traits, characterizing the vegetative and regeneration stages of the plant life cycle, including growth, dispersal, establishment and persistence. The database has so far contributed to about 45 scientific publications. Due to its origin from several independent datasets the joint database is a sparse matrix. This sparsity might be overcome using advanced methods currently being developed in applied statistics and machine learning (Shan et al. 2012).

This conference contribution will present the approach of the TRY initiative to data sharing, the current state of data coverage in the joint database, and introduce our approach to gap-filling and trait prediction.

Kattge, J. et al., 2011: TRY – a global database of plant traits. Global Change Biology 17:2905–2935.
Shan, H., Kattge, J., Reich, P., *Banerjee, A., Schrodt, F., Reichstein, M., 2012: Gap Filling in the Plant Kingdom: Trait Prediction Using Hierarchical Probabilistic Matrix Factorization. Proceedings of the International Conference on Machine Learning (ICML) 2012.*

Standard presentation

Comparability of analytical data as a basis of possible evaluation of European deposition, soil and foliage data

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Over 100 different labs are analysing water, soil and foliage samples within the monitoring program of ICP Forests. To guarantee the comparability of the analytical results between different laboratories in several countries and over time a quality assurance (QA) program is necessary with participation of all laboratories. The QA program in each laboratory should be based on three pillars:

- the use of harmonized, well-defined and documented analytical methods
- an internal quality control (QC) program
- an external QC program coordinated by the monitoring program organizers

One part of the external QC program are ring tests between all labs. The percentage of non tolerable results in ring tests can be seen as a degree of quality and comparability of results from participating labs.

The change of percentage of non-tolerable results in water, soil and foliage ring tests within the last 15 years shows the development of the quality of the labs, but also the limitation due to different analytical methods.

Another possibility to benchmark the comparability and quality of labs is to analyse the same standard material during the analytical routine in different labs over time. Within the German soil survey all participating labs had to analyse standard material for each parameter all 20 samples over more than 5 years. The results of these standard material measurements and of the parallel ring tests show a good comparability for most of the soil parameters but also some problematic parameters.

Poster presentation

Use of ICP Forests methodology for assessment of species diversity and invasibility of (peri-) urban forests

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The ICP Forests methodology (Canullo et al. 2011) has been tested for assessment of diversity of vascular plant species and plant invasion in the (peri-) urban forests of Ljubljana. Among these forests are also different alluvial and riparian forests with high levels of plant species diversity. However, due to the vicinity of urban areas, the human impact on these forests is intense, and they are also among the most exposed forests to the invasion of alien species.

In three selected locations in (peri-) urban forests of Ljubljana, 161 vascular plant species were recorded in total. The number of vascular species varied between 61 (Rožnik site; urban area) and 85 (Gameljne-poplar site in the flood area of the Sava River; peri-urban area) per site. High number of herb layer species, including only non-woody species, has been recorded (104 species or 65% of all).

In the studied (peri-) urban forests, numerous non-indigenous plant species were recorded. The majority of them have been declared to be invasive species in Slovenia, which adversely affect the forest habitats and outcompete native plant species. Presumably, these invasive species, which represent 6% of the flora recorded, come from the Sava River or from urban areas, i.e. gardens and parks. Among three studied locations, the level of plant invasion is the highest at Gameljne-poplar site (8 species). The most abundant invasive species are *Solidago gigantea* and *Fallopia japonica*. Other invasive species are *Robinia pseudacacia*, *Berberis thunbergii, Physocarpus opulifolius, Rudbeckia laciniata, Erigeron annuus, Helianthus tuberosus, Impatiens glandulifera* and *Impatiens parviflora.*

In this study, it has been proved that the modified ICP-Forests monitoring methodology may be appropriate for assessment of flora in (peri-) urban forests. The dynamics of expansion of invasive species should be carefully monitored, and appropriate measures for its limitation need to be established in the near future.

Canullo R, Starlinger F, Granke O, Fischer R, Aamlid D, Neville P, 2011. Assessment of ground vegetation. Manual Part VII-SP1, In: ICP Forests. Manual on methods and criteria for harmonized sampling, assessment, monitoring and analysis of the effects of air pollution on forests. UNECE ICP Forests Programme Co-ordinating Centre, Hamburg.
Kutnar L, Pisek R, 2013. Non-native and invasive tree species in the Slovenian forests. Gozdarski vestnik 71: 402-417.
Rejmánek M, Richardson DM, Pyšek P, 2005. Plant invasions and invasibility of plant communities. In: van der Maarel E (ed.) Vegetation ecology. Blackwell, p. 332-355.

Poster presentation

Intra-annual dynamics of stand basal area increment in four intensive monitoring plots (Level II) in Romania

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Knowledge of intra-annual tree growth dynamics allow a better understanding of tree reaction to short term climate variation. The main objective of our study was to modelling intra-annual dynamics of stand basal area increment (BAI) in four level II plots in Romania, composed of pedunculate oak (*Quercus robur* L.), sessile oak (*Quercus petraea* L.), Norway spruce (*Picea abies* [L.] Karst.) and European beech (*Fagus sylvatica* L.), which are placed in representative forest ecosystems as well as in respective climatic and altitudinal conditions. During the growing season period in 2010-2014, for a number of 60 trees (15 for each plot and species), the growth variations of the selected trees were recorded bimonthly using permanent dendrometric bands. Seasonal dynamics of radial increment were modelled using logistic functions. Results confirm that in each year the growing season period are different for each location. For pedunculate oak and sessile oak a common onset of the growing season was observed during whole period, except in 2012. The same situation was emphasized for European beech (situated at 1,300 m altitude) and Norway spruce. For these species located in mountain region the maximum seasonal growth is recorded in the same period (late of June). In general, in all studied plots the values recorded on permanent dendrometer bands regarding the onset and maximum growth are confirmed by the data recorded on continuous point dendrometers.

Short presentation

Geo-statistical modelling of bulk deposition of inorganic nitrogen to Italian forests

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Open field bulk deposition of inorganic nitrogen ($N\text{-}NO_3$ + $N\text{-}NH_4$) measured at Level II sites in Italy over the period 2000-2011 ranged from 3.9 to 16.2 kg ha^{-1} per year. A positive effect on basal area increment and C sequestration was detected at the same sites (Ferretti et al. 2014), but uncertainty remains on the overall impact of N deposition on the Italian forests.

Data on N deposition at national level are available only in the form of large-scale, emission-based models with relatively coarse spatial resolution (EMEP model, 50 x 50 km), which may be not reliable, when scaled down to local scales. Here we attempted to use measured Level II data from the Italian network to:

- Validate existing and freely available EMEP data; and
- develop an independent, deterministic geo-statistical model based on actual data measured at Level II sites over the period 2000 – 2011.

To validate existing model output we run a simple exercise comparing spatial and temporal pattern of measured and modelled N deposition in relation to those measured at the Level II sites.

For the geo-statistical model, we used the following predictors: latitude, longitude, elevation, aspect, annual precipitation and land use within three different buffer ranges: 3, 16 and 50 km radius from the very plot.

Here we present the first outputs of the study. These results will be used in three directions: to derive N deposition estimates for Level I plots (and other sites); to feed correlative studies on the effect of N deposition on forests; to re-design the Italian deposition monitoring program, in terms of number of sites and their spatial allocation (retrospective design).

Ferretti M., Marchetto A., Arisci S. et al., 2014: On the tracks of nitrogen deposition effects on temperate forests at their southern European range – an observational study from Italy, Global Change Biology 20: 3423–3438.

Standard presentation

Impacts of harvesting practice on base cation budgets of coniferous stands in Finland – a sustainability study

Päivi Merilä[1], Michael Starr[2], Brandon Stephens[2], Antti-Jussi Lindroos[1], Tiina M. Nieminen[1], Pekka Nöjd[1], Kirsti Derome1, Liisa Ukonmaanaho[1]

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We simulated the impacts of final felling harvestings on base cation (Ca^{2+}, K^{++}, Mg^{2+}) budgets in boreal forests under the scenarios of stem-only harvesting (SOH), whole-tree harvesting (WTH) and WTH + stump and root harvesting (WTSR). The study included five Scots pine and five Norway spruce stands belonging to the UNECE ICP Forests Level II programme in Finland. A mass balance approach was used: base cations (BC) in total deposition (TD), weathering (W), leaching (L), and harvesting removals (H) fluxes were estimated and analysed for the effect of tree species and climate (latitude). Soil stocks of exchangeable BC were measured and BC exports in the final fellings were estimated. A sustainability index (SI) for the hypothetical harvesting impacts on soil BC sustainability was calculated as: TD + W – L – H.

TD of BC on spruce plots correlated negatively with latitude, and was significantly higher than that for the pine plots. BC amounts in the final fellings of all scenarios were larger for spruce than for pine. In most stands, harvesting removals of BC were significantly higher in WTH than in SOH. BC removals in WTH and in WTSR did not differ significantly from each other. Harvesting intensity negatively impacted the sustainability of BC. WTH had more negative impact on soil BC stocks on the spruce than pine stands. The SI for pine K, spruce K, and spruce Ca were, on average, negative under WTH and WTSR, and SI for Mg were, on average, positive in all harvesting scenarios.

Short presentation

Deposition and soil solution chemistry in two adjacent mountainous forest ecosystems in Greece

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The deposition chemistry has been monitored in the area of the mountain Ossa in two adjacent forest ecosystems, beech and oak, in central Greece since 1997. Low pH values (pH < 5.65) in the bulk deposition were found mainly during winter months due to fuel combustion in the nearby area or neighboring countries. The origin of pollution sources has not been so far identified. The pH values of soil solution were found to be higher than those in bulk deposition. The concentrations of dissolved organic carbon in throughfall deposition were far greater in the oak forest (32.2 mg/l) than those in the beech forest (5.5 mg/l). It was also found that the Mg concentration in the leaves of both tree species followed a declining trend. The phenomenon needs further monitoring.

Standard presentation

Forest Management Scenario Study with BiomeBGC at nine ICP Forests Plots

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[4]Leibniz-Zentrum für Agrarlandschaftsforschung (ZALF) e.V., Germany. E-mail: Michael.Janott@zalf.de
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Human induced greenhouse gas emissions are at least part of the driving forces behind climate change. On the same time human action in terms of forest management provides opportunities to mitigate climate change e.g. by enhancement of carbon sequestration, carbon storage in forests and harvested wood products, or the substitution of mineral fuel or energy intensive alternative products. Hence, the quantification of the mitigation potential of forest management must be one of the most prominent tasks of actual forest research.

We simulated growth, carbon storage and wood extraction of forest stands at nine ICP Forests Level II plots located from northern Germany to northern Italy. The impact of climate change on forest growth was assessed by simulating with application of SRES scenarios B1 and A1B for 30 years periods 2001-2030 and 2071-2100, a constant climate scenario as well as variations with increased temperature and with increased precipitation.

The simulations were done with the Biome-BGC version ZALF. The applied growth model allowed for the definition and simulation of a ‘business as usual’ management for the four most important central European tree species as well as management alternatives for ‘mass production’ and ‘carbon storage’, respectively. The least common multiple of all applied rotation periods of 720 years defined the simulation period and allowed for the direct comparison of the simulation results.

In total, 405 long-term simulation runs are the main basis for the presentation. The contribution of the forest management parameterization concepts was analysed by a sensitivity study.
The importance of appropriate forest management with respect to climate change mitigation is underlined by the presented study results. The study highlights the capability of long term forest monitoring plots being a basis for research on sustainable forest management and the climate change mitigation potential.

Short presentation

Impact of weather conditions, atmospheric deposition and foliar nutrients in the Romanian intensive monitoring system

Stefan Neagu[1], Ion Barbu[1], Carmen Iacoban[1], Cristian Angheluș[1], Monica Ionescu[1]

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Climate change is gradually amplifying severe drought events in Romania, fuelling the tree morbidity and mortality, and in addition, it upsets the forests' carbon sink effectiveness. The research on the patterns, causes and effects on forest health status in the selected ecosystems of the Romanian monitoring network is intended to outline the impact of the explanatory indicators (e.g. climate, depositions and nutrients) and their relevance, in an attempt to describe the subsequent consequences of the missing leaves/needles and on forest growth in relation to non-segregated natural and anthropogenic disturbances.

The main research methods involved are well documented in the ICP-Forests manual concerning the sampling and analysis of meteorological, deposition, foliar, soil solution, crown condition and growth data. By means of stepwise regression analysis we highlighted the impact of the main explanatory indicators.

The preliminary results indicate that the leading predictor of the forest growth is the precipitation, as a common denominator at all locations (explaining 30-50% of the common variance). Sulfur and nitrogen deposition and in soil solution have an impact especially on oak forest stands (Stefanesti: *Quercus robur* and Mihaesti: *Quercus petraea*) (up to 10-20% of the shared variance explained). In the same oak stands, a possible explanation might be represented by particular nutritional imbalances triggered by relative high ionic rates (N/K) accompanied by inadequate supply of these elements. In the case of *Fagus sylvatica* (Fundata) the limiting nutritive factor is represented by a low ratio of N/P and in the case of *Picea abies* (Predeal) a low ratio of N/Ca.

Key note presentation

A trend analysis of the defoliation in boreal forests of Finland

Seppo Nevalainen[1]

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The level of pollutant deposition is low in Finland, as compared to e.g. central Europe. However, there is a clear south-north gradient in deposition and the harsh climate is an additional stress factor. The aim of the study was to analyze the possible causes for the trends and the spatio-temporal variation of defoliation of conifers in Finland.

Common level 1 observation trees in 1995-2008 were used in the plot-level trend analysis, which was computed with the Earth Trends Modeler of the Idrisi software (Taiga version). NFI data, as well as digital elevation maps and modelled climatic and deposition data were also exploited. Data mining techniques in R were used in addition to more conventional methods in the analysis.

Theil-Sen median slope estimator was used in to detect the magnitude of the defoliation trend. Theil-Sen is a non-parametric, robust estimator, and is resistant to the presence of outliers.

Increasing defoliation trends were found in 90% of the studied 265 Scots pine and Norway spruce stands. Most of the increasing trends were also monotonic, i.e. consistently increasing or decreasing, according to Mann-Kendall tau- statistics. The variation between even adjacent plots was large, however. The increasing trends in Scots pine plots were related to latitude, modelled N deposition in 1995, and slightly increased with elevation.

In Norway spruce plots, the magnitude of the upward trend was also dependent on stand age. About one half of the increasing trends were also linear. In other half, large deviation from a linear trend, i.e. low values of the coefficient of determination (r^2) indicated a strong influence of abiotic or biotic damage in some years during the study.

Standard presentation

Plant bio-indicators do not reflect temporal changes measured in forest soil pH and C/N ratio over 15 years

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Plant species are supposed to respond to environmental changes induced by atmospheric pollution, like soil acidification or eutrophication. Indicator values are commonly used to relate temporal changes in plant species composition to those of environmental quantitative parameters. However indicator values have been calibrated on the spatial distribution of plant species only and their ability to reconstruct temporal variations has been rarely tested.

Monitoring data from French Level II plots (RENECOFOR) give an opportunity to test whether indicator values calculated from repeated ground vegetation assessments followed the significant temporal changes measured in soil pH and C/N ratio over 15 years. In 45 plots, plant species composition was assessed every 5 years from 1995 to 2010. Soil sampling and analysis were repeated twice in 1993-1995 and 2007-2012, down to 40 cm depth. Both plant and soil surveys were realized with methods comparable over time, on separate permanent subplots replicated within the plot area. Ellenberg's acidity and nutrient and Ecoplant pH and C/N indicator values were each one averaged at the plot scale after pooling plant data from the subplots.

Overall, pH measurements significantly decreased for the 0-10 cm soil layer and C/N measurements significantly increased for all soil layers, whereas the corresponding plant-indicated variables followed opposite trends. Among plots, the spatial variations of soil pH and C/N measured in the 0 -10 cm layer were strongly correlated with corresponding plant-indicated values for any soil campaign (Spearman's rank correlation between 0.7 and 0.8, $p<0.001$). However there was absolutely no relationship between the temporal variations of the same measured and plant-indicated parameters. The same results were observed when calculating indicator values with the herbaceous layer only instead of all plant strata, or using abundance-weighted averages instead of presence-absence data.

These results raise questions about how changes in environmental factors are related to the temporal response of plant communities.

Short presentation

Chemistry of forest soils and the deposition load in the Czech Republic within the last two decades.

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Chemical properties of forest soils within the ICP Forests network in the Czech Republic were evaluated in two subsequent studies – ICP Forests survey in 1995 – 1997 and BioSoil project in 2005 – 2008. Although the methods and plot selection differed between these two surveys it is possible to compare set of chemical properties on 65 plots with Norway spruce as a main species. Significant increase detected by pair tests were found for pH value, C and C/N ratio in the organic layer (FH). Concentration of nitrogen has also increased but the difference is not significant on level 0.05. In mineral soil the significant increase of pH was found as well. Base cations content, however, exhibit prevailingly decreasing tendency in upper 40 cm of mineral soil which is significant for Ca and Mg in depth layer of 10 – 20 cm. Soil data were compared with the calculated deposition of sulfur, nitrogen and total acidity (sum of H+). The changes in upper organic layer are influenced by the nitrogen deposition. The real deposition of nitrogen seems to be underestimated because of lack in N/NH_3 and N/HNO_3 calculation and horizontal deposition assessment. The real input of these compounds is still uncertain but it is highly probable that the critical load of 1 $g.m^{-3}.y^{-1}$ is exceeded on the majority of forested area in the Czech Republic. Current N deposition represent thus a potential risk for balanced nutrition by excessive nitrogen supply on one hand and limited availability of base cations on the other.

Poster presentation

Microclimate matters for the long-term natural regeneration potential of woodlands in semi-arid regions

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Natural vegetation in semi-arid areas is known to have an important effect to arrest desertification and land degradation (DLD). Holm oak woodlands are the typical forest ecosystem occurring in this type of climate in south Europe, however the slow growth and high mortality rates of holm oak is a major concern at long term. Here we studied the influence of microclimate in the potential natural regeneration of holm oak woodlands at landscape level and along the time in one site without human intervention (>60 years), after agriculture abandonment. Using potential solar radiation (PSR) as surrogate of microclimate and old aerial photography we did a retrospective quantification of the holm oak cover and created a model along time and space. The tree performance was also studied using physiological measurements to evaluate the impact of microclimate at local level. We found contrast differences in natural regeneration within higher and lower PSR values. For values under 31,000 Wh/m2 the tree cover was just 20%, whether for higher values it was 90%. At tree level reflectance indices (e.g. NDVI) and specific leaf weight showed differences in the different microclimate conditions. The microclimate explained most of the differences found in the holm oak woodland natural regeneration rate. Places exposed to higher PSR could need more than 60 years to reach 10% of tree cover, only with assistance Holm oak woodlands will grow in less time. Otherwise, sites with lower PSR do not need to be reforested, the woodland will grow at meddle term, this findings are useful for forest managers to direct forestry efforts. Holm oak woodlands have contrasting grow rates dependent of microclimate conditions, the quantification of this pattern at landscape level and along the time will improve the successful long term planning to reduce DLD risk.

Standard presentation

Ozone impacts on forest's productivity and health in Europe

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Ozone (O_3) is both a greenhouse gas and a secondary air pollutant causing impact on climate, human health, and ecosystems (Shindell et al. 2009). In particular, ground-level O_3 affects trees through visible leaf injury, accelerating leaf senescence, decreasing foliar chlorophyll content, photosynthesis, growth, productivity and carbon sequestration, predisposing to pests attack and a variety of other physiological effects in plants (e.g. Sicard et al. 2011; Karnosky et al. 2007). The study aims to evaluate the effects of tropospheric ozone on Gross Primary Production (GPP) in several stations located in Europe over the time period 2000-2009/2010 and, to investigate the most important factors affecting forest's productivity and health. GPP represents the capacity of terrestrial ecosystems to capture CO_2 from the atmosphere and it is an important driver of the global carbon cycle. We hypothesized that high levels of O_3 concentration result in a decrease in carbon assimilation by trees and in the alteration of forests health. The methodological approach consists in the use of Partial Correlations and the Random Forests Analysis (RFA). The results show a severe negative impact of ozone in some stations (e.g. some stations located in Germany, Switzerland and Slovenia) and a slight or null impact in others.

This study improves the understanding of ozone impacts on ecosystems and it will aid in assessing the threat that O_3 plays to essential ecosystem services, including food production, carbon sequestration, and freshwater supply.

Karnosky D.F.,Skelly J.M.,Percy K.E.,Chappelka A.H.2007. Perspectives regarding 50 years of research on effects of tropospheric ozone air pollution on US forests. Environmental Pollution 147: 489–506.
Shindell DT., Faluvegi G, Koch DM, Schmidt GA, Unger N, Bauer SE. 2009. Improved attribution of climate forcing to emissions. Science 326:716–18.
Sicard P., Dalstein-Richier L., Vas N. 2011. Annual and seasonal trends of ambient ozone concentration and its impact on forest vegetation in Mercantour National Park(South-eastern France) over the 2000–2008 period. Environmental Pollution 159: 351–362.

Standard presentation

Changes in nutrient and carbon stocks in French forest soils under decreasing atmospheric deposition

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Atmospheric pollution and climate change affect major ecological processes in forest ecosystems, which in turn play an important role in climate change mitigation capacity. Forest litter and soil chemical properties are key parameters for assessing changes in acidification and eutrophication processes in response to decreasing sulphur and nitrogen atmospheric deposition. They also comprise the major part of the organic carbon stored in forest ecosystems. RENECOFOR is the French part of the European intensive forest monitoring network (ICP Forests Level II) and is made of 102 permanent plots. Soil sampling and analysis were performed twice in 1993–1995 and 2007–2012 on all plots using the same protocol and analytical methods. Both element concentrations and mass per hectare were measured for the litter and for 3 layers of systematic depth of the underlying mineral soil down to 40 cm. Spatial variability was assessed using 25 sampling replicates grouped into 5 composite samples per site and per campaign. The comparability of the chemical results was checked by reanalyzing samples dry-stored from the first campaign. Comparing the results of both campaigns revealed a carbon sink: soil organic carbon stocks (SOC) increased significantly ($p < 0.05$) and mainly in litter and topsoil (0 – 10 cm). Total nitrogen stocks increased less than organic carbon in topsoil and significantly decreased in the deeper layers (10 – 20 cm and 20 – 40 cm), so that the C/N ratio significantly increased for all layers. Probably as a consequence of the SOC increase, pH slightly decreased in the 0 – 10 cm layer while exchangeable cations and base saturation increased. However for the most acidic soils ($pH_{H2O} < 4.5$), both pH and base saturation significantly decreased, suggesting that the atmospheric deposition of acidifying compounds had remained too high in comparison to the limited buffering capacity of such forest soils.

Key note presentation

2000-2013 ozone trends across Europe

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Tropospheric ozone (O_3) has been recognized as an important factor within global change, that has the capacity of reducing carbon sink strength of forest ecosystems and thus represents a priority for the UNECE Convention on Long-range Transboundary Air Pollution.

The ICP Forests Expert Panel on Ambient Air Quality has coordinated the monitoring of ozone concentration and effects (i.e. foliar injury on native vegetation) since 2000 on an annual basis on intensive long-term forest monitoring sites across Europe (Level II). Methodologies, including quality assurance such as data harmonization, completeness and plausibility tests have been applied according to the ICP Forests Manual, parts X and XV (Schaub et al. 2010a & 2010b). Here, the authors evaluate ozone concentration, exposure, and foliar injury data that have been collected at the very forest sites across Europe from approx. 200 plots and 20 countries. Emphasis will be put on European scale analyses for spatial and temporal trends for ozone concentration and AOT40 exposure. These harmonized and aggregated data sets will serve as a valuable basis for further integrated analyses and validation of models, such as from EMEP.

Schaub M, Calatayud V, Ferretti M, Brunialti G, Lövblad G, Krause G, Sanz MJ (2010a) Monitoring of Ozone Injury. Manual Part X, 22 pp. In: Manual on methods and criteria for harmonized sampling, assessment, monitoring and analysis of the effects of air pollution on forests. UNECE ICP Forests Programme Co-ordinating Centre, Hamburg [http://www.icp-forests.org/Manual.htm]
Schaub M, Calatayud V, Ferretti M, Brunialti G (2010b) Monitoring of Air Quality. 13 pp. Part XV. In: Manual on methods and criteria for harmonized sampling, assessment, monitoring and analysis of the effects of air pollution on forests. UNECE, ICP Forests Programme Co-ordinating Centre, Hamburg [http://www.icp-forests.org/Manual.htm]

Poster presentation

Impact of air pollution and climate change on forest ecosystems in the Polish-Saxon border region

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The condition of forest ecosystems in the region also known as the “Black Triangle” has been analysed. A trend analysis of the last 40 years´ climate has been made. Additionally, a future climate projection up to the year 2100 was performed, considering 5 different climate scenarios. Besides this, the emission data of different air pollutants (oxidized nitrogen and sulphur and ammonia) have been researched.

The FRAME model was used to compute the changed transport of air pollutants with respect to changed climate conditions (Kryza et al. 2013). The Critical Load for acidification and eutrophication were calculated using the results of the climate analysis and the air pollutant analysis, also considering the 5 climate scenarios. The exceedance of Critical Load was calculated as well.

The analysis of these results shows a predominantly increased sensitivity of ecosystems concerning eutrophication due to climate changes. The effect concerning acidification is less pronounced. Rather large differences in the trends of acidification and eutrophication were detected. Fewer ecosystems have been threatened by acidification in the past, which can also be expected for the future. In contrast, the eutrophication caused by deposition of nitrogen is a growing threat to the ecosystems. Although the situation of emission is improving, the positive effects due to less emissions of nitrogen will in parts be compensated by climate effects. Here, increasing eutrophication has to be expected in all climate scenarios which were considered.
The main conclusion is that basically both, the emission situation of the regarded air pollutants and climate effects have essential impacts on the ecosystems.

Flügel I., Scheuschner, T., 2014: Einfluss von Luftschadstoffen auf die Gefährdung von Ökosystemen im polnisch-sächsischen Grenzraum. Peckiana 9: 21-37.
Kryza et al., 2013: FRAME Deposition Modelling in the KLAPS Area, Department of Climatology and Atmosphere Protection Wroclaw University.
Nagel, H.D., Scheuschner, T., Schlutow, A., Weigelt-Kirchner, R., 2013: Klimawandel, Luftverschmutzung und Belastung von Ökosystemen im polnisch-sächsischen Grenzraum. Entwicklung von ökologischen Belastungsgrenzen – Critical Loads – verschiedener Ökosysteme im Untersuchungsgebiet. Abschlussbericht. Im Auftrag vom LfULG (Sächsisches Landesamt für Umwelt, Landwirtschaft und Geologie). Strausberg, Dresden.

Poster presentation

Methodology to assess and map potential developments of forest ecosystems exposed to climate change and atmospheric nitrogen deposition by example of Germany

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A methodology for spatial explicit assessments of ecosystems and their potential development under climate change and atmospheric nitrogen (N) deposition was developed by example of Germany. It integrates data on vegetation, soil, climate change and atmospheric N deposition. This data is used to classify ecosystem types regarding six ecological functions and interrelated structures. Respective data covering 1961-1990 was regarded as reference. The assessment of functional and structural integrity relies on comparing a current or future state with the ecosystem type-specific reference. Whilst current functions and structures of ecosystems were quantified by measurements, potential future developments were projected by geo-chemical soil modelling and data from a regional climate change model.

The ecosystem types were referred to the potential natural vegetation and mapped using data on current tree species coverage and land use. By this, current ecosystem types were derived which were then related to data on elevation a.s.l., soil texture, air temperature, humidity, evapotranspiration, and precipitation 1961-1990. These relations were quantified by Classification and Regression Trees which were then used to map the spatial patterns of ecosystem type clusters for 1961-1990. The climate data 1961-1990 were replaced subsequently by results from a regional climate model for 1991-2010, 2011-2040, and 2041-2070. Accordingly, for each of these periods one map of ecosystem type clusters were produced and evaluated with regard to the development of areal coverage of ecosystem type clusters across time. This evaluation of structural aspects of ecological integrity in terms of bio-geographical coverage on the national level was added by projecting potential future values of indicators for ecological functions at site-level by using the Very Simple Dynamics soil modelling technique based on the above mentioned climate data and two scenarios of atmospheric N deposition as input. The results were compared to the reference and enabled evaluating site-specifically ecosystem integrity across time.

Jenssen, M., Hofmann, G., Nickel, S., Pesch, R., Riediger, J., Schröder, W., 2013: Bewertungskonzept für die Gefährdung der Ökosystemintegrität durch die Wirkungen des Klimawandels in Kombination mit Stoffeinträgen unter Beachtung von Ökosystemfunktionen und -dienstleistungen. UBA-Texte 87/2013. Dessau, Textband + 9 Anhänge:1-381

Schröder, W., Nickel, S., Jenssen, M., Riediger, J., 2015: *Methodology to assess and map the potential development of forest ecosystems exposed to climate change and atmospheric nitrogen deposition. Pilot study Germany. Science of the Total Environment, in press*

Short presentation

Heavy metals and nitrogen concentrations in moss collected across Europe from 1990-2010: Meaningful for ICP Forests / Modelling and Mapping?

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Assessments of ecological effects of air pollution need monitoring of atmospheric deposition. For enhancing the spatial resolution of measuring deposition by technical devices and of deposition modelling, moss is used complementarily as bio-monitor. This paper introduces into the methodology and exemplary results of the **European Moss Survey (EMS).** By this, it aims at inducing a discussion whether the EMS could be meaningful for ICP Forests / Modelling and Mapping.

Since 1990, the EMS been repeated at five-yearly intervals providing data on concentrations of ten heavy metals (HM) arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), mercury (Hg), nickel (Ni), lead (Pb), vanadium (V), zinc (Zn) in naturally growing moss, and since 2005 also for the metals aluminium (Al) and antimony (Sb) and for nitrogen (N). In 2010, the latest EMS was conducted including a pilot study on the application of moss as bio-monitor of selected persistent organic pollutants. Until 2000, the EMS has been coordinated by the Nordic Council of Ministers and since 2000 by the ICP Vegetation, established in 1987 as one of seven ICP / Task Forces of the Working Group on Effects reporting to the United Nations Economic Commission for Europe (UNECE) Long-Range Transboundary Air Pollution (LRTAP) Convention on the effects of atmospheric pollutants on the environment and human health.

Issues dealt with, are:

- Establishing statistical relations between concentrations of Cd, Pb and N in moss and in atmospheric deposition modelled by EMEP (European Monitoring and Evaluation Programme)
- Spatial and temporal trend of HM concentrations in moss using a multi-metal-index calculated for Germany
- Estimating atmospheric deposition of N and HM from respective moss concentrations across Europe, at national level (Norway, focusing on correlations of HM concentration in moss and soil) and at site level (north-western Germany, focus on canopy drip influencing N concentration in moss).

Meyer, M., Schröder, W., Pesch, R., Steinnes, E., Uggerud, H.T., 2014: Journal of Soils and Sediments 14: 1-15.
Meyer, M., Schröder, W., Pesch, R., Steinnes, E., Uggerud, H.T., 2015: Journal of Soils and Sediments 15: 410-422.
Nickel, S., Hertel, A., Pesch, R., Schröder, W., Steinnes, E., Uggerud, H.T., 2014: Atmospheric Environment 99: 85-93
Nickel, S., Hertel, A., Pesch, R., Schröder, W., Steinnes, E., Uggerud, H.T., 2015: Environmental Science and Pollution Research (Published online first: 30 December 2014)
Pesch, R., Schröder, W., 2009: European Journal of Forest Research 129: 475-488.
Pesch, R., Schröder, W., Schmidt, G., Genssler, L., 2008: Environmetal Pollution 155: 528-553.
Schröder, W., Pesch, R., 2007: Science of the Total Environment 374: 311-327.
Schröder, W., Pesch, R., Schoenrock, S., Harmens, H., Mills, G., Fagerli, H., 2014: Ecological Indicators 36: 563-571.

Standard presentation

Radial growth response to ozone exposure and uptake of sessile oak (Quercus petraea) in Mihaesti Level II forest monitoring plot, Romania

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There is a lack of data regarding the specific effects of ozone on sessile oak mature trees, especially in the presence of co-varying influence of other environmental factors, despite the ecologic and economic importance of this species. In this framework, continuous measurements of ozone concentrations, meteorological parameters and tree growth were performed during the 2012-2014 growing seasons in Mihaesti Level II plot (405 m a.s.l.). The main species are sessile oak (*Quercus petraea*) – 80% and beech (*Fagus sylvatica*) – 20%, the mean temperature having values of approximately 10°C in all years and the precipitation quantity ranging between 562 mm (2013) and 897 mm (2014). Fluxes of ozone were calculated as described in UNECE Manual (2004), using CCE parameters for the "generic" deciduous tree species, except f_{phen} for which real observations were used. Hourly growth data from four trees were processed as described in Deslauriers et al. (2011). Daily and cycardian cycle basal area increments for each tree were calculated. Growth data were partially correlated (Kendall test) with AOT40 and ozone flux (sum of hourly ozone fluxes) at daily/cycle level, with meteorological parameters as controlling variables. AOT40 calculated for the growing season had decreasing values, from 12.7 ppm h in 2012 to 10.3 ppm h in 2013 and 4.9 ppm h in 2014. On the contrary, POD_0 registered values of 4.9 mmol O_3 m^{-2} in 2012, 5.3 mmol O_3 m^{-2} in 2013 and 10.4 mmol O_3 m^{-2} in 2014. Although not statistically significant, negative correlations between daily/cycle growth and AOT40 or ozone flux appeared at 3 trees in 2012 and 2013 and at 2 trees in 2014. Multiple regression analysis showed a reduction in 2012 daily growth up to 2% due to ozone (both in AOT40 and flux terms) for 3 of the trees. Further analysis will be performed and presented.

Deslauriers, A., Rossi, S., Turcotte, A., Morin, H., & Krause, C., 2011: A three-step procedure in SAS to analyze the time series from automatic dendrometers. Dendrochronologia 29: 151-161.
UNECE, 2004: Manual on methodologies and criteria for modelling and mapping critical loads & levels and air pollution effects, risks and trends. UNECE: http://www. icpmapping. org.

Standard presentation

Environmental factors explaining the N and δ15N values in the moss collected inside and outside canopy drip lines

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To document current status and changes in the environment, monitoring of pollutants is essential. Increased concentrations of nitrogen (N) compounds have recently been identified as a critical load for the environment on a global scale. Reduced and oxidized N compounds have different ^{15}N isotope signatures ($\delta^{15}N$). Based on the $\delta^{15}N$ values in mosses, the N emission sources can be hypothesized. The aims of this study was to evaluate the influence of selected site-specific environmental characteristics on the N and $\delta^{15}N$ values in moss sampled under canopies and in forest openings and to explore to what extent the additional N inputs into the moss collected under canopies, compared with the N concentrations in mosses collected in forest openings, could be explained by a statistical model by accounting for the selected environmental characteristics.

Samples of moss *Hypnum cupressiforme* Hedw. were collected in the summer 2010 at 103 locations in forests of Slovenia. At each location, samples were taken at two types of site: under tree canopies and in adjacent forest clearings. Additionally data on environmental characteristics were collected at all sites (15 site-specific and 16 regional characteristics).

The results show that the moss collected in the forest openings reflects the surrounding land-use characteristics (the percentage of urban land within an 80 km radius is the most important variable) and, consequently, the possible main N emission source. For moss sampled under canopies, the characteristics of the forest at the moss-sampling locations are more important than the main emission sources outside the forest. A regression model was used to provide the N concentration in moss from the forest openings in relation to the N concentration in moss under canopies and other environmental variables.

Skudnik, M., Jeran, Z., Batič, F., Simončič, P., Kastelec, D., 2015. Potential environmental factors that influence the nitrogen concentration and $\delta^{15}N$ values in the moss Hypnum cupressiforme collected inside and outside canopy drip lines. Environmental Pollution 198: 78-85.

Short presentation

The change of forest soil conditions in beech stands (*Fagus sylvatica*) of the Vienna Woods within the last three decades due to declining deposition of atmospheric pollutants

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Comparison between chemical parameters of soil from the infiltrations zone of stemflow near the base of the stem and from the between trees areas in old beech stands by Lindebner (1990) in the Vienna Woods (sample collection in 1984) proved a significant impact of deposition of atmospheric pollutants: soil acidification, heavy metal accumulation, increased sulphur contents and loss of the base cations calcium and magnesium, especially in the infiltration zone. Based on his results, a comparative study on 97 beech stands was carried out to investigate changes of soil conditions within the last 30 years. Meanwhile, SO_2 emissions, the most important precursor of Acid Rain, declined sharply since the 1980s. Soils were analysed from the infiltration zone of stemflow and the between trees areas at different soil depths. Top soil pH values increased significantly indicating quicker recovery of the stemflow area. However, pH values of the deeper soil horizons declined suggesting that the acidification front moved downwards over time. Soil contents of C, N and S decreased within the stemflow area but did not change in the between trees area. Heavy metal (Pb, Zn, Fe, Ni Cu, Mn) and base cation (Ca, Mg, K) soil contents changed significantly over time. Ca and Mg showed increasing but K decreasing patterns with increasing distance from the stem base. Changes of heavy metals over time were different for the individual elements, however, the huge decline of Pb within the stem area was most impressive.

Lindebner, L., 1990: Der Bodenzustand in Buchenwäldern des Wienerwaldes unter besonderer Berücksichtigung von Veränderungen als Folge der Einträge von Luftschadstoffen. FIW-Forschungsbericht 1990/2, Österreichische Gesellschaft für Waldökosystemforschung und experimentelle Baumforschung, Vienna, 154 pp. ISBN: 3 900997 02 0

Short presentation

Long-term trends and effects of air pollution on British forests and soils

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Overview of ICP Forests long-term intensive and extensive forest monitoring and spatial soil surveys along with experimental research, undertaken by Forest Research during the last 20 years will be presented, summarising the long-term trends in air pollutants (sulphur, nitrogen and acidity) and their effects on the forest and soil biogeochemistry.

Long-term trends in deposition and soil, soil solution and forest biological responses to deposition changes will be presented. The role of forest canopy in N transformations will be demonstrated through stable isotopes study and the role of tree species and soil type from spatial forest soil survey BioSoil. The impact of N on forest growth, nutrient and carbon cycling will be discussed by presenting some updated results from detailed gradient studies from point sources of N pollution and regional study comparisons between forest areas with low and high N deposition

The likely contribution role and links of N, S and acidity deposition to tree health and nutritional cycling will also be discussed by presenting examples of current research on the links of current spread of acute oak decline in the UK to deposition chemistry.

Short presentation

Tree phenology in relation to meteorological conditions and crown defoliation on intensive forest monitoring plots in Slovenia

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Data from the intensive forest monitoring programme in Slovenia were used to assess the relationship between tree phenology, crown defoliation and meteorological conditions in *Fagus sylvatica*, *Quercus robur* and *Picea abies* forests in 2004 - 2013. We hypothesized a species-specific response of first leaf unfolding, general leaf colouring, the length of the growing season to crown defoliation, air temperature, precipitation and soil water.

In accordance with the hypothesis, we found a high sensitivity of first leaf unfolding to air temperature and precipitation for all species, exhibiting contrasting responses. We observed strong sensitivity of beech defoliation to precipitation and soil water conditions. Oak crown defoliation and next-year phenology were correlated, with higher crown defoliation contributing to earlier leaf unfolding, later autumn leaf colouring and longer growing season of oak in next year. We found no correlation between crown defoliation and phenology for beech nor spruce.

Keywords: forest monitoring, tree phenology, crown defoliation, air temperature, precipitation, soil water content, Slovenia

Key note presentation

Changes over the past 25 years in rainwater and groundwater quality in nature areas in The Netherlands as a result of emission reduction policy

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Atmospheric emissions from industry, traffic and agriculture reach the ground elsewhere. Excessive deposition of nitrogen and sulphur induces acidification and eutrophication of the soil. This process adversely affects the quality of soil, water and biodiversity.

Air pollution is a transboundary phenomenon. International agreements have been reached on how to address the issue. In the Convention on Long-Range Transboundary Air Pollution (CLRTAP) as well as in the EU, agreements were reached on the reduction of emissions of acidifying and eutrophying components, i.e. the Gotenburg protocol and NEC-directive.

The Dutch National Acidification Trend Monitoring Network (TMV) was established in 1989. This network monitors the impact of the atmospheric deposition of acidifying and eutrophying substances on groundwater quality. It specifically monitors the quality of the upper meter of the groundwater under nature areas (forest and heath) with sandy soils. Other than influx from the air, these areas have no other significant sources of acidifying or eutrophying substances, which are responsible for contaminating the groundwater. Between 1989 and 2014, the upper meter of groundwater of 150 locations was sampled 6 times.

Furthermore, for this study 6 locations of the national rainwater quality network were selected, with a sampling period for the acidifying components of 2 weeks.

Our analysis of the measurements shows that rainwater quality and groundwater quality in nature areas have improved significantly over the past 25 years. The impacts of lower emissions of nitrogen and sulphur are found in rainwater, shallow groundwater and groundwater at 10 m below the surface. In 2014 the median N concentration in rainwater had decreased by 44% compared to 1988, while the S concentration had dropped by 81% during the same period. The median concentrations of N and S in the upper groundwater decreased between 1988 and 2014 by 61% and 54% respectively.

A location-wise comparison of the observation data from 2014 and 1989, using a paired samples t-test, revealed that the pH was significantly higher in 2014 than in 1989, while the nitrate, sulphate and aluminium concentrations were significantly lower ($\alpha < 0.05$).
The analysis of the combined observations shows that the (inter)national measures taken to reduce emissions have resulted in less acidification and eutrophication in nature areas with sandy soil.

Standard presentation

Degradation of *Fagus sylvatica* on Trnovo plateau in southwest Slovenia

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The major aim of long-term monitoring of forest ecosystems is to document the current status and changes of the forest vitality. In this particular study we want to include different aspects of Level II monitoring network, with the aim to study causes and trends of *Fagus sylvatica* dieback. Additionally we also wanted to evaluate if currently available time series of different parameters are long enough and sufficient to recognise causes and trends of identified *Fagus sylvatica* dieback. All research was done in the frame of Level II intensive monitoring program.

The assessment of crown condition of more than 100 beech trees was performed yearly from 2003 onwards. The foliar samples were collected bi-yearly from 2005 onwards. Deposition measurements (bulk, throughfall, and stemflow deposition) were performed since 2003 with 28-days periods. Ozone injuries on vegetation were monitored and ozone measurements were performed during the growing season since 2005 with passive samplers.

It has been for ten years that the defoliation of beech trees in Level II plot Trnovo is slowly increasing. In all these years the rate of nitrogen bulk deposition is decreasing for a quarter of the value in 2004, but still 15 kg of N/ha. Both sulphur and nitrogen throughfall deposition is in stagnation. The amount of deposited nitrogen and sulphur in this unpopulated Alpine area is similar to the amount of deposition in intensively agricultural area in north east of the country. Comparing to other four *Fagus sylvatica* Level II plots the yearly increment is half of the value. The mass of the leaves decreased from 10 to 50% in ten years. The passively measured ozone concentration was in the year 2013 in the range of 50 to 95 µg/m^3 and indeed the ozone injuries on vegetation were detected.

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