IUFRO 2015
International Congress
GreenInUrbs & IUFRO RG 7.01

International Congress

Global Challenges of Air Pollution and Climate Change to Forests

Programme and Abstracts

1-5 June, 2015
Hyatt Regency Palais de la Méditerranée
Nice, France

Organized by

International Union of Forest Research Organizations - Research Group 7.01
COST Action FP1204 GreenInUrbs

IUFRO NICE 2015

COST FP1204 GreenInUrbs

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Elena Paoletti, *Italy*
Andrzej Bytnerowicz, *United States*

Scientific Committee

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Salim Belyazid - Lund University, Department of Chemical Engineering, *Sweden*
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Nancy E. Grulke - US Forest Service, Pacific Southwest Research Station, *United States*
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Website: http://iufro-nice2015.com

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CONSEIL GÉNÉRAL

VILLE DE NICE
www.nice.fr

This conference, for the first time integrating the IUFRO Research Group 7.01 and the COST Action FP1204, is an excellent example of effective international collaboration in the forestry research. The back-to-back meetings IUFRO 7.01 and COST Action "GreenInUrbs" takes place in Nice at the "**Palais de la Méditerranée**" along the famous "Promenade des Anglais".

IUFRO Research Group 7.01.00 "Impacts of air pollution and climate change on forest ecosystems" promotes international cooperation, for more than 30 years, encouraging an interactive process between scientists, policy makers and representatives of local to regional governments and institutions, in order to share scientific knowledge and harmonize effective strategies aimed to reduce the risk for forests related to air pollution and climate change.

The main objective of COST action FP1204 "GreenInUrbs" is to increase understanding of the role of Urban Forests in the framework of Green Infrastructures from a scientific and a socio-economic perspective, in terms of the ecosystem services provided to people and to the urban environment. In this context, it is highly relevant to understand the adaptation of the urban and peri-urban vegetation to urban conditions which often recalls the pressures of the climate change. In the meantime the mitigation potential of climate change and of air pollutants by urban and periurban vegetation is gaining more and more attention.

Therefore, the different session of the joint IUFRO and COST conference offers a unique possibility and basis to discuss the significance of long-term ecological research solving the main problem – reaction, adaptation and sustainability of ecosystems to changing air pollution and climatic condition as well as mitigating the processes of global changes. On behalf of all organisers, we are pleased to welcome you at the conference and wish you a very fruitful event.

Elena Paoletti

"As new Coordinator of the IUFRO Research Group 7.01.00, I am glad to invite all the experts in air pollution and climate change impacts on forest ecosystems to our traditional biennial conference. Do not miss this cornerstone of international science and the opportunity to contribute at defining the strategies for improving global and local forest health. I look forward to meeting you in Nice".

Andrzej Bytnerowicz, deputy IUFRO RG7.01

"The conference aims to provide an attractive stage for fruitful scientific discussion and assessment of the current state of knowledge to identify priorities and challenges for future research with an ultimate goal of improved health, sustainability and productivity of forests worldwide".

Pierre Sicard, local organizer

"The conference wishes to initiate scientific interaction between international researchers and to promote collaboration between the forestry scientists, managers and decision makers aiming at better understanding of the effects of air pollution and climate".

Scope and objectives

The impacts of air pollution and climate change on ecosystems have been issued in many studies in the last decades. Impacts of climate change and air pollution on ecosystems interact in two basic ways: climate can change the effects of exposure of ecosystems to air pollution, and *vice-versa*; climate change can affect the sensitivity of ecosystems to specific impacts of air pollution and *vice-vers*a.

The main objective of the IUFRO Research Group 7.01 "Impacts of Air Pollution and Climate Change on Forest Ecosystems" is to address complex effects of air pollution and climate change on forest ecosystems, through an active interaction between specialists in several areas of forest sciences.

The 27th international biennial conference of the IUFRO RG7.01 entitled "**Global Challenges of Air Pollution and Climate Change to Forests**" takes place in Nice (France) on June 2-5, 2015. The conference gathers **122 participants** from **38 countries**, with 71 talks and 47 posters, to share current state of knowledge and discuss scientific gaps in the understanding of the interaction of climate change, air pollution and atmospheric deposition and their integrated and synergetic effects on forest ecosystems.

The conference wishes to initiate scientific interaction between international researchers and to promote collaboration between the forestry scientists, managers and decision makers aiming at a better understanding of the biological effects of air pollution and climate.

The conference allows providing an attractive stage for fruitful scientific discussion and assessment of the current state of knowledge to **identify priorities and challenges** for future research with an ultimate goal of improved health, sustainability and productivity of forests worldwide.

The meeting allows identifying a number of emerging research needs such as (i) understanding the disruption of metabolic pathways, (ii) impacts of air pollution on soil fauna, (iii) insect interactions and biogenic emissions, (iv) effects of secondary organic aerosols on trees, (v) effects of climate change and air pollution on plant phenology and reproductive fitness, (vi) mechanisms of whole-tree allocation (including genetic control) under ecologically meaningful climate change scenarios to develop reliable risk assessments, (vii) how to make ozone standards more biologically based and at the same time practical for a wide use, (viii) the concepts of nitrogen saturation and critical loads, and (ix) trophic, competitive and host/parasite relationships under changing pollution and climate regimes.

There is a clear need of improved communication between scientists and policy makers to achieve a science-based management and address future research and environmental policies. IUFRO promotes interdisciplinary and global cooperation in forest related research and is the best site for scientific knowledge dissemination and international policy development.

The venue

The **French Riviera** (La Côte d'Azur) is a cosmopolitan Mediterranean destination situated at the heart of Europe. It enjoys a climate blessed by the gods with over 300 days of sunshine per year. Its unique natural environment, intense light and mild climate are key attributes of the stylish living synonymous with the **French Riviera**. Land of exception and emotion, the **French Riviera** owes much of its success to extraordinary diversity and wealth. A unique identity forged by the contrast between sea and mountains. The **French Riviera** owns a wonderful cultural heritage, an abundant crucible of creative activity for artists from all over the world, a profusion of international festivals and large events, and gourmet food bursting with sunshine given a contemporary twist by the greatest chefs.

The "French Riviera" between Sea and Mountains

"One day, eternal beauty went in search of a place that would never shun it. It discovered the French Riviera and settled there, immediately feeling at home... And there it has remained ever since."

Louis NUCERA, local writer (1928-2000)

Nice, a refined lifestyle

Nice is the fifth most populous city in France, after Paris, Marseille, Lyon and Toulouse. The city is called ***Nice la Belle***, which means Nice the Beautiful, which is also the title of the unofficial anthem of Nice. Nice is the capital of the "Alpes-Maritimes" county. Nestled between the sea and the mountains, **Nice** has an irresistible charm. Visitors can soak up the colors of its old Baroque town, its cuisine and major museums before contemplating the site as a whole from the Castle Hill or strolling in the sea air on the city's best-known boulevard, the "Promenade des Anglais". Come and absorb its unique light, a light which accentuates all the colors, the blue of the sky and the sea, the green of trees, the ochre of the facades, "trompe l'œil" and frescoes. With your eyes wide open, all your senses are aroused! Come and discover or rediscover Nice, a city of multiple perfumes and flavors. Here, the gentle lifestyle is as much due to the city's beauty as to its exceptional climate.

Nice: old-town

"When I realised I would see that light every morning, I could not believe my happiness ... I decided never to leave Nice and remained here for my almost my entire existence".

Henri Matisse, painter (1869-1954)

In case of problems - Important information

Telephone Numbers

The France's country code: +33. The most important institutions have two-digit telephone numbers that you can reach even without a SIM card inserted in your mobile phone. The service is free. **Emergency call 18 -** Ambulance service phone 15 - **Police phone 17.**

Health care

Providers of health care in the EU accept patients with European health insurance cards. Night pharmacies (Pharmacies de nuit) - 7 days a week, 24 hours a day.

7, rue Masséna - Tel. +33 (0)4 93 87 78 94
66, avenue Jean Médecin - Tel. +33 (0)4 93 62 54 44

Local contact and for emergency

Dr Pierre Sicard
Mobile phone: +33 (0)6 16 43 20 65

Hyatt Regency Nice - Palais de la Méditerranée

Built in 1929, the majestic Art Deco facade of the Hyatt Regency Nice **Palais de la Méditerranée** enjoys an exceptional location on the "Promenade des Anglais". The hotel's majestic Art Deco facade, a national historic monument, has been sumptuously restored and can be admired today in all its original splendor. Just minutes from the old town, the hotel is the ideal location for a shopping spree or for exploring the wonders of the Riviera.

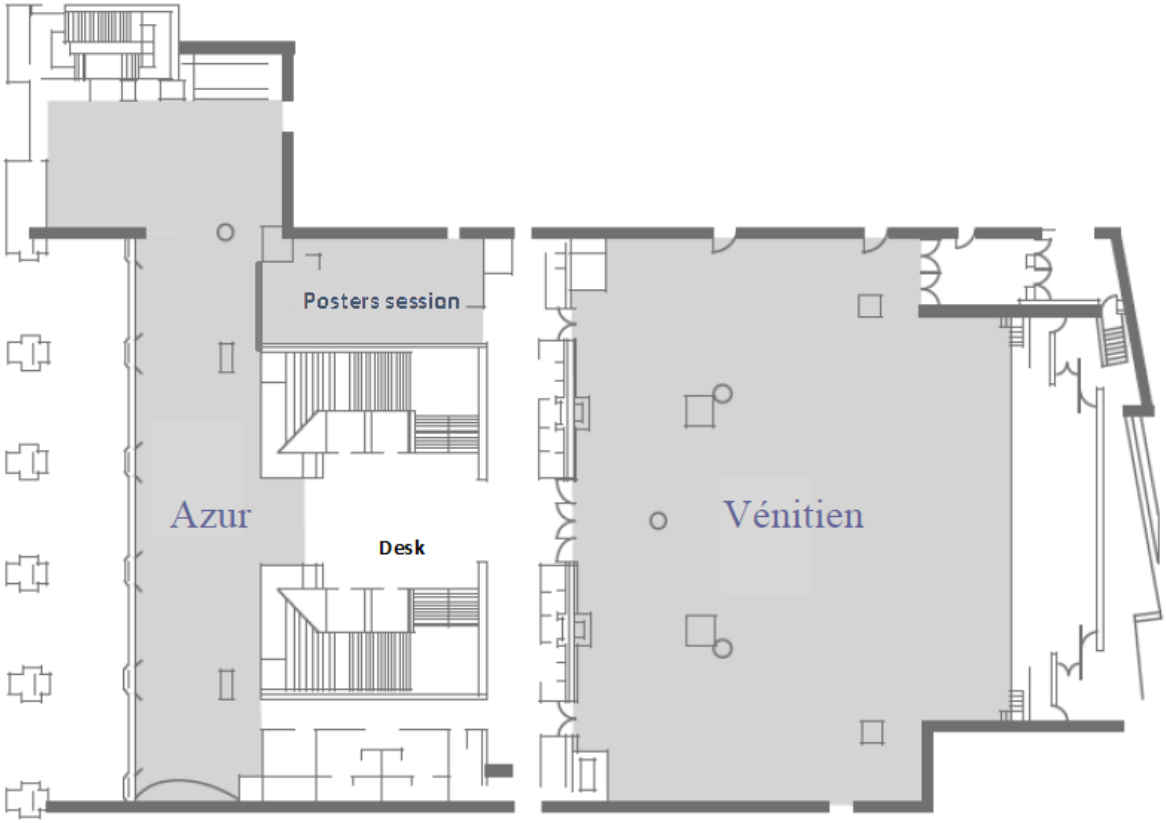
Address
13 Promenade des Anglais
Nice, France, 06000
Tel: + 33 (0) 4 93 27 12 34

Hyatt Regency Nice Palais de la Méditerranée is an ideal site to hold meetings and conferences at the heart of the Mediterranean region. The hotel offers seven rooms providing a nearly unlimited choice of size, set-up and function to ensure a perfect fit with any event.

Hyatt Regency Nice Palais de la Méditerranée

IUFRO RG7.01

The entrance to our conference is through the entrance of the Casino. All sessions, coffee breaks and wine tasting are in room Vénitien, poster sessions and lunches are in room Azur. Both rooms are located at the 1st floor

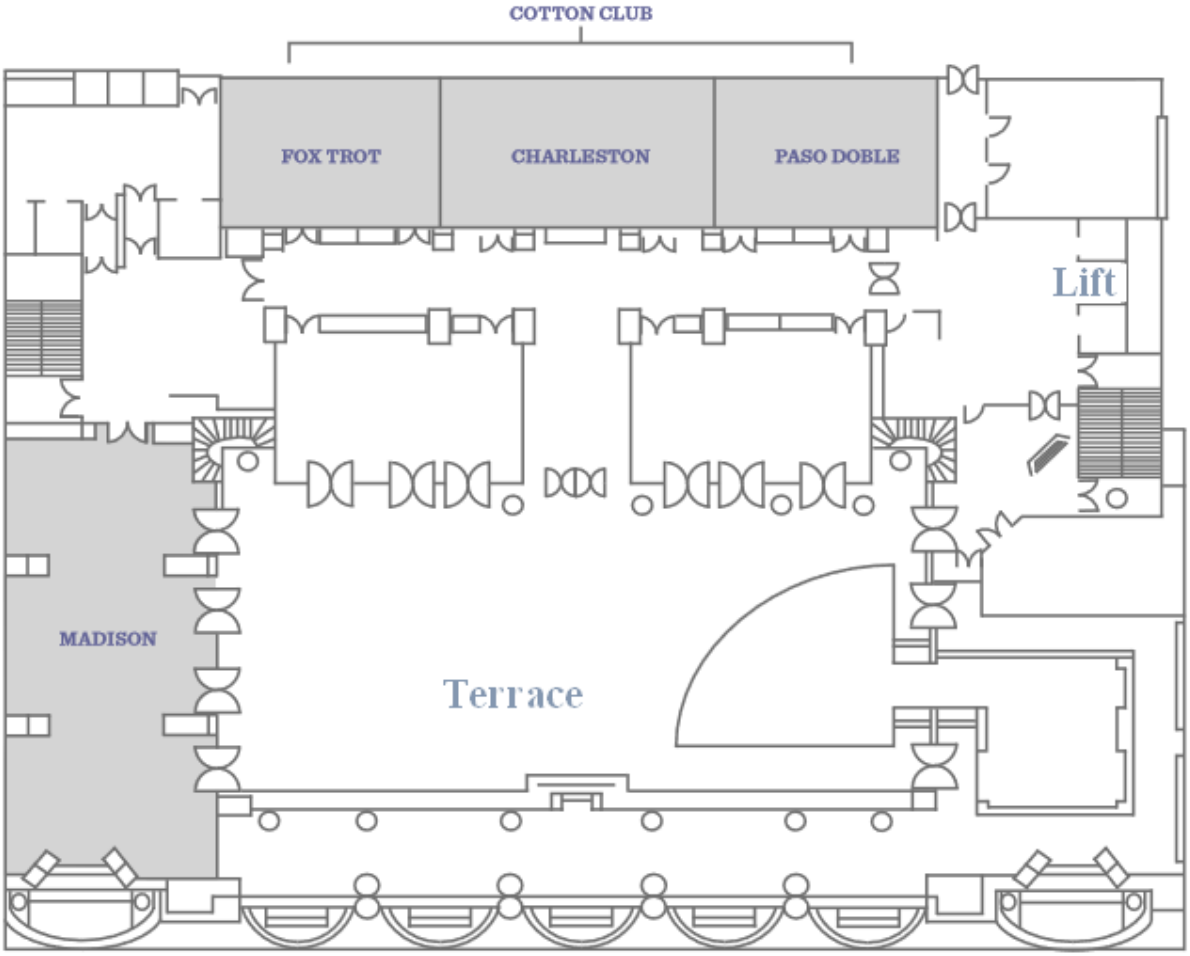


Palais de la Méditerranée – 1st floor

Palais de la Méditerranée – 1st floor : room Vénitien and Azur

COST Action FP1204 "GreenInUrbs" Working Group meetings

The entrance to this meeting is through the main entrance of the hotel (turnstile). In the lobby, there is a screen, close to the lift, with the event announcement. All sessions and coffee breaks are in rooms Charleston, Fox Trot and Pasodoble (3rd floor). The lunches will be served in the Madison room or on the terrace. The coffee breaks will be served in front of each room. The 3rd floor restaurant offers a Mediterranean menu featuring choices made from seasonal and local products.



Palais de la Méditerranée – 3rd floor

Palais de la Méditerranée – 3rd floor : terrace and room Pasodoble

Green path in Nice: La Promenade du Paillon

Our in-congress tour is to this recently-installed infrastructure. Besides beneficial effects on air quality, urban vegetation provides also other services that can improve human well-being and the sustainability of cities. Urban trees provide a number of services (e.g. provisioning, regulating, supporting, cultural services) that contribute directly and indirectly to human wellbeing. These services are a part of the **aesthetic legacy** of mankind and counteract stress in human beings, supporting our psychological capacity and mental health.

A green area of 12 hectares in the heart of the old-city for the citizen well-being: conviviality, pleasure, recreation... A botanical trip across continents... The green path represents 40,000 m² of planted areas with: 1,600 trees, 50 different tree species from the 5 continents, according to the "zoological gardens" concept; 22.000 m² of wooded banks ("a wealth riparian forest"); 17.000 m² of lawned area; 6,000 shrubs and 50,000 perennials and grasses. All species are marked by flash codes to obtain more information by Apps.

Mediterranean honor **-** The Mediterranean is widely present in the green patch with Holm oaks, majestic Stone pine or cypress of Provence. The central green strip is planted with olive trees, vineyards, carob, pomegranate, fig trees and other trees of southern Europe.

Asia **-** Camphor trees and giant bamboo (already a height of 10m), as well as a collection of citrus to keep in mind that before to bloom along the French Riviera (17th century), lemons and oranges are native to China and India.

Africa **-** A grove of Senegal date palm (*Phoenix reclinata*), consisting of several amazing palm trees with several trunks, the Coral trees (*Erythrina*) with a splendid orange-red blooming in spring, and the exceptional scarlet Aloe flowers.

Oceania and Australia **-** Walk in a eucalyptus forest with remarkable specimens. In summer, the red-flowered kurrajong (*Brachychiton*) will compete with the "wheels of fire" of *Stenocarpus sinuatus*, flamboyant inflorescence trees. Dozens of tree ferns (up to 2 m of height) are planted under the protection of a giant *Ficus*.

South America **-** The yellow flowers of *Tipuana tipu*, also known as *Rosewood* and *Pride of Bolivia* or the pink flowers of the silk floss tree (*Chorisia speciosa*), a bottle-tree, with a thorny trunk to protect itself against the attacks by herbivores. Among other curiosities, *Jubaea chilensis* (Chilean Wine Palm) producing mini coconuts (edible).

North America **-** Dozens of magnolias, oaks, Walnut trees and maples of America. Tones from yellow to red and brown ... for an Indian summer in Nice.

Preservation of Dianthus **-** *Dianthus* is a genus of about 300 species of flowering plants in the family Caryophyllaceae, native mainly to Europe and Asia. Common names include carnation (*D. caryophyllus*), pink (*D. plumarius* and related species) and sweet william (*D. barbatus*). An area of more than 2000 Carnations, symbol of the city, recalls the period when Nice was the world's capital of Carnations. These flowers, covering the hills of Nice, were exported around the World.

A large "water mirror" - A large "water mirror", of 3.000 m² with 128 water jets, constitutes a thin water layer on natural stones. The haze zone, of 1.400 m², on a basament with basalts and limestones, is composed by 960 sprayers, shaping a "cloud" where you can meander. The humidity and coolness allow the discomfort mitigation produced by the urban heat island.

La Rotonde - An outstanding and a magical place on the Riviera

Our conference dinner is organized at a unique location. A true architectural masterpiece from the "Belle Époque", **la Rotonde** housed the restaurant of the former Bristol Hotel. Capped with a cupola which floods it with light, this magic circular building is today listed as a Historical Monument. Overlooking the marina, les *Salons de la Rotonde Lenôtre* offer a beautiful view over the sea and its palm tree-lined coast. Lenôtre's renowned prestige gastronomy helps celebrate the sweetest emotion with delicate menus, outstanding desserts and unique creations. Lenôtre gives you the benefit of its experience, its know-how and its passion to make sure every reception is graced by subtle flavors.

The Art of Elegant Entertaining: a prestigious gastronomy mixed to creativity signed by Eric Finon (Meilleur Ouvrier de France 2011) and wines are selectionned by Olivier Poussier (Best "Sommelier" of the World 2000).

Programme

Monday 1st June, 2015

9:00-18:00 - COST Action FP1204 "GreenInUrbs" Working Group meetings - *3rd floor* - Rooms Charleston, Fox Trot and Pasodoble

18:00-19:30 – Meeting for IUFRO Task Force 'Climate Change and Forest Health' members only (Room Charleston)

Tuesday 2nd June, 2015

8:00-8:30 - Registration of IUFRO participants

8:30-12:30 - COST parallel session - 3rd floor - COST Action FP1204 members only

8:30-12:30 - IUFRO parallel session - 1st floor

8:30-10:00 - Opening remarks by Pierre Sicard (local organizer), Elena Paoletti (IUFRO), Danilo Mollicone (FAO), Manuel Nicolas (National Forests Office) and Philippe Mondielli (Foundation "Prince Albert II de Monaco")

10:00-10:30 - Coffee break

10:30-12:30 - Session 1 Environmental status and health of Mediterranean forest ecosystems Chairs: Elena Paoletti and Pierre Sicard

10:30	De Marco	The Mediterranean forests as a critical target for air pollution and climate change
10:45	Fenn	Effects of nitrogen deposition and ozone on tree growth and mortality in California forests
11:00	Gratani	The evergreen species response to Mediterranean climate stress factors
11:15	Dalstein-Richier	Health and vitality of two pine species in the context of climate change in Southern Europe
11:30	Branquinho	Functional diversity as an indicator of ecosystem transitions between sub-humid and semi-arid in Mediterranean areas
11:45	Cariñanos	Phenological trends and effects of climate change in oak forests of south-eastern Spain
12:00	Ugarković	Microclimate of the Holm oak (*Quercus ilex* L.) forest and degradation stages of maquis and garrigue in the area of Mediterranean Croatia
12:15	Fares	Multiple interactions between anthropogenic pollutants, greenhouse gases and biogenic volatile organic compounds in a Holm oak peri-urban forest

12:30-14:00 - Lunch

14:00-16:30 - Session 2 Impacts of air pollution and climate change on forests in the wildland-urban interface Chairs: Carlo Calfapietra and Algirdas Augustaitis

14:00	Calfapietra	Towards a network of urban forest eddy covariance stations: an innovative case study in Naples
14:15	Verlič	Harmonized monitoring of urban and periurban forests in European cities – Examples of Milano and Ljubljana
14:30	Sgrigna	Particulate Matter deposition on leaves across European urban environments: *Platanus* sp. sampling campaign within COST Action FP1204
14:45	Samson	Impact of PM deposition on urban trees
15:00	Calatayud	Responses of four common urban trees in China to elevated ozone
15:15	Wang	Periodic drought influences the effects of elevated ozone on growth and physiology of Shantung maple
15:30	Silaghi	Radial growth response of *Quercus robur* trees to ambient air pollution in a Bucharest periurban forest, Romania
15:45	Watanabe	Difference in photosynthetic responses to ozone between canopy positions in Japanese oak
16:00	Rupel	Slovenian forests, urban forests and periurban forests are endangered from pollution by air (ozone)
16:15	Ellsworth	Effect of drought and elevated CO_2 on volatile carbon emissions for Eucalyptus in a periurban forest

16:30-17:00 - Coffee break

17:00-17:15 - Introduction to the Green Path site visit by Zürcher N. (Consulting Arborist) - "Living with Urban Trees: Accommodating Their Needs, Enhancing the Benefits".

17:15-18:30 - Guided visit to the "Green path" in Nice - Jean-Michel Meuriot and Alexis Maia; botany experts from the Botanical Garden of Nice.

18:30-20:00 - Wine tasting and poster session (Room Azur)

Wednesday 3rd June, 2015

8:30-10:05 - Session 3 Physiological and genetic mechanisms underlying stress responses of forest trees and forest ecosystems Chair: Om Rajora

8:30	Rajora	Effects of climate change on gene expression and associated physiological processes in a boreal conifer
8:50	Oksanen	Adaptation and acclimation of silver birch (*Betula pendula)* provenances in a common garden experiment
9:05	Bahadur	Determining the frost tolerance potential of commercially important *Eucalyptus* species in South Africa
9:20	David-Schwartz	Genetic variation in cavitation resistance driven by anatomical traits in *Pinus halepensis*
9:35	Le Thiec	Distinct responses to ozone of stomata in three poplar genotypes
9:50	Chen	Proteome analysis of proteins responsive to ambient and elevated ozone in *Machilus pauhoi kanehira* seedlings

10:05-10:30 - Coffee break

10:30-12:05 - Session 3 Physiological and genetic mechanisms underlying stress responses of forest trees and forest ecosystems Chair: Rainer Matyssek

10:30	Matyssek	Can we link genetic control with physiological activity? Exemplifying beech response (*Fagus sylvatica*) to oxidative stress
10:50	Wieser	Is it all genetics? New evidence on an old issue
11:05	Velikova	Biogenic volatile isoprenoids – strategies for sustainable forestation in changing environment
11:20	Mikkelsen	UV-induced N_2O emission from plants
11:35	Sõber	Acclimation of deciduous trees to increasing air humidity and interacting environmental drivers
11:50	Koike	Plant defense and photosynthesis of Japanese white birch saplings grown under a free-air O_3 fumigation system

12:05-13:30 - Lunch

13:30-16:00 - Session 4 Health and growth of forests: bridging monitoring and modeling
Chair: Alessandra De Marco

13:30	de Vries	Assessment of impacts of nitrogen deposition, ozone exposure and climate change on carbon sequestration by monitoring and modeling
13:45	Escobedo	Modeling and mapping the spatial and temporal effects of land-use and climate change on forest ecosystem services
14:00	Feng	A stomatal ozone flux-response relationship for five poplar clones widely planted in China
14:15	Hoshika	To develop stomatal conductance modeling under elevated ozone in forest trees
14:30	Moura	Variation in O_3 symptom development in plants exposed to tropical environments
14:45	Melo	Prediction of geographic distribution of endangered species of the Brazilian Atlantic forest
15:00	Rizzetto	Modelling the impact of climate change and atmospheric N deposition on French forests biodiversity
15:15	Badea	Effect of climate change on tree growth from intensive forest monitoring network in Romania
15:30	Seidling	Accumulating influences on individual parameters of tree performance
15:45	Liampas	Hellenic Positioning System (HEPOS) in the service of accuracy control in semi-mountainous area

16:00-16:30 - Coffee break

16:30-17:45 - Session 4 Health and growth of forests: bridging monitoring and modeling
Chair: Salim Belyazid

16.30	Ledermann	Analyzing site productivity and stand risk of Norway spruce (*Picea abies* [L.] Karst.) in Austria
16.45	Kozlov	Confirmation bias affects the results of monitoring: a case of leaf fluctuating asymmetry
17.00	Ferretti	Monitoring and modeling the long-term impact of air pollution on forest health and growth in Europe
17.15	Schaub	Ozone risk assessment for European forests – A ten-year study on permanent monitoring plots

17:30	Andivia	A process-based soil-plant model to assess nutritional limitations on forest growth within a changing environment

17:45-19:00 - Poster session and voting for the best poster award

19:00-20:00 - Meeting for IUFRO RG 7.01 officers only (room Venitien)

19:30 to Midnight - Cabaret dinner "Chez Fanny" (Meeting point: Palais de la Méditerrannée, transfer by bus for participants and by car for IUFRO officers from 20:00).

Thursday 4th June, 2015

8:30-12:00 - Session 5 Biogeochemistry and multiple stressors Chairs: Nancy Grulke and He Shang

8:30	Grulke	Introduction to the session
8:40	Grote	BVOC emissions from trees - forming ozone or protecting against ozone?
8:55	Domingos	PAHs and heavy metals in forest remnants in the central-eastern of São Paulo State, SE Brazil
9:10	Fuentes	Influence of air pollution on plant-insect interactions
9:25	Grulke	The role of abiotic and biotic stressors in pine susceptibility to bark beetle
9:40	Braun	Tree mortality in Swiss forest observation plots: the role of drought, nutrition, and N-deposition
9:55	Vollenweider	Response of low-elevation pine stands in the Central Alps to changes in land use in a warmer climate

10:10-10:30 Coffee break

10:30	Alonso	Interactive effects of O_3, N, and climate on annual understory pastures of Holm oak forests
10:45	Hayes	Combined effects of O_3 and N on ecosystem services: experimental results and modelled future impacts
11:00	De Witte	Changes in ectomycorrhizal species composition along a N-deposition gradient in Swiss beech forests
11:15	Pickles	Success of migrated Douglas-fir seedlings is mediated by ectomycorrhizae and other soil factors
11:30	Nickel	Effect of climate change and atmospheric nitrogen deposition on ecological integrity of forests
11:45	Belyazid	Integrated effects of atmospheric deposition and climate change on forest ecosystem services

12:00-13:30 - Lunch

13:30-16:45 - Session 6 Forest ecosystems, atmospheric deposition and the water cycle
Chairs: Yusuf Serengil and Mark Fenn

13:30	Malek	The impact of deforestation on the localization of springs and their chemistry on Skrzyczne in the Beskid Śląski Mts.
13:45	Serengil	A hydrological evaluation of forest fragmentation along urban-rural transition using SWAT model
14:00	Vilhar	Influence of conversion of spruce monocultures into mixed beech - spruce forests on the river basin runoff
14:15	Krecek	Long term impacts of biomass harvesting on hydrology and nutrient leaching of boreal forests
14:30	Balestrini	Long-term patterns of deposition, soil solution and stream water chemistry in an Alpine forest ecosystem
14:45	Du	Inorganic nitrogen deposition in China's forests: Status and characteristics
15:00	García-Gómez	Atmospheric concentration and deposition of nitrogen in four Mediterranean holm oak forests
15:15	Hůnová	A novel approach for spatial quantification of nitrogen deposition: A case study for Czech forests
15:30	Schröder	Concentrations of heavy metals in moss and natural surface soil sampled in Norway from 1990 to 2010
15:45	McNulty	Where no forest has gone before: New forest stress response patterns and adaptive management options
16:00	Pascaud	Impact of base cation deposition trends on exceedances of critical load of acidity in French forests
16:15	Ning	Response of urban oak species to flooding and elevated CO_2 in the Gulf Coast region of USA
16:30	Saenger	Changes in nutrient and carbon stocks in French forest soils under decreasing atmospheric deposition

16:45-17:00 - Closing ceremony with delivery of the best poster award - Closing remarks by Mr. Eric Ciotti, President of the General Council

19:00 to Midnight - Gala dinner (Meeting point: Palais de la Méditerrannée, transfer by bus)

Friday 5th June, 2015

9:00-9:45 Transfer by bus from Nice to Cannes

10:00-10:15 Transfer by boat from Cannes to Lérins island

10:15-10:40 Coffee break with a talk given by the local Forest ranger (National Forests Office)

10:45-12:15 Free time along the botanical path to discover an exceptional Mediterranean flora

12:30-14:00 Bucolic/pastoral "Provençal" lunch

14:15-14:30 Transfer by boat from Lérins island to Cannes

14:40-15:10 Transfer by bus from Cannes to Grasse

15:15-15:25 Perfurmer (Nose) conference at the Flower Factory

15:30-16:30 Visit of the historic Perfumery Fragonard in Grasse

16:40-17:15 Coffee break with three talks:

> **Dr. Thierry Gauquelin** (Mediterranean Institute of marine and terrestrial Biodiversity and Ecology, France) "The Oak Observatory O3HP: interdisciplinary and experimental approaches to study Mediterranean forest functioning under climate change".
>
> **Prof. Jose D. Fuentes** (Department of Meteorology - The Pennsylvania State University, USA) "Flowers' fragrance diminished by air pollution - What are the consequences for perfume industry and biodiversity?"
>
> **Dr. Martine Adrian-Scotto** (Chemistry Institute in Nice, ICN) "The national research group Odourant, Odour and Olfaction".

17:20-18:00 Visit of Grasse old-center

18:00-18:45: Transfer by bus to Nice

Lérins Islands: An exceptional and typical Mediterranean flora

The **Lérins Islands** (in French: *les Îles de Lérins*) are a group of four Mediterranean islands off the French Riviera, in front of Cannes. The two largest islands in this group are the **Île Sainte-Marguerite** and the Île Saint-Honorat. The islands are first known to have been inhabited during Roman times.

Just a few minutes by boat from Cannes, the **Île Sainte-Marguerite** (2.5 Km²) offers an exceptional site, in a harmonious blend of nature, culture and leisure. The island helds a fortress where The Man in the Iron Mask was held captive for a time. The mysterious individual was believed to be of noble blood, but his identity has never been proven. In 1707 the Lérins were occupied by the English navy, under the command of Sir Cloudesley Shovell. This was done in order to block the military port of Toulon to help the army of Victor Amadeus II Duke of Savoy and his cousin Eugene besiege that city.

The true natural richness of the **Sainte-Marguerite Island** can be admired along a botanical path with an exceptional Mediterranean flora. You are captivated by the fragrance of pine and eucalyptus trees and the plenitude of flora on this island. The island vegetation is made of Aleppo pines and Holly oaks. The bush consists of lentisques, myrtles, filarias, together with olive-trees, white and pink cistus, honeysuckle, clematis. The forest of the Islands of Lérins shelters many animal species like the pheasant, the Montpellier Snake, the owl small duke, the Kestrel Falcon and the hedgehog. The pond of Batéguier shelters a true ornithological reserve. At the sea side, the Posidonia flower forms under water prairies. This herbarium produces oxygen and constitutes excellent shelter for aquatic fauna and flora.

Grasse: The world's capital of perfume

Around the Mediterranean basin, over the time period 2000-2010, the highest ozone mean concentration at suburban sites were found at Grasse, where the non-methane volatile organic compounds (NMVOC) emissions were increasing until 2007 because of the development of the perfumery and industrial chemical factories (Directive 96/61/CE).

Abundant flowers have made Grasse the International Capital of Perfumery. The city once proudly displayed its gardens, which shone both for their beauty and their fragrance, along with fields of jasmine, rose and tuberose flowers, the three key ingredients in the art of perfumery. As the centuries passed, Grasse's reputation increased, with many great perfume brands (Chanel and Dior).

The Grasse flower factory reveals the fundamental stages of perfume production, including cutting-edge techniques like chromatography, the filling chain, and the soap roller.Visit the laboratory, the packaging studios, and the soapmaking plant and see how every product available in the stores is manufactured. Beginning of the spring, visits to the factory come to a close in the flower garden, replete with plants like rose de mai, lavender, broom, syringa, and honeysuckle. These provide essences for Grasse-style perfumery.

A **perfumer** is a term used for an expert on creating perfume compositions, sometimes referred to affectionately as a Nose (French: *le Nez*) due to their fine sense of smell and skill in producing olfactory compositions. The perfumer is effectively an artist who is trained in depth on the concepts of fragrance aesthetics and who is capable of conveying abstract concepts and moods with fragrance compositions. There are 500 "*Nez*" in the World; one of them will give a talk about the activities.

The historic factory in Grasse - Built in 1872, this historic tannery turned perfumery is now a museum. Visits to this historic factory thread their way through the perfumer's laboratory, with its perfume organ, the distillery, the maceration and filtering studios, the enfleurage rooms, and the artisanal packaging and soapmaking workshops.

Grasse, where architecture is heritage - Grasse has a rich architectural heritage that dates back to the Middle Ages. Explore its narrow, winding streets which will keep you cool in the summer. Stop to admire the cathedral of Notre-Dame du Puy, with its works attributed to artists such as Pierre-Paul Rubens and Jean-Honoré Fragonard. Stroll around the pretty squares and discover the city's fine old town houses.

The Oak Observatory O3HP: interdisciplinary and experimental approaches to study Mediterranean forest functioning under climate change

Dr. Thierry Gauquelin - Equipe Diversité et Fonctionnement : des Molécules aux Ecosystèmes. Institut Méditerranéen de Biodiversité et d'Ecologie UMR 7263 CNRS, 237 IRD. Université d'Aix-Marseille, France.

The functioning of Mediterranean forests is contingent on the existence of this dry summer period. Intensified and prolonged drought periods related to climate change are then of special concern in these ecosystems. Currently, our understanding of the response, in terms of biodiversity and functioning, of Mediterranean forests to extreme drought conditions is limited. An experimental facility with a rain exclusion system study situated is a French Mediterranean natural old-growth oak forest and called Oak Observatory at the OHP (O_3HP) allow to investigate on different functional components of the ecosystem : for example, phenology, litter decomposition and biogenic volatile organic components emission by trees. Changes in biodiversity-functioning relationships are also studied concerning soil biodiversity, playing a major rule in biogeochemical cycles. These controlled field experiments, even if they are recent, show changes in ecosystem functioning due to drought increase.

Flowers' fragrance diminished by air pollution - What are the consequences for perfume industry and biodiversity?

Prof. Jose D. Fuentes - Department of Meteorology, the Pennsylvania State University, USA.

Unfortunately recently the flowers' fragrance has been seriously diminished by high air pollution with potentially significant consequences for the perfume industry. During the excursion the impacts of air pollution on secondary plant compounds and volatiles produced by plants which are used in the perfume (and cosmetics) industry will be discussed. Scientists already knew that scent-bearing hydrocarbon molecules released by flowers can be destroyed when they come into contact with ozone and other pollutants. The chemical reactions alter the floral scents and contribute to production of compounds such as acetone, formaldehyde, and carbon monoxide. Air pollution is destroying the fragrance of flowers and thereby inhibiting the ability of pollinating insects to follow scent trails to their source. This could partially explain why wild populations of some pollinators, particularly bees, are declining in several areas of the world.

The French national research group "Odourant, Odour and Olfaction"

Dr Martine Adrian-Scotto - Equipe Diversité, Intitut de Chimie de Nice, Université Nice-Sophia-Antipolis, France.

A short description of the French national research group O3 will be given. The national research group O3 was created to federate all research work in French academic laboratories around the areas of the perception of odors, odorous compounds and olfaction. The aim is to develop a multi and trans-disciplinary research around six different themes: (1) Physiology and psycho-physiology of olfaction; (2) Odourous compounds and innovation; (3) Odor and health; (4) Odours and cultures; (5) Odorants as ways of communication; (6) Odour and taste.

Abstracts

Session 1 "Environmental status and health of Mediterranean forest ecosystems"

Tuesday 2nd June, 2015
10:30-12:30

Chairs: Elena Paoletti and Pierre Sicard

Mediterranean-type ecosystems are found in five regions of the globe: California, central Chile, Mediterranean Basin, southern Cape region and South Australia. The flora of the Mediterranean areas is one of the richest in the world. The climate is highly seasonal and characterized by warm, dry summers and cool, rainy winters. Mediterranean climate is at high risk of change due to atmospheric pollution because it represents a transition zone between arid and humid regions of the world. Mediterranean forests have historically been subjected to numerous threats (forest fires, over-exploitation, deforestation, degradation), today accentuated under climate and land use changes. The **Mediterranean forests** are a critical target for air pollution and climate change. This session summarizes the present knowledge about air pollution and climate threats to Mediterranean forests, in particular ozone (O_3) and nitrogen (N) risk, climate-driven phenological and physiological alterations, elucidating how Mediterranean forest health is challenged by traditional and new stress factors. The speaker, rather than the lead author is highlighted in the overview that follows.

Climate change and increasing nitrogen deposition and surface O_3 concentrations are threatening Mediterranean forests in an unpredictable way, and the responses greatly change with the tree species. **De Marco et al**. analyze sensitivity and eco-physiological response of Mediterranean forests to air pollution and climate change at ecosystem level concerning the impacts of O_3, N deposition and meteorology on 12 tree species over Europe. They obtain a projection of defoliation in 2030 according to three climate change scenarios and the expected change in N deposition. Furthermore, little is known of the dose response for tree growth and mortality to the combined exposure to these two pollutants under ambient conditions in the Mediterranean climate. **Fenn et al**. present the preliminary analysis of the effects of O_3exposure and N deposition on carbon sequestration in aboveground woody biomass and tree mortality for 13 species across California.

The Mediterranean Basin is recognized as a model region for studying global change effects on terrestrial ecosystems. **Gratani et al.** raise the issue of the evergreen species response to Mediterranean climate stress factors through an analysis of variations in the respiration and photosynthesis ratio of species co-occurring in the Mediterranean maquis. This ratio is indicative of the capacity of plants to produce new biomass for growing and reproduction. The predicted global warming might differently affect carbon balance of evergreen species. The results highlight the importance of including seasonal variations of this ratio in carbon balance models under a Mediterranean type of climate. For **Dalstein-Richier et al**., South-eastern France can be considered as a case study for assessing global change impacts on forests. In the current climate change context, a deterioration of the crown conditions was observed for two pine species (*P. halepensis* and *P. cembra*). If such ecological changes are now being detected when the climate has warmed in the last 20 years, it can be expected that many more impacts on tree species will occur in response to predicted temperature changes by 2100. Climate change will create additional challenges for forest management with substantial socio-economic and biological diversity impacts.

A predicted increase in aridity in the Mediterranean would reduce the functioning and ecosystem services provided by dryland ecosystems, where 38% of the human population lives. Beyond a certain pressure the ecosystem may undergo a sudden change towards another alternative state, i.e. a critical transition. In order to anticipate the occurrence of critical transitions, the development of early warning indicators is useful. **Branquinho et al.** propose two approaches, i.e. the plant and lichen functional diversity, as indicators of ecosystem transitions between sub-humid and semi-arid in Mediterranean areas. **Cariñanos et al**. raise the issue of phenological trends and effects of climate change in oak forests of south-eastern Spain through analysis of pollen emission and meteorological variables recorded for a 22-year series. The pollen counts provide a useful biological indicator of the reproductive status of Mediterranean oak forests and their response to climate change.

Holm oak is the main indigenous forest species of EU-Mediterranean area in Croatia. **Ugarković et al**. present microclimate measurements (e.g. temperature, relative humidity, soil water content) in the Holm oak forest and in the degradation stages of maquis and garrigue. This kind of analysis can be used to better understand ecological conditions of forest habitats.To fully explore soil-plant-atmosphere interactions under environmental stress, **Fares et al.** raise the issue of the bi-directional exchanges of trace gases (i.e. VOCs, NOx, CO_2, water and O_3) in a peri-urban Mediterranean Holm oak forest (Castelporziano, Italy) by Eddy Covariance technique. A novel multi-layer model to predict greenhouse gas and pollutant exchanges between plant and the atmosphere can be used as a main step toward a complete evaluation of the ecosystem services provided by forests.

Dr. Elena Paoletti, senior scientist at CNR (National Research Council) in Italy. She is Forest ecophysiologist with focus on the impacts of air pollution and climate change on forests.

Coordinator of the IUFRO Research Group 7.01 "Impacts of Air Pollution and Climate Change on Forest Ecosystems" (2000-2010, 2014-).

- IUFRO Forest Health Award 2010 for Achievement in Forest Health Research.
- Member of the Scientific Advisory Board of the European Forest Institute (2015-) & Member of the extended IUFRO Board (2014-).
- Member of the Steering Committee of the IGAC activity Tropospheric Ozone Assessment Report: Global metrics for climate change, human health and crop/ecosystem research (2015-)
- Coordinator of the IUFRO Task Force on Climate Change and Forest Health (2015-2017).
- Secretary and former Vice-President of the Italian Society of Silviculture and Forest Ecology (2008-).

Dr. Pierre Sicard, PhD in Atmospheric chemistry, is responsible for the French Riviera air quality pilot in European projects. He works on air quality impacts on human health (development of an Aggregate Risk Index) and ecosystems, particularly, on the ground-level ozone impacts on forest through epidemiological studies. He was coordinator (2011-2014) of the FO_3REST project (www.fo3rest.eu). The main objective was to suggest new ozone flux-based critical levels, more appropriated, for Mediterranean forest protection against ozone. He is involved in the Tropospheric Ozone Assessment Report: Global metrics for climate change, human health and crop/ecosystem research.

The Mediterranean forests as a critical target for air pollution and climate change

A. De Marco [*(1)], P. Sicard [(2)], M. Vitale [(3)], C. Proietti [(3)], A. Anav [(1)], E. Paoletti [(4)]

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Abstract

Air pollutants and climate change provide unfavorable conditions for vegetation growth and may affect plant's metabolism, ecosystem structure and functions in different ways. Among common air pollutants, ozone (O_3) and Nitrogen (N), potentially the most damaging to forest vegetation, reach high concentrations over large regions of the world. Mediterranean area is hardly affected by both climate change, due to the increase of temperature and soil drought , and air pollution, because of the photochemical pollution due to light and temperature peculiarities. Mediterranean forest vegetation has evolved cross-tolerance to deal with a harsh environment. Climate change and increasing N deposition and tropospheric O_3, however, are threatening Mediterranean forests in an unpredictable way, and the responses greatly change with the tree species. Ozone effect depends on the amount of gas entering through stomata rather than on the concentration of O_3 in the air. To date, most experiments to establish biologically relevant plant responses to ozone have been performed under controlled conditions, not representative of actual field conditions. FO_3REST project analyzed sensitivity and ecophysiological response of Mediterranean forests to air pollution and climate change at ecosystem level concerning O_3. Plant species-specific responses to N deposition are little explored, since Mediterranean vegetation has to face multiple and consecutive stresses conditions. The impacts of different environmental conditions, both in terms of N deposition and meteorological parameters, have been assessed all over Europe on 12 tree species, with different ecological requests. The results obtained by projection of defoliation in 2030, considering three different climate change scenarios and the expected change in N deposition, showed that the defoliation is generally decreasing in northern part of Europe, while for some species (beech and holm oak) Mediterranean environment, with expected future increase in drought and temperature, shows a clear trend in increasing the defoliation percentage.

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Effects of nitrogen deposition and ozone on tree growth and mortality in California Forests

Mark Fenn [*(1)], Jeremy Fried [(2)], Haiganoush Preisler [(3)], Andrzej Bytnerowicz [(1)], Sarah Jovan [(2)], Susan Schilling [(1)]

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Abstract

Long term N deposition and ozone exposure are the two major pollutants impacting forests in California, USA. Little is known of the dose response for tree growth and mortality to the combined exposure to these two pollutants under ambient conditions in the Mediterranean climate of California. In contrast to the spatially extensive field survey on which this study is based, controlled experiments with N generally involve N fertilization additions which cannot replicate the chronic atmospheric inputs of N to forest canopies as deposition in dry (gaseous and particulate), cloud-water, and wet forms. Likewise many ozone studies are based on fumigation chamber experiments with seedlings or saplings or Free-Air Controlled Exposure studies using a limited number of tree species. We will present the preliminary analysis of tree volume growth and mortality in response to these pollutants for 13 species across California based on data from the US Forest Service, Forest Inventory and Analysis (FIA) program. Because available ozone exposure data does not cover the entire state of California, separate models of tree response to air pollution will include N deposition only and where possible, both pollutants. Ozone exposure data consists of 2-week average concentrations from a monitoring network equipped with Ogawa passive samplers. N deposition data is from the EPA CMAQ model in which simulated annual N deposition data have been adjusted with empirical throughfall N deposition data. Tree evaluations are based on field plots initially sampled in 2001-2003 and then remeasured ten years later. Preliminary results will be presented on the effects of ozone exposure and N deposition on C sequestration in aboveground woody biomass and tree mortality. The effects of both oxidized and reduced forms of N will be evaluated, although we anticipate that N form is not a major factor.

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The evergreen species response to Mediterranean climate stress factors

Loretta Gratani *, Rosangela Catoni, Laura Varone

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Abstract

The Mediterranean Basin has long been recognized as a model region for studying global change effects on terrestrial ecosystems. The main object of this research was to analyze variations in the respiration and photosynthesis ratio (R/P_N) of species co-occurring in the Mediterranean maquis. R/P_N is indicative of the capacity of plants to produce new biomass for growing and reproduction. The results show differences in physiological and morphological traits among the considered species. *Cistus incanus* has the highest P_N and R during the favorable period, relatively low leaf mass area (LMA) and leaf tissue density (LTD). *Erica multiflora* and *Rosmarinus officinalis* have the highest LMA and LTD, higher R during the year and the lowest P_N in the favorable period. *Erica arborea*, *Pistacia lentiscus*, *Phyllirea latifolia* and *Quercus ilex* are in the middle. *Arbutus unedo* and *Smilax aspera* are close to this group, despite a lower R during the year and the relatively low LMA and LTD. LMA correlates with leaf life-span (LL), P_N and R describing the trade-off between long-lived leaves vs. short-lived leaves. Among the considered species, the typical sclerophyllous have the longest LL, followed by the narrow-leaf species, *A. unedo* and *S. aspera* and *C. incanus*. Thus, LL is a good indicator of carbon investment strategy. The predicted global warming might differently affect carbon balance of the evergreen species, with a possible change in Mediterranean shrublands composition in the long term. *P. latifolia*, *P. lentiscus*, *Q. ilex*, *A. unedo* and *E. arborea* might be favored by their capability to maintain a lower R/P_N during drought. The results highlight the importance of including seasonal variations of R/P_N in carbon balance models under a Mediterranean type of climate.

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Health and vitality of two pine species in the context of climate change in Southern Europe

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Abstract

The Mediterranean Basin is expected to be more strongly affected by ongoing climate change than most other regions of the earth. The South-eastern France can be considered as case study for assessing global change impacts on forests. Based on non-parametric statistical tests, the climatic parameters (temperature, relative humidity, rainfall, global radiation) and forest-response indicators (crown defoliation, discoloration and visible foliar ozone injury) of two pine species (*Pinus halepensis* and *Pinus cembra*) were analyzed. In the last 20 years, the trend analyses reveal a clear hotter and drier climate along the coastline and slightly rainier inland. In the current climate change context, a reduction in ground-level ozone (O_3) was found at remote sites and the visible foliar O_3 injury decreased while deterioration of the crown conditions was observed likely due to a drier and warmer climate. Clearly, if such climatic and ecological changes are now being detected when the climate, in South-eastern France, has warmed in the last 20 years (+ 0.46-1.08°C), it can be expected that many more impacts on tree species will occur in response to predicted temperature changes by 2100 (+ 1.95-4.59°C). Climate change is projected to reduce the benefits of O_3 precursor emissions controls leading to a higher O_3 uptake. However, the drier and warmer climate should induce a soil drought leading to a lower O_3 uptake. These two effects, acting together in an opposite way, could mitigate the harmful impacts of O_3 on forests. The development of coordinated emission abatement strategies is useful to reduce both climate change and O_3 pollution. Climate change will create additional challenges for forest management with substantial socio-economic and biological diversity impacts. However, the development of future sustainable and adaptive forest management strategies has the potential to reduce the vulnerability of forest species to climate change.

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Functional diversity as an indicator of ecosystem transitions between sub-humid and semi-arid in Mediterranean areas

Cristina Branquinho *(1), Alice Nunes (1,2), Paula Matos (1,2), Pedro Pinho (1,3)

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Abstract

Understanding the consequences of changing precipitation and temperature patterns in drylands is vital considering that 38% of the human population lives there. Moreover, climate change is expected to cause several impacts at the global scale and these drylands will be among the most affected areas. As a result of global change, dryland ecosystems may change non-linearly meaning that beyond a certain pressure the ecosystem may undergo a sudden change towards another alternative state. This is called a critical transition and the pressure value above which the transition occurs is called a tipping point. In order to anticipate the occurrence of critical transitions from sub-humid to semiarid in these ecosystems the development of early warning indicators is of critical importance. It's currently accepted that these indicators should be based on integrated response of ecosystems. However, at present no early-warning indicators of such processes are available. Using space for time, we look at the integrated ecosystem structure and function along a spatial climatic gradient using two approaches: i) the plant functional diversity; and ii) the lichen functional diversity. Moreover, we upscale the information at the landscape level using remote sensing information. An integrated approach using the information from the different levels showed a common non-linear response of ecosystem indicators in relation to the spatial transition between sub-humid and semiarid. This non-linear response suggests a tipping point between 550 and 600 mm of precipitation. A predicted increase in aridity in Mediterranean would dramatically reduce the functioning and ecosystem services provided by these dryland ecosystems, where one third of the human population lives. This research was financed by FCT-MEC project, PTDC/AAC-CLI/104913/2008 and grants BPD/75425/2010, BD/51419/2011, BD/51407/2011 and Investigador FCT contract.

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Phenological trends and effects of climate change in oak forests of South-eastern Spain

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Abstract

Of more than $26x10^6$ ha of forest surface in Spain, a 1.26% (330.000 ha.) is located in the province of Granada (south-eastern of the Iberian Peninsula), of which one third are hardwood formations, being the different species of *Quercus* (*Q.ilex* subsp. *ballota, Q. coccifera, Q. pyrenaica, Q. suber*) the most frequent. The aim of this work is to chart trends in the dynamics of *Quercus* forests in Granada province, through analysis of pollen-emission over time. For this purpose, pollen counts recorded for a 22-year series using a volumetric trap were analyzed and main parameters for the flowering season were defined. Phenological and meteorological variables were fitted to simple lineal regression model to chart trends, and statistic tests were performed to ascertain the impact of weather-related parameters on pollen dynamic. The results have shown that the flowering of the different species of *Quercus* takes place successively between March and July, by registering a pollen index with large annual fluctuations, dependent on weather conditions each year. Trends analysis of phenological parameters shows a progressive increase in the Pollen Index, and advance of the start of the flowering and a lengthened of the pollination period. Statistics correlation with the meteorological parameters confirm the maximum temperature of the month prior to flowering as the most influential parameter on the start date, while autumn rainfall influence the pollen production. The ability of adaptive response of these species to recurring drought episodes is also observed. It can be concluded that pollen counts provide a useful biological indicator of the reproductive status of Mediterranean oak forests and their response to environmental conditions of climate change.

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Microclimate of the Holm oak (*Quercus ilex* L.) forest and degradation stages of maquis and garrigue in the area of Mediterranean Croatia

Damir Ugarković [*(1)], Željko Španjol [(1)], Milan Oršanić [(1)], Ivica Tikvić [(1)], Roman Rosavec [(1)], Marko Vučetić [(2)]

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Abstract

Holm oak (*Quercus ilex* L.) is the main indigenous forest species of EU-mediterranean area in Croatia. Holm oak can be found in all forms of breeding and degradation stages, and maquis and garrigue are most found degradation stages of holm oak forests. Forest ecosystems are influenced by numerous local meteorological and climatological conditions. Numerous ecological processes are closely related to weather conditions, and correct data on forest climate are needed to study them. Disorganized and uncontrolled cuttings of high forest stands and their conversion into degradation stages, changes microclimate conditions of certain stand. Microclimate researches were done in the area of Island Mljet. Forest microclimate depends on the local climate, relief, soil and forest stand structure. Measurements were done in the holm oak forest and in the degradation stages of maquis and gariggue. During one year was measured air temperature and soil temperature (°C), relative air humidity (%), specific air humidity (%), and volumetric soil water content (%). Average temperatures of air and soil were highest in the gariggue stage, and the least in the maquis stage. The highest absolute maximum air temperature was measured in the gariggue stage, and the highest minimal in the maquis stage. Average relative air humidity had the highest value in the high forest stand. The values of volumetric soil water content were the lowest in gariggue, and the highest in maquis. The highest variations of microclimate elements were measured in degradation stages of holm oak. Microclimate conditions in degradation stages of holm oak are less favourable for growth and development in relation to microclimate conditions in high forest stand. Correlations of microclimate elements in studied forest stand and degraded stages were positive, significant and high to complete. Analysis of these data can be used to better understand ecological conditions of forest habitats.

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Multiple interactions between anthropogenic pollutants, greenhouse gases and biogenic volatile organic compounds in a Holm oak peri-urban forest

Silvano Fares *(1), Flavia Savi (1,2), Alessandro Alivernini (1), Federico Brilli(3), Elena Paoletti(3), Cheng Wu (4), Juergen Wildt(3)

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Abstract

Mediterranean forest ecosystems are exposed to high loads of anthropogenic pollutants. In order to fully explore plant-atmosphere interactions under environmental stress, bi-directional exchanges of Volatile Organic Compounds (VOCs), nitrogen oxides (NOx), CO_2, water, and ozone were investigated in a Mediterranean Holm oak forest in Castelporziano presidential estate, a peri-urban forest near the coast of Tyrrhenian sea, 20 km from Rome downtown, Italy. Fluxes were measured using the Eddy Covariance techniques and by application of inverse lagrangian models. Laboratory experiments were carried out using plant enclosure systems to 1. Quantify the capacity of Oak leaves to sequestrate oxidation products between VOC and ozone, and 2. Estimate the capacity of emitted VOC to form ozone into the atmosphere through photochemical reactions. Results showed that low temperatures lead to almost negligible VOC fluxes during cold seasons. Summer fluxes were largely represented by BVOC (mainly monoterpenes) and were recorded in the central hours of the day in response to high light and temperature. In the same periods, high amount of ozone was sequestrated by plants mainly through stomatal uptake. Laboratory studies showed that leaves can remove products of VOC oxidation into the atmosphere. However, the ozone forming potential of emitted VOC is high and must be considered for computing a realistic ozone balance in a VOC-limited environment. Data collected in the field and in the laboratory were used to parameterize a novel multi-layer model here proposed as a novel tool to predict greenhouse gas and pollutant exchanges between urban plant and the atmosphere. We discuss here the potential of our model to calculate bi-directional fluxes of trace gases in the soil-plant-atmosphere continuum as a main step toward complete evaluation of ecosystem services provided by forests.

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Session 2 "Impacts of air pollution and climate change on forests in the wildland-urban interface"

Tuesday 2nd June, 2015
14:00-16:30

Chairs: Carlo Calfapietra and Algirdas Augustaitis

Urban environments that are stressful for plant function and growth will become increasingly widespread in future. Analyzing plant responses to urban conditions, which we define as 'Urban Plant Physiology', represents an important opportunity to gain an insight into immediate physiological responses, tolerance of plants and extent and mechanisms of short- and long-term plant adaptations often simulating climate change conditions. Woody species are particularly important in this context, because of their longevity and the possibility of studying the mechanisms of long-term adaptation. The transition zones between urban centers and rural and natural areas, including the urban-rural interface represent a gradient of stress conditions and thus provide a scene for unique case studies along stress gradients. Physiological responses to these stressful conditions also affect the capacity of urban and peri-urban vegetation to provide key environmental services.

The session includes presentations focusing on the effect of the main urban pollutants on plants as well as estimations of the mitigation potential by urban plants in urban and peri-urban environment. Ozone is the main pollutant considered in these studies especially to evaluate the adaptation and responses of urban trees either in fumigation chambers and in outdoor urban environment. In all cases O_3 is reducing photosynthesis and/or growth of the tested trees thus compromising the carbon sequestration potential of the urban and peri-urban forests. Analysis of important O_3 precursors in urban environment such as Volatile Organic Compounds (BVOC) emitted by urban trees show that elevated CO_2 can considerably inhibit isoprene emission thus reducing the ozone forming potential in cities where high CO_2 levels are observed.

Another major pollutant considered in this session is Particulate Matter (PM) which is known to be very detrimental for human health. Data of PM deposition on urban trees are discussed either for a case study city and from a European campaign involving 30 cities and organized in the framework of the COST Action FP1204 "GreenInUrbs".

The session evidences the importance of urban and peri-urban forests for ecosystem services in our cities but at the same time the possible threats represented by air pollutants which might considerably limit the provision of those services.

Dr. Carlo Calfapietra (www.carlocalfapietra.com)

He is a researcher at the Italian National Research Council (CNR), Institute of Agro-Environmental & Forest Biology (IBAF) and Lecturer in Urban Forestry at University of Tuscia. His main interests are the biosphere-atmosphere interactions and the effects of global change and air pollutants on these with a particular focus on the biogenic VOC emission both in urban and rural environments.

Dr. Calfapietra has published about 70 research papers on international journals/books on these topics (H-index: 31). He is Member of the Editorial Board of several journals, Member of the Scientific Committee "Life, Environmental and Geosciences" of Science Europe, Chair of the COST Action FP1204 "GreenInUrbs" and member of the Centre of Excellence Czechglobe for the study of climate change.

Prof. Dr. Algirdas Augustaitis

Lithuanian University of Agriculture. Head of Forest Monitoring Laboratory (1985-). Professor on Aleksandras Stulginskis University (2010-).

Coordinator of the IUFRO Working Group 7.01.01 "Impacts of air pollution and climate change on forest ecosystems – Detection, monitoring and evaluation" (2012-).

His main interests are the (i) integrated impact of natural and anthropogenic environmental factors on forest ecosystem; (ii) sustainability of terrestrial ecosystem; (iii) analysis of the regeneration processes of damaged forests and development of measures for their recovery in polluted areas.

- Member of COST action FP 0903 (2010-2013)
- Works deputy of the IUFRO WG 7.01.01 "Detection, monitoring and evaluation" (2004-2012)
- Coordinator of Integrated monitoring activities and integrated evaluation of impact of long range air pollutant, heavy metals and ozone on forest ecosystem in Lithuania (2004-2012)
- Works deputy of the IUFRO WG 7.01.05 "Modelling and risk assessment" (1997-2004)
- Forest Health Monitoring on global EMAP net in Baltic Region, (US-Baltic states project, 1994-1997)
- Intensive monitoring of forest ecosystem in Lithuania (1994-)
- Forest ecosystem monitoring in National Parks (1986-)

Towards a network of Urban Forest Eddy Covariance Stations: an innovative case study in Naples

Gabriele Guidolotti [(1)], Emanuele Pallozzi [(1)], Raffaela Esposito [(1)], Michele Mattioni [(1)], **Carlo Calfapietra** [*(1, 2)]

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Abstract

Urban forests are by definition integrated in highly human-made areas, and interact with different components of our cities. Thanks to those interactions, urban forests provide to people and to the urban environment a number of ecosystem services, including the absorption of CO_2 and air pollutants thus influencing the local air quality. Moreover, in urban areas a relevant role is played by the photochemical pollution which is strongly influenced by the interactions between volatile organic compounds (VOC) and nitrogen oxides (NOx). In several cities, a high percentage of VOC is of biogenic origin mainly emitted from the urban trees. Despite their importance, experimental sites monitoring fluxes of trace gases fluxes in urban forest ecosystems are still scarce. Here we show the preliminary results of an innovative experimental site located in the Royal Park of Capodimonte within the city of Naples (40° 51'N-14°15'E, 130 m above sea level). The site is mainly characterised by Quercus ilex with some patches of Pinus pinea and equipped with an eddy-covariance tower measuring the exchange of CO_2, H_2O, N_2O, CH_4, O_3, PM, VOCs and NOx using state-of-the art instrumentations; it is running since the end of 2014 and it is part of the large infrastructural I-AMICA project. We suggest that the experience gained with research networks such as Fluxnet and ICOS should be duplicated for urban forests. This is crucial for carbon as there is now the ambition to include urban forests in the carbon stocks accounting system. This is even more important to understand the difficult interactions between anthropogenic and biogenic sources that often have negative implications for urban air quality. Urban environment can thus become an extraordinary case study and a network of such kind of stations might represent an important strategy both from the scientific and the applicative point of view.

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Harmonized monitoring of Urban and Periurban forests in European cities – examples of Milano and Ljubljana

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Abstract

Urban and periurban forests (UPF) play an indispensable role in an urban landscape. They are can improve health and well-being of citizens and value of the City. Being prone to broad scope of impacts, such as air pollution, climate change and urbanization, their status needs to be monitored in order to adapt their management. Within the framework of the LIFE+ project *EMoNFUr – "Establishing a monitoring network to assess lowland forest and urban plantation in Lombardy and urban forest in Slovenia*" Milano (Italy) and Ljubljana (Slovenia) initiated first efforts in order to harmonize selected monitoring methods to assess the status of UPF in European cities, such as forest health, biodiversity or soil. Among others, methods for monitoring UPF ambient air quality by passive (diffusive) samplers for nitrogen and sulfur compounds and ozone, were prepared and tested, and an impact of UPF on the regulation of the quantity of water resources and preserving the quality of drinking water sources was assessed. The results show that, among other, the air in UPF in Ljubljana was minimally polluted with SO_2 and NH_3, while the levels of NO_2 and O_3 were significant but still below the levels that would require action and warning. Those UPF were found to be heavily laden with nitrogen as the value on an annual level was ranging between 27 and 44 kg N ha^{-1}. We have created a list of the most important indicators of the impact of UPF in regulating the quantity of water resources and preserving the quality of drinking water sources. The initiative to establish a pan European network for harmonized monitoring of UPF needs to continue by harmonizing more monitoring methods and including more cities in order to develop a responsive system that will be able to adapt to global challenges.

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Particulate Matter deposition on leaves across European urban environments: *Platanus sp*. sampling campaign within COST Action FP1204

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Abstract

The campaign was launched within the COST Action FP1204 "Green Infrastructure approach: linking environmental with social aspects in studying and managing urban forests (GreenInUrbs)". 19 Countries participated to the sampling campaign, with 31 involved cities. The overall objective was to estimate particulate matter (PM) deposition on urban tree leaves in different European cities. *Platanus* sp. was taken as model tree due its wide distribution across different latitudes and cities. Participants collected five leaves from three London plane trees selected from different urban areas, namely parks, residential areas and streets. Metadata of air pollution and traffic fluxes were also collected and compared to results of PM deposition on leaves. PM deposition on sampled leaves was analyzed by Scanning Electron Microscope (SEM) and through biomagnetic analysis by means of SIRM (Saturation Isothermal Remnant Magnetization). Results evidenced significant differences among samples, with growing levels of PM in the gradient parks/residential areas/high traffic streets. Results from SIRM showed high differences among samples within a single city. SEM results evidenced differences among PM size distribution between park trees and trees along high traffic roads. Comparison between the two methodologies allowed to prove that SIRM analysis, can be considered a suitable proxy for a cheap and quick analysis of PM deposition but SEM analysis offer a unique tool especially for the qualitative determination of PM. Moreover the widespread sampling campaign allowed a large spatial comparison of the PM pollution and of the biomonitoring potential across several European cities.

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Impact of PM deposition on urban trees

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Abstract

Urban environments are characterized by high loads of airborne particulate matter (PM). This PM is well known to have adverse effects on human health. However, this PM also deposits on plants, especially on their leaf surfaces. Therefore, leaf deposited PM can be used as indicator of time-integrated local PM exposure. Moreover, this deposited PM can have an impact on leaf characteristics at the anatomical, morphological and physiological level. And the deposition and impact of PM can vary throughout the season. In this presentation we will on the one hand demonstrate how leaf deposited PM varies at the level of a street canyon – horizontally, with height and according to azimuth – in terms of particle mass and dimensions. On the other hand we will discuss the spatial variation in leaf deposited PM, how this differs between species, how it varies throughout the season, and how leaf PM deposition influences morphological, anatomical and physiological leaf characteristics. Finally, we will discuss the potential of high resolution chlorophyll maps of urban green, and how these maps can help indicating the health status of urban trees as influenced by urban traffic and overall air quality. The latter maps are important for e.g. the assessment of the CO_2 mitigating capacity of urban trees.

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Responses of four common urban trees in China to elevated ozone

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Abstract

Potted plants of *Ailanthus altissima* (Mill.) Swingle (AA), *Fraxinus chinensis* Roxb. (FC), *Platanus orientalis* L. (PO), and *Robinia pseudoacacia* L. (RP) were exposed to enhanced ozone levels (NF+40, averaged O_3 concentration of 69 nmol mol^{-1} from 09:00 to 18:00) in Open Top Chambers. These species are among the most common ornamental plants in streets, gardens and tree plantations in most Chinese cities, where ozone precursors such as NO_2 are steadily increasing. Ozone induced visible injury in all species as well as microscopic alterations such as thickening of the cell walls, collapse of the palisade parenchyma cells, callose accumulation or chloroplast degradation. Ozone-induced symptoms were consistent with those observed the same year in the field in three of the species (AA, FC, RP; Feng et al., 2014, Environ. Pollut. 193:296-301). Ozone reduced the maximum activity of Rubisco ($V_{C,max}$) or the maximum electron transport rate (J_{max}) in PO and FC already in August, before any significant change in light saturated CO_2 assimilation (A_{sat}) was detected. In September, A_{sat} declined between 11% and 31% in all species, and also stomatal conductance (g_s) in AA (-37%) and RP (-34%). Changes in fluorescence parameters were also observed in PO and RP. Although there was a consistent tendency towards a reduction in chlorophylls and carotenoids due to the effect of ozone, changes induced by this pollutant were not statistically significant. In all species, Total Antioxidant Capacity (TAC), phenols and ascorbate (total and reduced) content significantly increased after ozone exposure. These leaf-level effects were however not reflected in significant changes in biomass parameters. Longer experiments involving several growing seasons are needed in order to assess how chronic ozone concentration might affect the different biomass components and water use in these species.

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Periodic drought influences the effects of elevated ozone on growth and physiology of Shantung maple

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Abstract

Long term effects of O_3 and drought stress on *A.truncatum* had been carried out by open-top chamber at Beijing suburb (North China) in 2012-2013. Results showed that elevated O_3 concentration and drought stress both had significantly reduced LMA, Gs, A_{max}, and subsequently aboveground and belowground biomass at the end of the experiment. Although drought stress could mitigate the O_3 damage on the foliage injury, LMA, leaf photosynthetic pigments and growth of height and basal diameter, due to limited carbon fixation, the O_3-induced reductions in A_{max}, Gs and total biomass were enhanced 23.71%, 15.48% and 8.14% under drought stress, which means drought did not protect Shantung maple from O_3 when the whole plant was considered.

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Radial growth response of *Quercus robur* trees to ambient air pollution in a Bucharest periurban forest, Romania

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Abstract

Forest ecosystems placed in the proximity of urban areas offers a bundle of social, cultural, economic and environmental services. But their capacity to provide goods and services is often influenced by different drivers, of which the most important are air pollution and climate change. The objective of this research is to determine the effects of air pollution (especially ozone) and different meteorological factors on intraanual tree growth in Stefanesti - stejar intensive monitoring plot, placed in Stefanesti periurban forest, at approximately 10 km from Bucharest, Romania. Continuous measurements of ozone concentrations and meteorological parameters were performed during 2010-2014 growing seasons (1st April – 30 September). Also, passive sampling of ozone, ammonia and nitrogen dioxide and permanent measurements of stem growth for 15 trees (*Quercus robur*) were performed biweekly in the same period. The biweekly ozone average varied between 11.4 and 38.7 ppb (2010-2012), AOT40 exceeding the 10 ppm h threshold in 2010. Mean basal area growth for the growing season had the lowest value in 2010 (13.6 cm^2) and the highest in 2013 (17.8 cm^2). Negative correlations, although not significant, between tree growth and AOT40 and mean temperature were observed. Multiple linear regression analysis (AOT40, temperature and precipitation as predictors) showed a statistically significant reduction in mean tree basal area growth of 1.6% due to ozone. Ozone fluxes for 2010-2014 period will be modeled and further exploratory analysis, including wet and dry deposition data, will be performed and presented. The initial part of this study was funded under the Life+ FutMon project (LIFE07 ENV/D/000218) and with the support of COST Action FP903 and POSDRU – postdoc project.

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Difference in photosynthetic responses to ozone between canopy positions in Japanese oak

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Abstract

Japanese oak (*Quercus mongolica* var. *crispula*) is a representative deciduous broad-leaved tree species in Japan. Although Japanese oak forests were originally located in rural areas, a distance from urban area has become closer due to spread of urban area. As a result, Japanese oak forests in edge of urban area are suffered from ozone air pollution from urban area. We have to understand impacts of ozone on Japanese oak to protect the forest as an urban-rural interface. To determine a whole-plant reponse to ozone, understanding defference in photosynthetic responses of individual leaves to ozone between canopy posisions is necessary. Therefore, we conducted free-air ozone fumigation study with Japanese oak sapling (10-year-old at the start of fumigation) to clarify the difference of ozone sensitivity of photosynthesis in upper and lower canopy leaves. The ozone at 60 nmol mol^{-1} during daytime was fumigated for two growing seasons (2011-2012). In June, August and October of 2012, we evaluated photosynthetic activity of upper and lower canopy leaves by analysis of intercellular CO_2 concentration-response curve of net photosynthetic rate (i.e. the A/C_i curve). Ozone-induced significant reduction in light saturated net photosynthetic rate was observed in October. At the same time, significant negative effect of ozone was observed in biochemical photosynthetic activities such as maximum rate of carboxylation (V_{cmax}) and maximum rate of electron transport (J_{max}), while stomatal limitation of photosynthesis was reduced. These effects of ozone were similarly observed in both upper and lower canopy leaves. The analysis for the relations between biochemical photosynthetic activities and leaf nitrogen content revealed nitrogen use efficiency to photosynthetic apparatus decreased under elevated ozone. We conclude the ozone sensitivity of photosynthesis in upper and lower canopy leaves of Japanese oak was similar, and the ozone-induced reduction of net photosynthesis was due not to stomatal closure, but to biochemical limitation.

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Slovenian forests, urban forests and periurban forests are endangered from pollution by air (Ozone)

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Abstract

OZONE in Urban Forests: The forecasts are global increase of ozone! The Slovenian Forestry Institute (SFI) have more than ten year study period (2004 – 2014), assessing ozone visible injury on forest vegetation in Slovenia, observed as foliage damage on the forest trees and shrubs species. Our first observations of negative impacts of ozone on forest tress were in year 2003. During these years the visible ozone demages were observing at 5 to 11 intensive monitoring plots (ICP-Forest Level II) and in the years 2013 and 2014 also in Ljubljana urban and peri-urban forests**.** The SFI has been performing passive sampling of ozone for more than 10 years. In 2013, we embarked on measuring sulphur dioxide, nitrogen dioxide and ammonia. We monitor air pollution with passive samplers also in the capital of Slovenia – Ljubljana. We perform measurements in urban areas and urban and peri-urban forests (city parks, nature park Tivoli, Rožnik, Šišenski hrib, forest covered hill Golovec, riparian forests). Identification of visible ozone or visible ozone like symptoms in small trees and shrubs in Ljubljana urban forests. Visible foliar injury by ozone we survey on 3 *off-plots*, on light-exposed sampling sites at urban forest edge being observed in 34 different species. Different species show different sensibility to the same ozone dose. Due to the environment pollution and impacts on the forest, urban and peri-urban forests**.** and vegetation, we present the acquired conclusions to the wider public.

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Effect of drought and elevated CO_2 on volatile carbon emissions for *Eucalyptus* in a periurban forest

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Abstract

VOCs emitted by trees have a strong influence on the formation of tropospheric ozone in nearby urban and suburban areas. The two most important biogenic VOCs (isoprene and monoterpenes) are synthesised in chloroplasts by trees using photosynthetic reductants and recent photosynthates as principal parts of their carbon skeletons. While this means that isoprene should be emitted in commensurate rates with photosynthesis in a range of environmental conditions, rising atmospheric [CO_2] stimulates photosynthesis (A_n) but inhibits isoprene emission rates (I_s). Moreover, drought is thought to do the opposite: it inhibits A_n but increases I_s. Thus, most atmospheric models simulating isoprene emissions in a future, higher [CO_2] atmosphere suggest reduced emission fluxes, but what about when drought and elevated CO_2 are combined? We undertook measurements during a strong drought in western Sydney, Australia in the *Eucalyptus* free-air CO_2 enrichment experiment (EucFACE). We measured leaf gas exchange at 30°C and 1000 µmol m^{-2} s^{-1} photon flux density at the canopy-top of mature *Eucalyptus* trees (18-24m high) in a remnant forest in western Sydney, Australia. I_s and monoterpene emissions were measured concurrently with gas exchange using adsorbent trapping cartridges. The measurements were done during two different periods, Nov. at the peak of a 6-month drought, and Feb. during the peak austral summer when soil moisture was high. I_s varied among species of *Eucalyptus* from 25 to 8 nmol m^{-2} s^{-1}. I_s was more strongly affected by elevated [CO_2] than drought in this system, with a 24% decline due to elevated [CO_2] across both sampling times. The data were also used to test the model based on the reductant-balance hypothesis of Morfopoulos et al. (2013). The CO_2-dependence of isoprene emissions has direct implications for our expectations of VOCs and consequently air pollutant loads in a future, higher-CO_2 atmosphere, particularly in urban and peri-urban regions.

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Session 3 "Physiological and genetic mechanisms underlying stress responses of forest trees and forest ecosystems"

Wednesday 3rd June, 2015
08:30-12:05

Chairs: Om Rajora and Rainer Matyssek

In aiming to explore the current state of knowledge on climate and air pollution stress on forest trees and ecosystems, and to identify priorities and challenges of future research towards consolidating forest health, sustainability and ecosystem services worldwide, one crucial frontier is to understand linkages between genetic responses and resulting physiological activities, i.e., genetic control of physiological responses. This session will focus on discussing physiological and genetic mechanisms underlying stress responses of forest trees and forest ecosystems to climate change and air pollution, with emphasis on linking genetic and physiological stress responses. The speaker, rather than the lead author is highlighted in the overview that follows.

Global climate change and air pollution are subjecting forests to significant stress, which can adversely impact adaptation, health, productivity, fitness and sustainability of forest trees and forest ecosystems. In order to understand adaptive mechanisms of forest trees to climate change and air pollution, it is critical to understand their responses, particularly genetic and physiological responses and functional cause and effect relationships between them. The **first part of Session 3** explores the genetic and physiological mechanisms and their inter-linkages underpinning forest trees' responses to climate change and air pollution. As well, genetic variation in acclimation and adaptive phenological, physiological and anatomical traits is addressed.

In the opening talk of the session, **Rajora et al.** will address the question how a boreal conifer, black spruce (*Picea mariana*), responds to climate change conditions for gene expression and physiological processes, and what is the functional linkage between the responsive genes and physiological processes. They used the whole transcriptome sequencing and bioinformatics approaches and also simultaneously measured photosynthesis rate and stomatal conductance of the treated cloned plants. They have identified a large number of genes expressed differentially in response to climate change conditions and associated physiological processes. **Rajora et al** conclude with what physiological and other biological processes are likely to be adversely affected by climate change and what are the implications for the health, adaptation, productivity and fitness of forest trees.

Forest trees may acclimate to changing climate conditions by developing phenotypic plasticity, extending their range to track the changed climate conditions, and adjusting their physiological and other biological processes resulting from genetic and epigenetic changes. Genetic diversity provides the raw material for such acclimation. Therefore, it is important to examine genetic and geographical variation in acclimation capacity of forest trees. **Oksanen et al.** will present results of their investigation of geographical genetic variation in acclimation capacity of silver birch (*Betula pendula*) to warmer temperatures in Finland and relationships with herbivory resistance, phenology and physiology. They will also discuss a novel hyperspectral imaging technique that they have developed and used for plant stress research.

Climate change can induce extreme high and cold temperature and unseasonal frost events. It is, therefore, important to determine the frost tolerance of forest trees in vulnerable areas. **Bahadur et al.** present the results of their investigation on frost tolerance of two *Eucalyptus* species and their interspecific hybrids based on the regulation patterns of reactive oxygen species (ROS), phenolic acids, electrolyte conductance, chlorophyll fluorescence, starch and total soluble sugars. Climate change with increasing temperatures can lead to drought conditions. Forest trees use various genetic, epigenetic, biochemical, physiological, anatomical and morphological mechanisms to cope with drought conditions. The resistance of xylem to cavitation is an important mechanism in drought tolerance. **David-Schwartz et al.** will talk about genetic variation in xylem cavitation resistance as conditioned by tracheid anatomical traits in a Mediterranean drought tolerant pine species, Aleppo pine (*Pinus halepensis*).

Elevated ozone is one of the major air pollutants in forests and forest ecosystems. It has been implicated in the decline of forests resulting from significant abiotic (oxidative) stress. Forest trees respond to elevated ozone, and some of the responses are acclimating and adaptive ones, such as stomatal conductance and ROS removal or detoxification. **Le Thiec et al.** will present the results of their study that examined the effects of ozone on stomatal response of three hybrid poplar cultivars and expression of genes involved in stomatal conductance. In another presentation on the response of forest trees to elevated O_3, **Chen et al.** will discuss their findings on the response of a subtropical Chinese species *Machilus pauhoi kanehira* at the protein expression level using the proteomics approach. Differentially expressed proteins in response to elevate O_3 included those involved in stomatal conductance, senescence, disease resistance, defense response, and flower development.

The **second part of Session 3** further explores the integrated understanding of climate and air pollution stress on forest trees and ecosystems across genetic and eco-physiological response levels. As a starting point, **Matyssek et al.** raise the question about extents of currently available knowledge by exemplifying beech response (*Fagus sylvatica*) to oxidative stress. For reaching the ecosystem level, two scaling interfaces are functionally crucial, (i) linking genetic control with physiological whole-tree activity, and (ii) embedding individual tree performance into the multi-factorial stand-level interaction network. Oxidative stress is represented by O_3 impact mimicking pathogen attack, as both agents are hardly distinguishable by plants in inciting stress response. Although interface (i) is emphasized in the presentation with differently aged trees from free-air O_3 fumigation experiments each, means of overcoming interface (ii) are outlined by highlighting modelling based on statistical learning theory. In view of (i), overlaps between transcriptome and proteome levels are quantified and interpreted, corroborating up-regulation of defence and O_3 as an "abiotic model pathogen" at increased "regulatory noise". Understanding functional coherence across interface (i) still appears to be at an initial stage. Interface (ii) requires balancing molecular *versus* ecosystemic knowledge, posing another challenge in view of the tremendous tree and ecosystem-level response plasticity. Statistical "support vector machines" open pathways in extending the conventional statistical testing theory towards universality assessments of findings derived from heterogeneous ecological scenarios and across ranges of plasticity in responsiveness.

Plant metabolism, development and emerging morphology arise both from modulative and modificative acclimations to concurrent environmental impacts and adaptations. Both means of coping with environment have been shaped during the plant's evolutionary history through the selection of genomic features proven to be advantageous.

As genotypic plasticity determines ecotypes, modulative and modificative responses, which do not mutually exclude each other, can be superimposed, enabling plants for fine-adjustment in resource utilization. Is it all genetics in plant response? This question is elucidated by **Wieser and Matyssek**, providing new evidence to an old debate by exemplifying how trees tree cope with specific environmental demands. Conclusions are drawn from datasets acquired during 15 years of field research, in a Mediterranean environment.

The predicted rise in global temperature will cause strong regional and temporal effects on isoprenoid emissions in semi-arid environments, so that the competitive balance between plant species may change. Striving for answering "why plants produce isoprenoids", **Velikova** stresses that these compounds are involved in a broad array of protective functions against biotic and abiotic stress. Genetic engineering nowadays allows studying isoprene functions in poplar through knockdown of emission. The role as antioxidants in improving the membrane structure and functionality of the photosynthetic apparatus has been proven. In addition, the suppression of isoprene production induces transcriptional changes and triggers wide rearrangements in the plant metabolome and proteome that minimize impairment at isoprene absence. The vision is that understanding interactions between biogenic emissions and environment will allow for plant selection in landscape architecture and forestry of improved environmental amenity.

The further three presentations follow the rationale of IUFRO Work Party 7.01.02 with ecophysiological focus on "Mechanisms of Action and Indicator Development" under climate change and air pollution impact in forest trees and ecosystems. Related to such impact, **Mikkelsen et al.** raise the issue of UV-induced N_2O emission from plants, given that the gaseous agent addressed here is an important long-lived greenhouse gas and precursor of stratospheric ozone depleting mono-nitrogen oxides. Plants release N_2O in response to the UV component of natural sunlight, with UV-A being more important than UV-B given the natural UV spectrum at Earth's surface. N_2O emission also occurs in darkness, although at reduced rates, being dependent on temperature dependent as requiring high activation energy. N_2O being formed at leaf surfaces as depending on atmospheric oxygen in addition to UV, only about 26% appears to originate from plant-internal nitrogen. Apparently, ecosystem N_2O emission may be up to 30% than widely assumed.

As air humidity is predicted to increase in Northern latitudes, **Sõber et al.** report on a five-year free-air humidity manipulation experiment on saplings of hybrid aspen and silver birch trees conducted in Estonia. Acclimation to high air humidity incipiently limited annual aboveground growth and allocation to fine roots before increases occurred towards the end of the study period. Birch was more responsive than aspen. Acclimation in growth rate was accompanied by changes in leaf secondary metabolism and chemical composition of wood. Wet soil amplified negative impact of enhanced air humidity and macroscopic leaf injury during wet springs. Drought alleviated growth limitation under high air humidity and fostered stimulation when exacerbating. Conclusions are drawn about effects of increasing air humidity on tree development in arid regions.

Sakikawa et al. explore insect feeding behavior on white birch on early and late-flushing leaves under elevated O_3, generated by free-air fumigation technology. Leaf phenology indicated similar leaf formation in ambient air (control) and under the enhanced O_3 regime. In ambient air, the number of attached leaves per shoot decreased after mid-July due to grazing by beetle larvae, as photosynthesis and the N level stayed higher than observed under the enhanced regime.

Levels of condensed tannins in early leaves were distinctly enhanced under the high O_3 regime so that ovipositing of female beetle adults is expected to become reduced on leaves under high O_3 exposure. Depending on leaf phenology, O_3 may act indirectly in foliar defense against leaf beetles.

Dr. Om Rajora is a Professor of Forest Genetics and Genomics at the University of New Brunswick. He was awarded the Senior Canada Research Chair in Forest and Conservation Genomics and Biotechnology.

Prior to joining the University of New Brunswick, Dr. Rajora was a Professor and StoraEnso Senior Chair in Forest Genetics and Biotechnology at Dalhousie University, Halifax, and an Associate and Assistant Research Professor at the University of Alberta, Edmonton.

He is the Coordinator of IUFRO units 2.04.01 "Population, Ecological and Conservation Genetics", and 7.01.04 "Impacts of Air Pollution and Climate Change on Forest Ecosystems – Genetics Aspects". Dr. Rajora is also an Honorary Adjunct Professor at TERI (The Resources and Energy Institute) University, New Delhi, India and Associate Editor or Editorial Board member of several international journals. He continues to serve on many national and international science advisory boards and committees. He has received many awards and honors. Dr. Om Rajora has expertise and extensive research experience in molecular, population, conservation, ecological and evolutionary genetics, genomics, biotechnology and breeding of forest trees.

Prof. Dr. Rainer Matyssek

Full-time professor at "Technische Universität München", head of Chair of Ecophysiology of Plants - Department of Ecology and Ecosystem Management (1999-).

Coordinator of Working Group 7.01.02 "Mechanisms of action and indicator development" within IUFRO Division 7.01 "Forest Health, Impact of Air Pollution and Climate Change on Forest Ecosystems" (2008-).

- Leader of Working Group (WG2) "Scientific gaps and modelling" within COST Action FP0903 "Climate Change and Forest Mitigation and Adaptation in a Polluted Environment" (2009-2013).
- National coordinator in Germany for COST Action E12 Eurosilva "European Initiative on Tree-Physiological Research", Working group leader (WG 3) "Biotic and Abiotic Interactions" (1995-2000).
- Co-editor of refereed scientific journals and book series: "Trees – Structure and Function" (1997-); "European Journal of Forest Research" (2005-); Subject Editor "Ecology" of Springer book series "Progress In Botany" (2014-).
- Elected member of "The National Academy of Sciences, Leopoldina" (2013) & Elected corresponding member of the "Académie d'Agriculture de France" (Paris, France, 2014).

Effects of climate change on gene expression and associated physiological processes in a Boreal conifer

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Abstract

Global climate change is subjecting our forests, especially boreal and temperate forests, to significant stresses, which can negatively impact their adaptation, health, productivity and fitness by affecting expression of genes and linked physiological processes. In order to develop meaningful measures for mitigating the negative impacts of climate change, it is critical to understand the effects of anticipated climate-change conditions on gene activities and linked physiological processes. We have addressed this aspect in an ecologically and economically important North American boreal forest tree species, black spruce (*Picea mariana*). We have used NGS whole transcriptome sequencing from the cloned genotypes of black spruce treated with elevated CO_2, drought, and combined elevated CO_2 and drought conditions to identify, annotate and characterize genes expressed differentially in response to these conditions. Photosynthetic rate and stomatal conductance were measured simultaneously with tissue collection for RNA extraction for the plants subjected to the combined elevated CO_2 and drought treatment. Several thousand genes involved in over 100 physiological and other biological processes and molecular functions showed differential expression (up-regulation, down-regulation or treatment-specific expression) in response to elevated CO_2, drought and/or their combined conditions. About 50% of the differentially expressed genes (DEG) were in response to the elevated CO_2 treatment. The most notable DEG-associated physiological processes include photosynthesis, stomatal conductance, oxidative stress response, glycolysis, chlorophyll, lignin, ethylene, amino acid and terpene biosynthesis, signal transduction, plant defense response, drought, cold and heat-shock responses, and IAA and brassinosteroid responsive pathways. The photosynthesis and stomatal conductance measures corresponded with the expression levels of certain genes. Overall, it appears that elevated CO_2 and combined elevated CO_2 and drought conditions may negatively impact photosynthesis, chloroplast integrity, removal power of ROS and tolerance to oxidative stress, disease and insect resistance, drought tolerance, and osmoprotection in boreal spruce species.

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Adaptation and acclimation of silver birch (*Betula pendula)* provenances in a common garden experiment

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Abstract

The climate change scenarios predict that the temperature will increase by 2-5°C by the year 2100 in the northern Europe, with the consequences that the thermal growing season will lengthen by 30-40 days and the effective heat sum will double in this area. We study geographical variation in acclimation capacity of silver birch (*Betula pendula*) to warming climate in a long-term multi-site common garden experiment, where altogether 26 genotypes, originating from six natural Finnish populations and representing a south-north cline of 60-67°N, grow in three sites along an equal latitudinal cline (www.uef.fi/birchadaption). The plant material is fully cloned from naturally regenerated stands and the southward latitudinal shift of birch origins resembles the future temperature conditions. Therefore, the experimental design enables examining the phenotypic plasticity and the acclimation/adaptation mechanisms of birch populations, as well as the consequences e.g. on herbivore resistance. The results show that there is extensive genetic variation among the birch populations, but instead of a clear latitudinal cline, the populations fall into two coarse groups: the southern and the northern populations, as indicated by the results from insect herbivory resistance, tree phenology, growth and photosynthetic studies. For example, the northern provenances showed higher total photosynthesis and stomatal conductance than the southern provenances. Also, the growth termination of the northern populations appears to be more strictly controlled by the photoperiod than the termination of the southern populations. The flavonoid and triterpenoid contents on leaf surface differed among the genotypes and provenances, implying that these compounds may have a role in adaptation to different light and/or climatic conditions. Besides the field experimentation, we have developed and applied novel hyperspectral imaging techniques (www.spectromics.org) for plant stress research. Spectral and fluorescence imaging data are combined with plant chemistry to promote fast and non-destructive monitoring of plant stress reactions, phenotyping and genetic research.

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Determining the frost tolerance potential of commercially important *Eucalyptus* species in South Africa

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Abstract

Currently *Eucalyptus* plantations in warm and cool temperate areas of South Africa are being exposed to damaging extreme high and low temperatures and unseasonal frost events. It is therefore necessary to identify and select species that are tolerant to these conditions for establishment on these sites, and responses to cold shock offers a means for this type of selection. In this study, the cold shock responses of *E.grandis*, *E.nitens* and 8 characterized *E.grandis* x *E.nitens* (GN) hybrids were evaluated as an indication of their frost tolerance potential, based on the levels of reactive oxygen species (ROS), phenolic acids (PA), electrolyte conductance (EC), chlorophyll fluorescence (CF), starch and total soluble sugars (TSS). Plants were subjected to standard conditions of 25^0C day/14^0C night temperature and a 12h photoperiod for 7 days and subsequently cold shocked at 5^0C for 24h. Frost conditions were simulated by freezing leaf discs from 2^0C to -6^0C at a rate of -4^0C/h with an hour hold at -6^0C. The ROS levels were variable between GNs and the possibility of ROS signalling was evident in *E.grandis* and two GNs with the up-regulation of ROS 30-90mins into the cold shock. The PA levels were stable in all of the tested material except for one GN where levels more than doubled under cold shock. The EC of frozen and unfrozen samples fluctuated marginally over the experimental period with the exception of two unfrozen GNs and frozen *E.grandis* samples under cold shock which had higher EC levels. CF was unaffected over the experimental period with the exception of three GNs. Starch and TSS assays are currently being completed. The results to date therefore seem to indicate that all the tested eucalypts, except two GNs, are tolerant to the cold shock treatment, with *E.grandis* appearing most sensitive to cold shock and simulated frost.

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Genetic variation in cavitation resistance driven by anatomical traits in *Pinus halepensis*

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Abstract

Climate change, which is leading to increased mean temperatures and, in the Mediterranean, to decreases in annual precipitation, may be too rapid to allow adaptation of long lived forest trees to the new environment. Trees use various strategies to cope with arid conditions. However, accumulating evidence suggests that an important factor in drought tolerance is the resistance of xylem to cavitation. Previous studies on various tree species reported very limited within-species genetic variation in resistance to cavitation. Here, we studied genetic variation in *Pinus halepensis* (Aleppo pine), which is a widespread species in the Mediterranean basin and one of the most drought-tolerant pine species. We measured hydraulic safety and efficiency and tracheid anatomical traits in several provenances and found genetic variation. This variation was supported by anatomical measurements that showed a positive correlation between conductivity and tracheid lumen diameter. Provenances were also varied in their cavitation resistance, which was expressed as the xylem pressure inducing 50% loss of conductivity (P_{50}). Moreover, analyses of the bordered-pit function and structure revealed differences in valve strength that was correlated to variation in pit aperture area. We suggest that adaptation of *P. halepensis* to xeric habitats has been accompanied by modifications of bordered-pit structure and function to better prevent embolism formation and spread under drought.

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Distinct responses to ozone of stomata in three poplar genotypes

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Abstract

Tropospheric ozone acts as a phytotoxin which produces an oxidative stress in plants. Two ways of defense are used, either by preventing ozone input through the regulation of stomatal conductance, or by detoxifying ozone and ROS in cells. It is known that stomatal movements are altered by ozone. We performed fumigation experiment on three euramerican poplar genotypes (*Populus deltoides x Populus Nigra: 'Carpaccio', 'Cima' and 'Robusta'*), cultivated in pots in phytotronic chambers submitted to 120 ppb ozone or filtered air. We explored the effects of ozone on stomatal responses to four environmental parameters (blue light, red light, CO_2 and VPD). We also find out using a porometer that the decrease of stomatal conductance due to ozone is earlier on the adaxial face than on abaxial face. Finally, to better understand these impacts, we studied ultrastructure of guard cells by TEM, stomatal density and size of stomata by SEM, and we performed X-ray microanalysis of guard cells mineral content. These approaches are coupled with the study on microdissected stomata of expression of genes involved in regulation of stomatal movements

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Proteome analysis of proteins responsive to ambient and elevated ozone in *Machilus pauhoi kanehira* seedlings

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Abstract

Towards the beginning of the twenty-first century, ozone has become a pollutant of great concern, regarding its impact on trees and forests, although the role of this agent in forest decline of the eastern USA and Europe has remained controversial. Amongst the developing regions, China and central Africa, in particular, may become new "hot spots" of high O_3 regimes. Although the physiological and morphological responses of tree seedlings to elevated ozone have been well characterized, little is known about the protein responses. We firstly investigated the protein responses in *Machilus pauhoi kanehira* seedlings under ambient and elevated ozone stress by a proteome approach in subtropical China. Seedlings were exposed to non-filtered air and elevated ozone (200ppb) in open top chamber for one month. Forty-five proteins were differentially expressed, including twenty five down regulated and twenty up regulated after exposure to elevated ozone. Only twenty proteins were identified including the proteins involved with stomatal movement, senescence, disease resistance, defense response and flower development. Further Bioinformatics analysis of the proteomics data has revealed the internal and external interaction networks among the key molecules and the relevant cell processes and phenotypes, and therefore indicated the potential mechanism of the role played by those differentially expressed proteins in response to ozone. These results showed that elevated ozone changed the protein expression in leaves, which led to biochemical and functional change in plant.

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Can we link genetic control with physiological activity ? Exemplifying beech response (*Fagus sylvatica*) to oxidative stress

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Abstract

Mechanistic analysis retracing cause-effect relationships towards ecosystemic understanding is indispensible for reliable risk assessment under environmental stress. Scaling enables the required integration of mechanisms that differ by spatio-temporal resolution. Two interfaces are ecologically crucial, (i) linking genetic control with whole-plant physiology, (ii) embedding the individual into the multi-factorial stand-level interaction network. The presentation will emphasize interface (i) by exemplifying differently aged beech under variable growth conditions as responding to ozone (O_3) and/or pathogenic stress. Both oxidative agents are hardly distinguishable by the plant in inciting its stress response. In adult forest trees under free-air fumigation, O_3 caused "noise" in gene expression, although consistencies emerged with changes in resource allocation and stomatal control. In younger trees, gene responses sharpened as coordinated regulation of all shikimate pathway genes became apparent, with overlaps even between transcriptome and proteome levels of two enzymes. Transcripts proved expression of salicylic acid conjugates, metabolites for ethylene biosynthesis and pathogenesis-related proteins. Down-regulation was apparent of structural mesophyll features and the Calvin cycle, for which reduced protein levels were assessable. As most defence genes were up-regulated upon O_3 or pathogenic impact, the view on O_3 as an "abiotic model pathogen" was corroborated. A scaling scheme will gather the molecular evidence from the different beech ages for exploring the mechanistic coherence between the gene and whole-plant level. Such coherence across interface (i) still reflects an initial stage. Interface (ii) is equally important for providing findings to stand-level risk management. To this end, molecular understanding is not a goal *per se*, given the challenging interface (i) and need for balancing molecular *versus* ecosystemic knowledge. Bottom-up (interface i) and top-down (interface ii) approaches must meet *via* merging whole-plant and stand-level resource allocation. Functional stand-level disorder must ultimately become traceable to affected plant-functional groups and such molecular evidence being essential for risk interpretation.

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Is it all genetics? New evidence on an old issue

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Abstract

Morphology, development and metabolism of plants display modulative and modificative acclimations to concurrent environmental impacts and adaptations that have emerged from evolutionary history upon genetic changes enabling for selective advantage. Modulative acclimation (≈functional flexibility) occurs rapidly and is of temporary nature, whereas modificative response (≈phenotypic plasticity) adjusts to the statistically predictable "average" site conditions during the growing season. Evolutive adaptations (≈.genotypic plasticity) are hereditary and determine ecotypes. Modulative, modificative, and evolutive responses do not mutually exclude each other, but can be superimposed, enabling plants for fine-adjustment in resource utilization. Here we provide examples from the life form tree, on how the three plant "options" for coping with environmental stress act in concert at the alpine timberline. This research issue having been started 35 years ago for unraveling plant adaptations to local radiation climate (as highlighted by Larcher 1980), can now be extended by recent evidence. The interaction between genetic control and physiological activity will be demonstrated in warranting tree persistence in a harsh environment.

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Biogenic volatile isoprenoids – strategies for sustainable forestation in changing environment

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Abstract

Volatile isoprenoids (VIP) are released by vegetation to the atmosphere in significant quantities. They can strongly contribute to the global change and play a crucial role in atmospheric composition. Volatile isoprenoid emissions are controlled by environmental variables (e.g. temperature, light, water availability, ambient CO_2 concentration). The predicted rise in global temperature will cause strong regional and temporal effects on isoprenoid emissions by the semi-arid environments. This alteration in the physical environment will change the balance of competition between plant species, to the benefit of species better adapted to the predicted climatic conditions. On the other hand, the production of VIP is metabolically and energetically costly for the plants and their release represents a non-trivial loss of carbon. Numerous studies have been also made to understand the physiological role of VIP, their biosynthetic routes, the molecular mechanisms that regulate their formation and functions. By searching the answer of the question "why plants produce isoprenoids" it became clear that they play not only significant role in biosphere – atmosphere interactions, but they are also involved in a broad array of protective functions against biotic and abiotic stresses. Genetic engineering nowadays allows studying the function of isoprene in poplar knockdown in natural isoprene emission. The role of VIP as antioxidants and in improving the membrane structure and functionality of the photosynthetic machinery is experimentally proven. Even more, the suppression of isoprene production at control conditions induces transcriptional changes and triggers wide rearrangements in plant metabolome and proteome to minimize the negative stress effects resulting from isoprene absence. By exploring the relationship biogenic emissions - environment it will allow selecting the most environmentally friendly plant species to be used for landscape architecture and forestation of areas with different levels of pollution, which in turn is related to air quality and human health.

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UV-induced N2O emission from plants

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Abstract

Nitrous oxide (N_2O) is an important long-lived greenhouse gas and precursor of stratospheric ozone depleting mono-nitrogen oxides. The atmospheric concentration of N_2O is persistently increasing; however, large uncertainties are associated with the distinct source strengths. Here we investigate for the first time N_2O emission from terrestrial vegetation in response to natural solar ultra violet radiation. We conducted field site measurements to investigate N_2O atmosphere exchange from grass vegetation exposed to solar irradiance with and without UV-screening. Further laboratory tests were conducted with a range of species to study the controls and possible loci of UV-induced N_2O emission from plants. Plants released N_2O in response to natural sunlight at rates of c. 20-50 nmol m^{-2} h^{-1}, mostly due to the UV component. The emission response to UV-A is of the same magnitude as that to UV-B. Therefore, UV-A is more important than UV-B given the natural UV-spectrum at Earth's surface. Plants also emitted N_2O in darkness, although at reduced rates. The emission rate is temperature dependent with a rather high activation energy indicative for an abiotic process. The prevailing zone for the N_2O formation appears to be at the very surface of leaves. However, only c. 26% of the UV-induced N_2O appears to originate from plant-N. Further, the process is dependent on atmospheric oxygen concentration. Our work demonstrates that ecosystem emission of the important greenhouse gas, N_2O, may be up to c. 30% higher than hitherto assumed.

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Acclimation of deciduous trees to increasing air humidity and interacting environmental drivers

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Abstract

Forest ecosystem vulnerability, induced by globally increasing temperatures, could be modified by co-occurring regional changes in atmospheric humidity. As air humidity is predicted to increase in Northern latitudes, free air humidity manipulation (FAHM) experiment was designed in Estonia. Saplings of hybrid aspen and silver birch trees where grown under 7% higher relative humidity, (RH) in years 2008-2012. Both species acclimated to alevated RH so, that annual aboveground growth decreased and allocation to fine roots increased during first years of experiment. A subsequent increase in annual growth followed during next two years. The growth rate of birch recovered, but growth rate of hybrid aspen stabilized at lower (compared to initial) level. The growth of buds was negatively affected in birch (all years), but this decrease was not signifficant in aspen. Acclimation in growth rate was accompanied by changes in leaf secondary metabolism and chemical composition of wood. The significant interaction was found between RH and soil moisture effects. Wet soil amplified negative impact of elevated RH and visual damage of young leaves occurred in wet springs. Drought alleviated negative effect of elevated RH and turned negative effect to positive in extremely dry year of 2011. If we could extrapolate our findings, we predict, that elevated RH should probably increase growth rate of trees in Mediterranean region, where draught conditions usually prevail.

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Plant defense and photosynthesis of Japanese white birch saplings grown under a free-air O3 fumigation system

Tetsuichi Sakikawa [(1)], Masahiro Nakamura [(2)], Makoto Watanabe [(3)], Sayako Kanie [(1)], Fuyuki Satoh [(2)] and **Takayoshi Koike** [*(1)]

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Abstract

Ground-surface ozone (O_3) is continuously increasing in Northeast Asia even though local precursors have been decreasing. At elevated O_3, photosynthetic rate is usually suppressed, which may reduce plant defense because its chemicals originate from carbon-based secondary compounds. Therefore, we expect an increase of grazing damages by insect herbivores. As plant production is closely correlated with leaf area of tree canopy, insect grazing of leaf surely reduces photosynthetic production. The reduction is also related to attacks of insect herbivore. Our aim was to explore an insects' feeding behavior on white birch with structured early and late leaves under elevated O_3. To reveal this, we monitored seasonal change in leaf phenology and insect's individuals in saplings grown under ambient air (AA) and under free-air O_3 fumigation (60 nmol mol^{-1} for daytime; EO). First, we predicted the decrease in shoot growth and the number of late leaves due to decrease of defense capacity of late leaves under early leaves at EO. Leaf phenology indicated that the total number of emerged leaves per shoot was almost the same between AA and EO; however, the number of attached leaves per shoot at AA decreased after mid-July due to grazing by larvae of the leaf beetle. Photosynthetic rate and leaf nitrogen (N) at EO were lower than those at AA in summer 2014. Allocation of N in leaf to Rubisco at EO was significantly suppressed except LHCP and electron transport. Concentration of condensed tannin in early leaves in EO was about 4.0 mg/g higher than that of leaves in AA. Female adults of the leaf beetle may avoid ovipositing on leaves exposed to EO. These findings lead to the plausible understanding of indirect effect of elevated O_3 on leaf phenology via foliar defense of white birch against leaf beetles.

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Session 4 "Health and growth of forests: bridging monitoring and modeling"

Wednesday 3rd June, 2015
13:30-17:45

Chairs: Alessandra De Marco and Salim Belyazid

Objective of this session is to highlight the use of different modeling approach as an essential tool to bridge the knowledge gaps in different scientific domains (air pollution, atmospheric deposition, climate change, forest impacts in terms of growth, health, yield, distribution and biodiversity loss) in order to: translate environmental observations and predictions into future scenarios; improve understanding of interaction between climate change, air pollutants and impacts on forest ecosystems; quantify the ecological responses under changing climate conditions on forest ecosystems; reduce uncertainties of current climate prediction; identify hot spot regions where action is needed; provide risk maps for forests at regional and local scale and propose adaptations and recommendations to forest ecosystem policy and management practices. The speaker, rather than the lead author is highlighted in the overview that follows.

De Vries et al. propose results of the combined effects of N deposition, O_3 exposure and climatic conditions on the forest ecosystem carbon balance by both an integrated analysis of growth, climate and deposition data of nearly 400 ICP-Forests level II plots across Europe during 15 years (1995 to 2010) and simulations for the period 1990–2050. **Escobedo** presents a landscape level analysis of the spatial-temporal effects of climate change - in the form of hurricanes and urbanization- on ecosystem services using models and available inventory data. The use of a similar approach for assessing the cost effectiveness of reforestation on ozone removal will also be discussed. **Feng et al.** present the dose-response relationships for risk assessment of O_3 on poplars in China, on the basis of the measurements of stomatal conductance (gs) and biomass of five poplar clones. A calibrated gs model was used to estimate the accumulated stomatal flux of O_3 above the threshold value. A literature survey allowing to investigate the key components of stomatal response to environmental factors (i.e., light intensity, temperature, air humidity and soil moisture) on Siebold's beech (Fagus crenata), the representative species in cool-temperate forests in Japan, will be presented by **Hoshika et al**. A analytical model is proposed based on the optimization model of stomatal conductance for maximizing carbon gain while minimizing accompanying water loss and ozone influx. Unlike temperate regions, where ozone (O_3) formation is seasonal, in tropical environments, O_3 concentrations shows, in an annual basis, little variation and no clear seasonality. **Moura et al.** present sensitivity to O_3 stress of leaves grown in different seasons. Indeed, in the state of Sao Paulo/Brazil, the seasons are determined by rainfall, and only a dry, and a wet season are identifiable. **Clímaco de Melo et al.** will focus on the fundamental role that the climate exerts on the geographic distribution of forest species, whose biota suffers different environmental pressures. In a map of probability of future occurrence it was observed that climate change may critically influence the organization and survival of some species. **Rizzetto et al.** estimated the impact of atmospheric Nitrogen deposition on forest ecosystem using a dynamic biogeochemical-ecological coupled model (ForSAFE-Veg) applied on three well known French forested sites.

The first results of plants biodiversity response to two atmospheric Nitrogen deposition scenarios are presented following a thorough calibration process of the ecological model Veg, based on two different ecological databases: the Veg table and the French EcoPlant database. **Badea et al.** identified the main climate drivers for tree growth, using basal area increment as a synthetic indicator. The growth reduction due to extreme climate years is significant only in case of oak species from south-eastern Romania where growth is constrained by drought and high temperature during the summer. **Seidling et al.** report the consideration that forests are subjected to multiple influences occurring on various scales which accumulate within e.g. the parameter 'defoliation'. To answer questions on the status of forests these factors need to be distinguished and included within statistical analysis. **Liampas et al.** present the HEPOS (Hellenic Positioning System) that consists of a network of 98 permanent satellite reference stations and a control centre located at the premises of the Cadastre SA.

Ledermann et al. developed a climate sensitive forest growth model and a stand risk model using meteorological data and data from the Austrian National Forest Inventory (ANFI), to simulate potential growth of Norway spruce under current climatic growth conditions and under various scenarios of climate change using these newly developed models. It is thus estimated the spatial pattern of potential growth of Norway spruce in Austria and how it is affected by climate change. Looking at the quality of data **Kozlov et al.** show that observer can unconsciously bias the results of observations. It is likely that confirmation bias is widely distributed in ecology. The use of blind methods is recommended whenever possible to minimize the impacts of confirmation bias on the results of ecological studies, and to mention the use of blind methods in publications. The benefits arising when monitoring is coupled with modeling techniques will be highlighted by **Ferretti et al**, to identify possible critical areas, and to emphasize that high-quality data are essential for models aiming at predicting air pollution effects on forest health and growth. **Schaub et al.** will put emphasis on European scale analyses for i) spatial and temporal trends for ozone concentration; ii) different AOT40 assessment methodologies; iii) comparison between measured concentrations with passive samplers, respective AOT40 estimates and modeled EMEP outputs; and iv) foliar injury occurrence in relation to ozone concentration and ozone exposures respectively. **Andivia et al.** present an ecosystem-scale model that dynamically combines a complete regulation of nutrient uptake by roots and mycorrhizas, according to tree nutrient demand, with soil chemistry reactions, nutrient retranslocation within the tree and with a mechanistic and physiological simulation of nutrient limitation effects on tree C assimilation and allocation.

Dr. Alessandra De Marco is a research biologist at the Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA).

Deputy of IUFRO Working Group 7.01.05 “Modelling and Risk assessment” under Impacts of Air Pollution and Climate Change on Forest Ecosystems.

Italian delegate to ICP-Modelling and Mapping (2002-); Italian delegate to ICP-Vegetation (2005-); Head of Italian delegation to Working Group on Effects (2013 under the CLRTAP.

Main interest field are: the impacts of air pollution on vegetation, with particular interest on tropospheric ozone and nitrogen deposition; climate change and air pollution interactions and their synergistic impacts on natural and anthropogenic ecosystems; integrated assessment modeling to estimate beneficial effects of policies and measures to reduce air pollution. She is looking forward to seeing everyone at the meeting!

Dr. Salim Belyazid, Assistant Professor at the Centre for Environmental and Climate Research at Lund University (Sweden) and Consultant at Belyazid Consulting (Sweden)

Coordinator of IUFRO Working Group 7.01.05 "Modelling and Risk assessment" under Impacts of Air Pollution and Climate Change on Forest Ecosystems.

He obtained a PhD in Chemical Engineering, Ecosystem chemistry at Lund University. Main interest field are: Systems Analysis, Ecosystem process modelling and Science for policy application.

Assessment of impacts of nitrogen deposition, ozone exposure and climate change on carbon sequestration by monitoring and modeling

W. de Vries *[1,2], S. Etzold [3], M. Posch [4], G. J. Reinds [1], L.T.C. Bonten [1], S. Solberg [5], P. Waldner [3], M. Schaub [3] and D. Simpson [6, 7]

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Abstract

Carbon sequestration of forest ecosystems is influenced by various drivers including changes in climate (temperature and water availability), nutrient (nitrogen, base cations, phosphorous) availability, carbon dioxide (CO_2) exposure and ozone (O_3) exposure. The combined effects of these drivers in forests and forest soils can either be synergistic (amplifying), antagonistic (dampening) or neutral (no interaction). An integrated analysis of 15 years (1995 to 2010) of growth, climate and deposition data was used to derive quantitative relationships between N, S and O_3 exposure and ecosystem carbon balance, accounting for differences in climatic conditions. Growth data of 392 even-aged ICP-Forests level II plots across Europe, dominated by beech, oak, spruce and pine trees were jointly analysed with meteorological data and deposition data derived from the Climatic Research Unit dataset and EMEP model results, respectively. To account for the impact of stand structure on forest increment, relative growth was calculated as residuals of a linear regression model of actual increment vs stand density index and age of the forest. Changes in the residuals could then be attributed to changes in environmental conditions. We also modelled the combined effects of past and expected future changes in those drivers on carbon sequestration in European forests and forest soils for the period 1990–2050. A forest growth model was coupled to a soil model predicting both tree and soil carbon sequestration in response to N deposition and climate change. For the future (2010-2050) we used two scenarios for deposition (current legislation and maximum technically feasible reductions) and two climate scenarios (no change and SRES A1 scenario). First results of both the monitoring study and simulations will be presented during the meeting and the combined results will be used to evaluate the combined effects of N deposition, O_3 exposure and climatic conditions on the forest ecosystem carbon balance.

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Modeling and mapping the spatial and temporal effects of landuse and climate change on forest ecosystem services

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Abstract

We mapped and modeled the effects of hurricanes as a proxy for climate change and urbanization as a proxy for landuse change on 3 ecosystem services: aboveground carbon (C) stocks, timber volume, and water yield. Using land cover data, available plot-level forest inventory data, hurricane-forest damage risk zones, decision tree based frameworks, the Integrated Valuation of Ecosystem Services and Tradeoffs model, and a human population distribution model; we determined the potential damage to forests from hurricanes and urbanization in the rural Lower Suwannee River (LS) and urbanized Pensacola Bay (PB) watersheds in Florida, US. Results show that 31% and 0.5% of the total aboveground carbon storage in the LS and PB respectively was located in high hurricane forest damage risk (HR) zones. The 15% and the 0.7% of the total timber net volume in the LS and PB respectively was under HR zones. Urbanization effect results show that C storage and timber decreased, but water yield increased during 2003-2060 in both watersheds. The use of this modeling approach for mapping hotspots and analyzing the use of reforestation as an ozone compliance policy are discussed as well. Understanding how climate change drivers influence the spatial and temporal dynamics of ecosystem services provides decision makers and planners the information necessary to develop regional-level modeling and management scenarios. The approach can also be used to design mapping and monitoring protocols for climate change assessments and identifying forests and communities susceptible to climate change impacts.

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A stomatal ozone flux-response relationship for five poplar clones widely planted in China

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Abstract

To assess regional effects of ozone (O_3) on poplar species whose planting area in China ranks first in the world, we developed a flux-based dose-response function for poplar. In this study, five poplar species (*Populus alba* × *Populus glandulosa*, *Populus* × *euramericana* cv. '74/76', *Populus deltoides* × *Populus cathayana* cl. 'Senhai 2', *Populus deltoides* cl. '55/56' × *Populus deltoides* cv. 'Imperial', *Populus deltoides* × *Populus cathayana* cl. '156') widely planted in Northern China were exposed to O_3 concentrations ranging from around 48.2 ppb (6:00-18:00) in the non-filtered air treatment up to 69.1 ppb (6:00-18:00) in the fumigated treatments. Measurements of stomatal conductance (g_s) on these five poplar species were used to calibrate a Jarvis-type multiplicative g_s model. The maximum g_s as well as other model parameters varied between species. The model includes functions describing the reduction of g_s of senescing leaves and the direct effects on g_s by light, temperature and water vapor pressure deficit. Comparison between simulated and observed g_s for the five poplar species resulted in an R^2 value at 0.55. The calibrated g_s model was used to estimate the accumulated stomatal flux of O_3 above the threshold value. The strongest relationships between relative O_3 effects on aboveground biomass and total biomass were obtained when POD was integrated using an uptake rate threshold of 8 nmol m^{-2} s^{-1} (POD_8) with an R^2 value of 0.89 over all five poplar species. The R^2 value was close to that for the corresponding relationship based on the accumulated ozone exposure over 40 ppb (AOT40; R^2 value of 0.86 and 0.89 for aboveground biomass and total biomass, respectively).

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To develop stomatal conductance modeling under elevated ozone in forest trees

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Abstract

Ozone enters leaves via stomata and causes a damage to leaves of trees. Modeling of stomatal conductance is considered as an essential factor to assess ozone impacts. In this presentation, recent developments for the modeling of stomatal conductance are summarized: 1) stomatal conductance parameters for the Jarvis-type model of forest trees throughout the world. A literature survey allowed to investigate the key components of stomatal response to environmental factors (i.e., light intensity, temperature, air humidity and soil moisture) according to the Jarvis-type model in forest plant functional types, and 2) an optimization model of stomata including ozone effects based on free-air ozone exposure experiment on Siebold's beech (*Fagus crenata*), the representative species in cool-temperate forests in Japan. To discuss the effect of ozone on stomatal conductance, we applied the optimal stomatal model involving water, CO_2 and ozone flux using gas exchange data of Siebold's beech. A analytical model was proposed based on the optimization model of stomatal conductance for maximizing carbon gain while minimizing accompanying water loss and ozone influx. Regarding 1), we found no significant difference across forest types' g_{max} (maximum stomatal conductance), which is the most important parameter in predicting stomatal conductance in the Jarvis-type model. The optimal temperature of stomatal conductance and stomatal response to predawn water potential changed according to the growth conditions. Regarding 2), the optimal stomatal model explained ozone-induced stomatal closure in early summer. This suggests that ozone-induced stomatal closure may reduce ozone influx, and allow maximum photosynthetic capacity to be reached. However, in late summer and autumn, the model did not explain the effects of ozone on stomatal conductance. Also an increase of y-intercept of photosynthesis-stomatal conductance relationship (g_{min}, minimum conductance) was found. This reflects the loss of closing response of stomata by ozone (i.e., stomatal sluggishness) such as under low light conditions.

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Variation in O_3 symptom development in plants exposed to tropical environments

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Abstract

Unlike temperate regions, where ozone (O_3) formation is seasonal, in tropical environments, O_3 concentrations show, in an annual basis, little variation and no clear seasonality. In the state of Sao Paulo/Brazil, the seasons are determined by rainfall, and only a dry, and a wet season are identifiable. Due to plants's phenotypic plasticity, leaves grown in different seasons may differ, which affects their sensitivity to O_3 stress. In this presentation, we intent to discuss two questions regarding the O_3 response of two species exposed to tropical conditions: 1) What are the climatic conditions that favor O_3 effect in tropical environments? 2) What are the leaf structural characteristics that increase the risks of O_3 damage? Based on recent data, we intent to demonstrate how O_3 levels and climate conditions vary throughout the year in the city of São Paulo/Brazil. We will also show that the leaf development of *Ipomoea nil* 'Scarlet O'Hara' is different during distinct seasons, i.e., thicker leaves, with higher stomatal density are formed during the wet season, when the development of O_3 symptom is positively correlated with stomatal density. In contrast, during the dry season, O_3 symptom is positively correlated with the palisade parenchyma thickness. In addition, differences in development of visible symptoms occurs throughout the year in *Astronium graveolens*. In the later species, besides the O_3 levels, high temperatures and high solar radiation play a role in O_3 symptom development, a situation in which plants present up to 83% of their leaves with O_3 symptom. We concluded that the two species mentioned above may exhibit heterogeneous responses to O_3 stress in tropical environments and that the O_3-flux concept must be a key to understand O_3 effects in plants exposed to tropical conditions.

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Prediction of geographic distribution of endangered species of the Brazilian Atlantic forest

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Abstract

The importance of rational use of natural resources has grown in the context of international discussions on climate change. This has motivated the scientific community to conduct studies on the impacts of potential climate scenarios on the society in many spheres. In this context, it has been disseminated the fundamental role that the climate exerts on the geographic distribution of forest species, whose biota suffers different environmental pressures. Considering the condition of stress already suffered by species whose compound the National List of Brazilian Flora Species Endangered, it becomes strategic design how climate change provided for may influence the condition of development and occurrence of populations. Thus, this work aims to simulate the geographic distribution of species endangered in the Mixed Ombrophilous Forest in front to potential future climate scenarios. For this, it was designed 4 climate scenarios of temperature rise (0.3°C; 2.4°C; 4.8°C and 6.0°C), as suggested in the last IPCC report, for the period of 2100 in the State of Parana, Brazil. The modeling related the combination data from naturally occurring species of *Araucaria angustifolia*, *Ocotea porosa*, *Ocotea odorifera* and *Ocotea catharinensis* with the panoramas of climate, delimiting the impact of potential increases in the temperature on the occurrence of the species evaluated. The results demonstrated the low resilience of species facing the warming that probably will occur in the State of Parana in the future. All species would be in the process of geographical retraction, with losses in area favorable to its development between 33% to 100%, the largest and smallest adaptation was given by species *O. odorifera* and *O. porosa*, respectively. Climate change provided for may critically influence the organization and survival of these species, resulting in profound changes in the landscapes and forest ecosystems, representing a negative scene of Brazilian biodiversity.

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Modelling the impact of climate change and atmospheric N deposition on french forests biodiversity

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Abstract

Since the 1980's, within the Geneva Convention on Long-Range Transboundary Air Pollution, European countries have joined their efforts to abate atmospheric acid pollution. Nevertheless, nitrogen emissions and depositions remain significant under ongoing climate change. Nitrogen atmospheric deposition is known to severely impact ecosystem functioning by influencing soil biogeochemistry, nutrients balance and, consequently, tree growth, forest health and biodiversity. The concept of "critical loads" was used and models were improved to mitigate the impacts of N deposition, by considering conjointly effects of climate change and N atmospheric deposition, to assess the evolution of forest ecosystem status over time. The purpose of this study is to predict forest vegetation response to the combine effects of nitrogen atmospheric deposition and climate change by using a dynamic coupled biogeochemical-ecological model (ForSAFE-Veg). The Veg module is composed of 476 understory plant species representative of the main French forest ecosystems, and parameterized for a set of environmental factors based on expert advices. In this study, we propose a new parameterization for six main factors using statistical regressions models based on measured data for about 4000 forest sites. After validation using another independent set of vegetation relevés, the biogeochemical model ForSAFE-Veg was run using the most appropriate Veg module, on three forest sites from the french ICP Forest network. Changes in biodiversity were estimated by analysing the evolution of plants cover over 100 years, and considering the impacts of climate change and atmospheric nitrogen deposition scenarios separately and conjointly. The modelling outputs were considered at both species and ecological functional groups scales, to evaluate their relevance in characterizing nitrogen deposition influence on biodiversity. This will allow generalizing this approach to other species for which environmental factors are not easy to parameterize.

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Effect of climate change on tree growth from intensive forest monitoring network in Romania

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Abstract

The health of forest ecosystems is mainly influenced by the negative action of air pollution and climate changes of different biotic and abiotic factors, and other disturbances. Tree growth and its dynamics at stand level were considered as the main synthetic indicators on stability, functionality and productivity of forest ecosystems. Consequently, the results obtained by complex investigations in the Romanian intensive monitoring network of forest ecosystems (Level II), revealed the distribution of the radial increment and basal area increment (BAI) in relation to the tree health and the uniformity of the biomass accumulation recorded by the healthy trees compared with the damaged trees, respectively. Using basal area increment as a synthetic indicator, the main climate drivers for tree growth were identified. Temperature and precipitation were used as climate indicators as well as several derived indexes like: SPIE, growing degree days – growing season length, number of warm and wet days derived from daily climate date of EOB-S grid dataset. According with species and region different climate response pattern was quantified. Norway spruce (*Picea abies*) growth is mainly limited by current growing season temperature. For beech, an altitude gradient was observed: beech from hilly region was more sensitive to precipitation from May compared with beech from mountain regions. For oak species (*Quercus sp.*) it was established a positive correlation with precipitation amount and drought indexes with difference according with species and region. Detailed climate analysis for extreme years (ex. Drought years) relieves different patterns of climate influence. The growth reduction due to extreme climate years is significant only in case of oak species from south-eastern Romania where growth is constrained by drought and high temperature during the summer. Calibrated growth-climate models were used to simulate the effects of different climate changes scenarios on tree growth.

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Quantifying future climate and site dependent growth deviation in *Picea abies*

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Abstract

Differences between tree species provenances result from adaptation to the local environment by natural selection. Genetically different, a comparison of provenances planted at one location disclose the differences between them. Using dendrochronological methods we sampled Norway spruce (*Picea abies* [L.] Karst) provenances planted at contrasting sites. Complimented by samples from the intensive forest monitoring plots in Germany. Applying our own program CLIMTREG, climate-growth patterns were detected on the basis of daily meteorological data; enabling us to estimate future growth till 2050 and compare the resistance and adaptive potential to a changing climate. Results show clear differences between the provenances with, however, the influence of the local site conditions dominating the overall growth pattern. Climate-growth correlations show patterns changing over time, with acclimatisation becoming clear over the years; thus decreasing the impact of the climate scenarios on growth. While the use of an early calibration period projects a growth decline after 2012, a growth increase is apparent for most provenances using a later calibration period. Differences between the modelled growth up to the year 2055 allows a quantification of the effect of acclimatisation as well as an estimate of the time needed for a tree to do so. Nevertheless, with extremely unfavourable site conditions acclimatisation plays a minimal role. Comparing the response to extreme climatic events (e.g drought year 2003) of the different provenances a relative homogenous pictures underlines the importance of site condition over the genetic differences. These results provide a quantification of adaptive processes as well as allowing a growth prediction for half a century.

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Hellenic Positioning System (HEPOS) in the service of accuracy control in semi-mountainous area

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Abstract

The Global Navigation Satellite System (GNSS) technology has many applications in many fields such as in surveying, in mapping, in forestry etc. All these fields, frequently, requires very high positioning accuracies in real-time. It is known that the positioning precision and accuracy under forest canopy are markedly lower than in areas with unobstructed sky conditions because trees attenuate or brake GPS signals. Several methods were developed to improve the accuracy and the precision on the positioning in difficult environments as are the forest ones. One of these is the implementation of the permanent reference stations. The permanent reference stations were used by government agencies from 1990's and the networking of the permanent reference stations became operational after 2000. The basic idea is to use the information from all reference stations in the network and not only from the nearest station. A reference station acts as a central unit (Control Center), which collects data from all stations of the network. The HEPOS consists of a network of 98 permanent satellite reference stations and a control center located at the premises of the Cadastre SA. The aim of the paper is to investigate the positioning accuracy in Oak forest stands using GPS receiver and HEPOS system in Real Time positioning. The evaluation is carried out by means of a comparison of the results obtained from using of the Leica GS09_GNSS receiver and the implementation of RTK techniques Single-Base, VRS and Network DGPS of HEPOS system, with the coordinates extracted from using the total station Leica TRC 407 whose measurements are taken as «true values». The measurements were carried out in the Public Forest of Vria-Ritini on Olympus Mountain, manages from the Forest Service of Katerini Pierias.

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Analyzing site productivity and stand risk of Norway spruce (*Picea abies* [L.] Karst.) in Austria

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Abstract

Norway spruce (*Picea abies* [L.] Karst.) is the most frequent and most important tree species in Austria covering a large proportion of total forest area. Currently, Norway spruce is growing on sites that range from low altitudes (300 m above sea level) to high altitudes (2000 m above sea level). In some regions Norway spruce is growing outside its natural range. For these reasons Norway spruce is assumed to be highly susceptible to impacts of climate change in terms of stand risk and future growth. Hence, it becomes necessary to analyze potential future growth and vulnerability of this tree species in order to propose adaptations and recommendations to forest management practices. We developed a climate sensitive forest growth model and a stand risk model using meteorological data and data from the Austrian National Forest Inventory (ANFI). We simulated potential growth of Norway spruce under current climatic growth conditions and under various scenarios of climate change using these newly developed models. Based on these simulations we were able to identify regions within Austria where future site productivity of Norway spruce will probably decrease as well as regions where its site productivity will increase. We also analyzed how the recurrence time of storm events affects the length of the optimal rotation period of Norway spruce stands that grow outside their natural range. The results revealed that on some specific sites there is a considerable discrepancy between the optimal and the actual rotation length. Based on these findings we derived some guidelines for the future management of such stands.

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Confirmation bias affects the results of monitoring: a case of leaf fluctuating asymmetry

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Abstract

Fluctuating asymmetry (FA) is often considered an index of stress experienced by an organism. We experimentally tested the hypothesis that the outcomes of studies based on FA measurements may be influenced by confirmation bias, i.e. the tendency of humans to seek out evidence in a manner that confirms their hypotheses. This bias, which is a well-documented phenomenon in psychology and cognitive science, results from automatic processes occurring unintentionally. We formed ten samples from dried and pressed leaves of downy birch (*Betula pubescens*) collected from a single tree (ten leaves in each sample) and asked 30 scientists (experienced in studying FA) to measure FA from the scanned images of these leaves, providing them with the false information about the origin of each sample. When the scientists were told that the leaves originated from a heavily polluted site, the values of FA were significantly higher than the values obtained from the same leaves when the samples were told to be collected from an unpolluted site. When the scientists were told that five samples originated from a heavily polluted site and other five samples from a clean site, the variation in FA among samples was higher than in the case when the same samples were told to be collected from a single tree. We conclude that when the scientists have some expectations on the levels of FA to be found in samples, their measurements are significantly affected by confirmation bias. This bias can be avoided only by using blind method (i.e. the person conducting measurements should not be aware on the origin of samples). However, only two of 30 scientists reported consistent use of blind method when measuring FA. We recommend to use blind methods whenever possible to minimize the impacts of confirmation bias on the results of ecological studies.

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Monitoring and modeling the long-term impact of air pollution on forest health and growth in Europe

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Abstract

European forests have been exposed to air pollutants since decades. While in the past sulphur compounds were of concern, nitrogen deposition, ozone and their interaction with biotic/abiotic drivers have received recent attention for their impact on forest health and growth. Long-term monitoring permit to (i) evaluate the actual impact of pollutants on forests, (ii) improve our understanding of the interactions between pollutants, climate, nutrients and forests as well as (iii) obtain data for modeling present and future forest exposure and response to pollutants, and for model validation. Together, monitoring and modeling have an immense potential for augmenting our insight in understanding, quantifying and predicting air pollution effect on forests. ICP Forests is the largest, long-lasting and most consistent forest monitoring system in Europe. Data cover drivers (e.g. climate, deposition, tropospheric ozone) and responses (e.g. health, growth, phenology, diversity, nutrients). These data have been and are being used in a number of studies based on modeling techniques, from plot-scale to European-scale. Results reveal the importance of monitoring data for detecting trends (e.g. foliar nutrition, its effect on forest health), identifying threshold/exceedance (e.g. critical limits/loads) and their development (e.g. dynamic modeling), identifying relationships (e.g. nitrogen deposition-carbon sequestration; climate and forest health; soil solution, climate, soil and forest characteristics), and for calibrating models for scenario analysis (e.g. economic value of European forests under climate change). They corroborate the importance of coupling monitoring and modeling to improve our understanding of the interconnection among forests, air pollution and climate change, and to predict future condition and sustainability of European forests. We review the results obtained to demonstrate the benefits arising when monitoring is coupled with modeling techniques, to identify possible critical areas, and to emphasize that high-quality data are essential for models aiming at predicting air pollution effects on forest health and growth.

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Ozone risk assessment for European forests – a ten-year study on permanent monitoring plots

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Abstract

Ground level ozone still poses a serious threat to forest ecosystems across Europe and 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 the available data on ozone concentration, exposure, and foliar injury that have been collected at the very forest sites across Europe from approx. 80 – 150 plots and over 1'000 native species. Emphasis will be put on European scale analyses for i) spatial and temporal trends for ozone concentration; ii) different AOT40 assessment methodologies; iii) comparison between measured concentrations with passive samplers, respective AOT40 estimates and modeled EMEP outputs; and iv) foliar injury occurrence in relation to ozone concentration and ozone exposures respectively. Considering stress factors such as drought and physiological response indicators, these analyses will favor a comprehensive evaluation of ozone risk for European forests based on data from the very forest sites. Furthermore, these harmonized data sets will serve as a valuable basis for further integrated analyses and validation of models, such as from EMEP.

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A process-based soil-plant model to assess nutritional limitations on forest growth within a changing environment

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Abstract

A general productivity increase has been reported for European forests over the last century, and has been attributed to a combination of increasing atmospheric CO_2 concentration, temperature and N deposition. Recently reported growth decline and decreased foliar nutritional status suggest that water and nutrient shortage could be major constraints of forest productivity in the future. Whereas change in water availability has been successfully accounted for in existing process-based models, nutrient uptake and the impacts of nutrient shortage are poorly addressed. Existing stand models compare tree nutrient demand with soil nutrient availability without considering the kinetics of transport and absorption and reduce growth to available nutrient levels in case of limitation. To predict how nutritional constraints will affect forest growth response to global change in a large diversity of soil conditions, more complex process-based models coupling the solute transport equation with nutrient absorption kinetics are needed as well as a more precise description of nutrient limitation effect on photosynthesis and allocation. As far as we know, such approaches were only applied to seedlings under controlled conditions. We developed an ecosystem-scale model that dynamically combines a complete regulation of nutrient uptake by roots and mycorrhizas, according to tree nutrient demand, with soil chemistry reactions, nutrients release by litter decomposition and weathering and nutrient retranslocation within the tree. Transport equations were solving by considering that roots and mycorrhizas behave as zero-sinks. This model has been coupled with water and carbon fluxes already accounted for in the ANAFORE growth model (Deckmyn et al. 2008), and a mechanistic and physiological simulation of nutrient limitation effects on tree C assimilation and allocation has been incorporated. The performance of this model is tested by comparing predicted amount of nutrients immobilized in tree structural biomass with the amounts estimated from allometric equations and growth measurements of long-term forest monitoring plots. This new model has the potentiality of assessing how nutrient availability will constraint tree/stand responses to climate change and N deposition under different scenarios.

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Session 5 "Biogeochemistry and multiple stressors"

Thursday 4th June, 2015
08:30-12:00

Chairs: Nancy Grulke and He Shang

The objective of this session is to highlight the effects of multiple stressors, whether biogenic or anthropogenic, abiotic or biotic, at the intersection of different trophic levels, and at the stand to landscape level. The first part of the session addresses new studies on biogenic volatiles, the confounding effects of air pollutants on insect receptors and pollination, loading of polycyclic aromatic hydrocarbons and heavy metals downwind from industrial centers, and changes in resin volatiles with drought stress in pine. The second part of the session addresses the interaction of ozone, nitrogen deposition, and components of climate on tree-, stand-, forest integrity, understory community structure, and ecosystem services. The speaker, rather than the lead author is highlighted in the overview that follows.

Grote et al. propose a new model for stimulus-feedback mechanisms between plant O_3 uptake, ROS production, reduced gs and uptake, and ROS-promoted detoxification and BVOC emissions. His double-feedback mechanistic explanation is supported by plant physiological observations. **Domingos et al.** related wet and dry depositional fluxes to both plant and soil accumulation of light and heavy polycyclic aromatic hydrocarbons. There were no seasonal differences in heavy metal depositional fluxes. Soil particle size affected metal enrichment of soils and a site near an industrial center had greater levels of PAHs in plant material and rainwater, independent of deposition loading. **Fuentes et al.** introduce us to the topic of air pollution effects on plant volatiles, which will be presented in depth on our field trip. Strong oxides and hydroxyl and nitrate radicals influence floral volatile and the ability for insects to locate plants and their resources. Time for plant-host recognition and foraging time was increased by air pollution-induced chemical changes and degradation in the scent plume. Both biotic and abiotic stressors modified success of bark beetle attack of pine (**Grulke et al.**). Stand density had no effect on pine susceptibility to bark beetle, but dense tree clumps increased susceptibility, irrespective of stand density Tight clumps of trees in thinned stands were most frequently attacked by bark beetle, wood borer, and a wide range of canopy phloem-sucking insects and pathogens. Attacked trees had greater physiological drought stress and had a significantly different signature of resin terpene and alkane volatiles.

In a long term study of European beech and Norway spruce forests, **Braun et al**. analyzed potential factors of tree mortality. Beech mortality was marked by slow canopy degradation, and was correlated with drought over the preceding 5 years. Norway spruce had a more rapid decline due to *Ips* attack and AET:PET over 3 years best predicted mortality. Thresholds of essential elements in foliage (K, Mg) preceded mortality in spruce. In a related system, **Vollenweider et al.** describe improvement in lower elevation pine stands affected by elevated temperatures through undergrowth removal, and improved site water balance. The effects of undergrowth removal continued near-surface xerification over 4 yrs, which was more important than stand thinning in improving site water availability for trees. Annual precipitation patterns drove production, composition, and growth of annual pastures underlying Holm oak woodlands (**Alonso et al.**). The deleterious effects of O_3 exposure and the fertilization effects of N deposition were mutually interactive, were species-specific, and will likely have impacts on understory plant community structure and composition.

Hayes et al. tested effects of O_3 and nitrogen deposition on *Betula pendula*. Similar to results presented by Alonso, N increased biomass, but this increase in carbon sequestration was reduced with increasing O_3. This result, as well as altered litter quality was modeled using and modifying MADOC to assess the effect of these depositional species on ecosystem services (net primary production, soil water quality, and soil C:N). Extending results to 2100, elevated O_3 and N deposition had competing effects on NPP, soil C, pH, and water DOC and DON. Ectomycorrhizal (EM) species composition was affected by excess nitrogen deposition and indirectly by associated declines in foliar phosphorus content (**de Witte et al.**). At high N deposition (50 g $ha^{-1}yr^{-1}$), EM colonization and species richness was halved. Along the N deposition gradient, the micro-local EM communities were dominated by different species and compositional shifts. With consideration for assisted tree species migration as a mitigative response to climate change, **Pickles et al.** tested the role of EM and soil origin (native and at varying geographic and climatic distance from origin) on EM colonization, and Douglas-fir seedling biomass and survival in a common garden, glasshouse experiment. Seedling biomass was most favorable when seed was grown in 'drier soils,' but survival was greater when elevational change was minimized. Fungicide-reduced EM reduced seedling biomass, but increased survival. Soil biota and complex interactions with parent material, water status, and temperature significantly affect tree seedling biomass and survival. 'Ecosystem integrity' is a poorly definable set of attributes, and **Nickel et al.** developed methodology for an integrative metric for this term, including reference and projected natural vegetation, chemical and physical soil conditions, N deposition, and stepped, modeled climatic change ('state and transition'). Biogeographical projections were valued by vegetation-related ecological functions at the site level. **Belyazid et al.** used a biogeochemical model parameterized by a high quality data set (from Hubbard Brook Experimental Forest) to predict future ecosystem services (tree survival, soil solution chemistry, understory composition). Although the model performed well, it did not predict [current] tree mortality. Under projected, future climate, seasonal variability and N deposition is expected to detrimentally affect ecosystem services. However, lack of model capability in tracking tree mortality limits quality of the predictions.

Dr. Nancy Grulke is a supervisory research biologist, and Director of the Western Wildlands Environmental Threats Assessment Center with the USDA Forest Service.

Coordinator of IUFRO Working Group 7.01.07 "Multiple stressors on ecosystems" under Impacts of Air Pollution and Climate Change on Forest Ecosystems.

She has been working on climate change effects (temperature changes, cryoturbation dynamics) on arctic and alpine ecosystems since 1977, and air pollution effects (elevated CO_2, O_3, and N deposition) on herbaceous species and trees since 1985 in a number of different locales. She thanks her cooperators for these opportunities, and is looking forward to seeing everyone at the meeting.

Prof. dr. He Shang

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- Independent Expert on Prevention of Desertification of the United Nations.
- Assessment Expert on International Cooperation Project of Ministry of Science and Technology, China.
- Member of Committee of Experts on Identification and Estimation of Environmental Damage, Chinese Association of Environmental Science.
- Postdoctor course in Laboratoire Pollution Atmosphérique, INRA - Centre de Recherche de Nancy, France (2000-2002).

Research Fields and Intrests: Effects of Air Pollution on Forests; Bioindication; Bioremediation; Wellands; O_3 and Plants.

BVOC Emissions from trees – Forming ozone or protecting against ozone?

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Abstract

Emissions of Biogenic Volatile Organic Compounds (BVOC) are known to take part of the photochemistry that produces ozone and other compounds. They are also supposed to function as detoxifying agent in the leaves and thus protect plant tissue from high ozone concentrations. It has been reported that BVOC emissions are increased under higher air pollution stress, emphasizing its role in plant defense allocation. However, there is no model available today that considers the feedback between ozone concentrations and BVOC emissions. Thus, a mechanistic estimation of plant damage by ozone as well as of air chemistry impacts of plants is difficult if not impossible. Herewith, a model is proposed that considers two feedback loops: First, ozone is taken up depending on concentration difference and stomatal resistance. Ozone within the leaf tissue triggers the production of reactive oxygen species (ROS) which are affecting stomata resistance (positive feedback loop). Second, increased ROS concentrations are supposed to increase the efficiency of detoxifying processes which are (species-specifically) linked to BVOC emissions (negative feedback loop). Detoxification comes with respiration costs but prevents photosynthesis from being damaged. Only if ROS concentration rises above threshold, photosynthesis is decreased, implying that stomatal resistance is increased (secondary negative feedback) but BVOC production decreased (secondary positive feedback). The model might explain a number of observed features in plant physiology and may be coupled to common photosynthesis and BVOC emission models. Further parameter estimation and evaluation is, however, necessary.

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PAHs and heavy metals in forest remnants in the central-eastern of São Paulo State, SE Brazil

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Abstract

Wet and dry depositions are important input pathways of heavy metals and polycyclic aromatic hydrocarbons (PAHs) in different forest compartments, which may cause disturbances in the whole ecosystem. So, the aims of this study were: a) to evaluate seasonal and spatial variations in wet and dry deposition fluxes ($ng.m^2.d^{-1}$; $\mu g.m^2.d^{-1}$) and plant and soil accumulation of light and heavy PAHs (14 priority compounds according to US-EPA) and metals (Al, Cr, Cu, Fe, Mn, Ni, Pb, Sr, V, Zn); b) to calculate enrichment factors (EF) of the same pollutants, using local background values, in PM10, rainwater, soil and leaves of native tree species (*Piptadenia gonoacantha* for PAHs and *Croton floribundus* for metals) in two remnants of the Semideciduous Atlantic Forest located in an urban (Campinas city-CA) and industrial site (Paulínia city-PA), which are included in a metropolitan region of the central-eastern of São Paulo State surrounded by different particulate pollution sources. Higher wet deposition flux of benzo(a)pyrene and higher dry deposition flux of fluorene, pyrene, benzo(a)pyrene and benzo(g,h,i)perylene were observed in both forests during wet seasons compared to the dry seasons. No seasonal differences were registered for metal deposition fluxes. The dry deposition flux of V was significantly higher in PA-forest than in CA-forest. The soil from CA-forest was more enriched by all metals and PAHs than that from PA-forest, due its higher clay and organic matter contents. The highest EF of light-PAHs (2.7), heavy-PAHs (2.4), Zn (35) and Cr (6) were estimated in PM10 sampled next to the PA-forest, possibly due the proximity to petrochemical sources. The highest EFs of light-PAHs (1.8) and Al (2.7) in leaves and of Cr (4) in rainwater were found in the CA-forest, suggesting that the vegetation in CA is more exposed to these pollutants, independently of the level of atmospheric inputs.

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Influences of air pollutants on plant-insect interactions

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Abstract

Plants produce and emit volatile organic compounds that play crucial roles in plant-insect interactions. Pollutants such as ozone, hydroxyl radical, and nitrate radical can deleteriously impact plant-insect interactions in multiple ways. They may reduce production of floral volatiles, which are used by insects to locate host plants; they may damage insect antennae, which detect host volatiles, and they may react with plant volatile compounds, changing hydrocarbon composition and reducing the distance that scents travel from their source. The impacts, individually and in combination, could detrimentally impact insect pollinators, herbivores, herbivore natural enemies, and vitality of plant communities. This presentation will provide experimental and theoretical results to evaluate the general hypothesis that enhanced air pollution adversely impacts pollinators and plant communities due to reduced quality and quantity of hydrocarbon mixtures. In one study, an insect failed to detect its host plant when ozone mixing ratios exceed 80 parts per billion (ppb) because chemical reactions alter the quality and the quantity of scents. In polluted environments, insects may not recognize the plant-emitted scents because the proportion of each chemical species in the plume is modified by chemical reactions. Results from a three-dimensional Lagrangian diffusion model indicate that insect foraging times significantly increase in polluted conditions due to considerable scent plume degradation and changes in the composition of the hydrocarbon scents. Results also indicate that increased levels of air pollution could contribute to the observed declines in the insect pollinators and reduced pollination efficiency done by bees and other pollinators.

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The role of abiotic and biotic stressors in pine susceptibility to bark beetles

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Abstract

Physiological drought stress triggers a cascade of responses that, depending on the level of stress experienced, may predispose trees to successful insect attack. We hypothesized that 1) under moderate physiological drought stress, resin production is stimulated and bole cambium ψ_p is sufficient to express the resin, but 2) under severe drought stress, resin production is highly upregulated, but there is insufficient ψ_p to express resin. We tested the physiological basis for pine (*Pinus Jeffreyi* Grev & Balf.) susceptibility to bark beetle (*Dendroctonus Jeffreyi* Hopkins) under differing levels of soil moisture, evapotranspirational deficits, stand density, and disturbance. Tree attributes used to determine susceptibility included measures of physiological drought stress, resin quality and exudation flow rates. The study was conducted at 5 sites along a 1000 km latitudinal gradient in the Sierra Nevada, over 3 yrs. At the northern-most site, trees in dense stands were more physiologically stressed than in thinned stands. At the southern 4 sites, lower precipitation increased tree drought stress, but there was no difference in tree stress between dense and thinned stands. Jeffrey pine that was attacked was significantly closer to another single tree, but had fewer trees within its sphere of influence. Physiological tree drought stress as measured in the canopy was correlated to lower turgor potential in bole phloem, a specific signature of resin quality, and low resin exudation flow. In this study of 500+ trees, 9% of the trees were attacked by Jeffrey pine beetle, primarily in the year following drought, and 7% of the attacks occurred in thinned stands. There was no trend of increasing mortality with decreasing latitude. In initial attack in a stand, Jeffrey pine beetle may be able to detect the differences in resin quality observed in drought-stressed trees.

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Tree mortality in Swiss forest observation plots: the role of drought, nutrition and N-deposition

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Abstract

Predictions of forest performance in a changing environment need also an understanding of tree mortality. High age or dense stands may provoke tree mortality but also drought and parasite infestation, with the latter often being a consequence of the other factors. Long-term forest observation is an excellent opportunity to follow mortality in mature stands. The dataset from a network of observation plots in Switzerland including 115845 observations of *Fagus sylvatica* (51-92 plots during 27 years) and 69250 observations of *Picea abies* (18-71 plots during 24 years) was analyzed for possible factors explaining mortality using mixed logistic regression. Backwards analysis of crown transparency revealed that the dying process in beech extended usually over several years. The factor explaining beech mortality was drought averaged over 5 preceding years, with the best drought predictor being the minimum annual site water balance. In Norway spruce, mortality occurs more suddenly; in most cases by an attack by the bark beetle *Ips typographus*. But even in this case, drought averaged over 3 years (ratio between actual and potential evapotranspiration) was a better predictor for mortality than more acute events. This suggests that the pathway of drought related mortality in mature forests is rather predisposition for parasites than acute hydraulic failure. In Norway spruce, mortality was also distinctly increased when foliar potassium concentrations in needles dropped < 2.8 mg g^{-1} and magnesium < 0.8 mg g^{-1}. The data suggest also that there is an interactive effect between drought and modelled total N deposition: at higher N deposition (>20-25 kg N ha^{-1} yr^{-1}) the drought effect is increased. Thus, future modelling of climate change effects must include also interactions with current pollutants.

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Response of low-elevation pine stands in the Central Alps to changes in land use in a warmer climate

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Abstract

Within alpine regions of Central Europe during the 20th century, temperatures have increased about twice as fast as measured globally, whereas precipitations have shown few changes. During the last decades, the low-elevation forests have experienced increased drought stress and pine stands within central valleys have declined. Since the 1950s however, land use in these forests has also drastically changed with progressive cessation of pasture and litter harvest and development of competing undergrowth. With regard to recent decline events, the respective role of changes in climate and land use is still little understood. To analyze the role of undergrowth competition in low-elevation forests, an experiment removing the lower canopy bushes and saplings has been established in April 2010 in a pine stand on a dry, south-facing slope in Central Valais, Switzerland. The soil moisture in the lower soil layers responded rapidly to the smaller water demand and the water fluxes within dominant pine trees were increased. After 4 years of undergrowth removal however, the foliage density, branch and needle growth had shown few changes only. Moreover, the soil respiration and litter mineralization had been reduced and the herbaceous layer composition shifted, indicating that site xericity had increased. By reducing the competing undergrowth hence, the removal treatment has improved the water supply of dominant pines, which has also resulted from the probably deep and far reaching root system of these trees. The so far negligible effects of stand thinning on foliage parameters may relate to the prevailing dry conditions in the upper soil. These findings thus suggest that changing land use and climatic conditions can have interactive effects on the growth and vitality of dry pine stands at low elevation in valleys of Central Alps.

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Interactive effects of ozone, nitrogen and climate on annual understory pastures of Holm oak forests

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Abstract

Air pollution represents a threat for biodiversity and other ecosystems services throughout the world and particularly in the Mediterranean area, where high tropospheric ozone (O_3) concentrations and atmospheric nitrogen (N) deposition are frequently recorded. Additionally, the Mediterranean climate is characterized by high interannual variability and this variability is expected to intensify with climate change. Broadleaf evergreen Holm oak (*Quercus ilex*) open forests are one of the most characteristic landscapes of the Mediterranean countries. Holm oak forests understory is formed of annual pastures with high species richness. The ecophysiology and composition of these communities is controlled by water availability depending on annual precipitation. Experiments were carried out in open-top chambers to study the interactive effects of O_3 and N fertilization on a simplified annual community composed of six representative species. Plants were exposed to four O_3 levels and three nitrogen fertilization treatments. Results from experiments in open-top chambers have been combined with field measurements on gas exchange and pasture growth to disentangle the possible interactions between air pollutants and climate. Open-top chamber experiments showed that O_3 induced visible injury and reduced the yield and gross primary production of the community. Nitrogen could partially counterbalance O_3 effects when the levels of the pollutant were medium, but at the same time O_3 reduced the fertilization effect of higher N availability. The results indicate that O_3 and N effects and interactions are species specific resulting in complex responses in biodiverse plant communities. On the other hand, field data revealed that soil water availability controls not only gas exchange, but also the composition and growth of annual pastures. Thus species composition is one of the keystones to understand interactions of O_3 effects with climate and nitrogen.

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Combined effects of ozone and nitrogen on ecosystem services: experimental results and modelled future impacts

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Abstract

Combined effects of ozone and nitrogen pollution on *Betula pendula* were investigated in solardomes at CEH Bangor using a factorial combination of seven ozone treatments and four nitrogen regimes. Although N increased biomass production, and therefore carbon sequestration, this effect was reduced with increasing ozone. In addition, N content of senescing leaves was increased with increasing ozone exposure, implying decreased resorption of nitrogen and alterations in litter quality. A model of soil and vegetation responses to atmospheric nitrogen pollution and other drivers, MADOC, was extended to simulate effects of ozone on plant productivity and litter quality based on these and other published data. The revised model was applied to several experimental and long-term monitoring forest sites from across Europe, producing reasonably accurate predictions of NPP, soil water quality and soil total C/N. The model was then used to predict the impact of potential future ozone and nitrogen scenarios (up to 2100) at the sites, to show ecosystem relevant effects including carbon sequestration, soil water pH and DOC. The predicted impacts were for elevated ozone to cause a reduction in NPP, soil carbon and DOC in soil water, but for an increase in the pH of soil water. However, elevated N deposition caused an increase in NPP, soil carbon and soil water DOC and DON.

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Changes in ectomycorrhizal species composition along a nitrogen deposition gradient in Swiss beech forests

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Abstract

Environmental change has serious implications for functional biodiversity in temperate beech forests that cover large parts of Swiss lowlands. Forest trees depend on mycorrhizal fungi for nutrient and water uptake, but excess atmospheric nitrogen deposition may alter fungal communities. Foliar phosphorus concentrations in mature beech forests have decreased strongly since the 1980's and are today at a deficient level. Therefore, we investigated the changes in ectomycorrhizal diversity and community composition along a gradient of modelled total nitrogen deposition (ranging between 15 and 50 kg N/ha/yr) and foliar phosphorus concentrations using molecular techniques. In 15 permanent forest observation plots, ectomycorrhizal colonization of root tips and species richness were significantly reduced, from 56 species at lowest to 23 species at highest nitrogen deposition. The local communities are dominated by different fungal species and community composition shifts along the nitrogen deposition gradient. We also explored possible relationships between the observed ectomycorrhizal community changes and the nutritional status of the trees. A shift in exploration types can be observed in a gradient of foliar phosphorus concentrations. We now investigate activity of ectomycorrhizal species and presence of extrametrical mycelium to find confirmation.

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Success of migrated Douglas-fir seedlings is mediated by ectomycorrhizae and other soil factors

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Abstract

Separating out the edaphic impacts on tree distributions from those of climate and geography is notoriously difficult. Aboveground and belowground factors play important roles, and determining their relative contribution to tree success will greatly assist in refining predictive models and afforestation strategies in a changing climate. In a common greenhouse, seedlings of interior Douglas-fir (*Pseudotsuga menziesii* var. *glauca*) from multiple source populations were grown in multiple forest soils. Soils were obtained from field sites with varying geographic and climatic distances from the seed origins, and were compared using a 'transfer function' approach. Fungicide was applied to half of the seedlings to separate soil fungal from abiotic impacts on seedling performance. Soil origin was partially responsible for the success of seedling populations. Seedling height and biomass were optimized when seed was transferred to climatically drier soils, whereas survival was optimized when elevation transfer was minimized. Fungicide application reduced ectomycorrhizal root colonisation by approximately 50%, with treated seedlings exhibiting reduced biomass but greater survival. The success of Douglas-fir seedling populations in different soils was mediated to some extent by soil fungi in 56% of soil origin by response variable (growth, survival, etc.) combinations. Mediation by non-fungal soil factors alone occurred in 25% of combinations. Our research indicates that the soil biota, hitherto unaccounted for in climate models, interacts with biogeography and local genotypes to influence plant regeneration success, and hence ranges, in a changing climate.

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Effects of climate change and atmospheric nitrogen deposition on ecological integrity of forests

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Abstract

By example of Germany, a comprehensive and spatial explicit methodology for evaluating ecological integrity was developed. The approach integrates data on vegetation, chemical and physical soil conditions as well as on climate change and atmospheric deposition of nitrogen. Key component for evaluating ecosystem integrity is a classification of ecosystems containing information on ecological functions. Respective data covering 1961-1990 was regarded as reference. The assessment of ecological integrity relies on comparing a current or future ecosystem status with the reference. Whilst current 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 additionally using geo-data on current tree species coverage and land use. The current ecosystem types were related to geo-data (elevation a.s.l., soil texture, air temperature, humidity, evapotranspiration, precipitation 1961-1990) by Classification and Regression Trees. The relations determined by this were applied to the above mentioned geo-data and then used to map the spatial pattern of ecosystem type clusters for 1961-1990. Then, the climate data 1961-1990 were replaced by results from a regional climate model for 1991-2010, 2011-2040, and 2041-2070. Accordingly, for each period one map of ecosystem type clusters were produced and evaluated with regard to the development of areal coverage of ecosystem clusters across time due to climate change. 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. This was achieved by using the Very Simple Dynamics soil modelling technique using the above mentioned climate data and two scenarios of atmospheric nitrogen deposition as input. The results were compared to the reference and enabled evaluating site-specifically ecosystem integrity across time.

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Integrated effects of atmospheric deposition and climate change on forest ecosystem services

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Abstract

Long term ecosystem monitoring and manipulation experiments provide unique collections of data to understand ecosystem processes. We used an integrated ecosystem model to simulate the biogeochemistry, tree growth and ground vegetation communities in three intensively studied forests of the North-Eastern USA (Hubbard Brook, Bear Brook East and Bear Brook West). The model was successful in capturing the levels and trends of ecosystem indicators at all levels (trees, soil solution chemistry, ground vegetation composition) with limited calibration requirements thanks to the high quality of input data and good understanding of ecosystem processes. However, the model failed to predict or explain tree dieback at the Hubbard Brook site, a phenomenon not fully understood empirically. The model was used to forecast the responses of the studied ecosystems to global changes, taking into account the wide variability of climatic conditions and deposition levels expected in the remainder of the century. Climatic seasonal variability and deposition levels will be detrimental for the provision of different ecosystem services, but the fact that the causes of forest dieback remain unclear limits the predictability of the model simulations.

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Session 6 "Forest ecosystems, atmospheric deposition and the water cycle"

Thursday 4th June, 2015
13:30-16:45

Chairs: Yusuf Serengil and Mark Fenn

Water is a major determinant of ecosystem response to stress factors. Air pollution, climate change, land use and management, pest outbreaks, fire and other factors may have adverse effects on water availability and quality, and watershed nutrient cycling. We invite studies on the various aspects of forests, hydrology and nutrient cycling. The response of ecosystems to dry conditions, water deficits and altered water and nutrient cycling due to climate change and air pollution are examples of presentations desired for this session. The scope of the session also includes non-forest ecosystems and desertification studies. We expect that the session will provide the groundwork for integrating research findings on the water cycle, atmospheric deposition and ecosystem behavior so that solid management strategies can be developed for better environmental policies and adaptation of ecosystems that ensure sustainability. The speaker, rather than the lead author is highlighted in the overview that follows.

The impact of deforestation on the occurrence of springs and their chemistry in the Beskid Śląski Mts in the Carpathian range in Poland will be discussed (**Malek et al**). Deforestation was found to temporarily affect concentrations of some cations in shallow springs. A modeling study near Istanbul, investigated the effects of forest fragmentation on streamflow (**Serengil et al**). The results indicated that fragmentation and land use change greatly increased streamflow in areas experiencing urban sprawl. In Central Europe, many pure Norway spruce stands, established on primary beech sites, were converted into mixed stands over the last 60 years (**Vilhar et al**). Such changes in forest stand composition may also affect the quantity of catchment runoff. Results indicate higher interception, infiltration and accumulation of precipitation in the river basin with higher share of spruce in the mixed spruce-beech forest. Forest management practices, including silvicultural measures, should aim towards decreased surface runoff in alpine climates. The effects on water quality of harvest practices in Finnish boreal forests show that NO_3 concentrations in groundwater were highest in clear cut forests with soil preparation and remained high for 20 years (**Krecek et al**). The effects on nitrate leaching of several harvest treatments will be presented.

Changing climate and emissions are resulting in similar changes in atmospheric deposition patterns and chemical changes in surface waters and soil solution in an alpine catchment in Italy (**Balestrini et al**). In China NH_4 deposition in bulk deposition and throughfall was approximately 2.5 times greater than NO_3 deposition, with urban NH_4 deposition hotspots near urban source areas (**Du et al**). Large forested areas in China are in exceedance of N critical loads. Nitrogenous pollutants along with dry and wet deposition of N fluxes were quantified at 4 Holm oak forests in Spain **(García-Gómez et al)**. Dry deposition is the dominant input form in these forests, and canopy consumption of N was observed during most of the year, while loss of NO_3 in soil water was highest during periods of low biological activity. Nitrogen deposition in the Czech Republic was estimated using a hybrid approach based on empirical data and model outputs from the CAMx model (**Hůnová et al**). With this approach dissolved organic N, deposition from fog and the main N pollutant drivers of N deposition were included to more realistically estimate N deposition inputs.

For enhancing the spatial resolution of measuring deposition by technical devices and of deposition modelling, moss is used complementarily as bio-monitor. By example of Cd, Hg and Pb, **Schröder et al.** investigated correlations (e.g. descriptive statistics, geo-statistics and multivariate statistical techniques) between heavy metal concentrations in moss and natural surface soil collected in Norway, covering tree-dominated ecosystems, and environmental factors from 1990 to 2010.

Also to be presented in this session is a conceptual model of new forest stress response patterns. As a result of climate change, forests are now responding to stress that has not previously been observed in recorded history. This will require new management options for maintaining forest resilience and sustainability under an increasingly variable climate (**McNulty et al**). In France the extent of forest ecosystems subject to exceedances of critical loads of acidity ranged from 5% to 20% (**Pascaud et al**). Although deposition of acidifying compounds has decreased for the last 20 years, exceedances of critical loads of acidity were reported in a growing number of ecosystems due to a concomitant decrease in the base cation deposition. The physiological effects of flooding and elevated CO_2 on urban oak species in the Gulf of Mexico indicate that during the flooding cycle, live oaks were not affected by flooding significantly until the CO_2 level was elevated to 800 ppm, while other oak species were affected at lower CO_2 levels (**Ning et al**).

Results for the French monitoring plots (**Saenger et al**) from the European intensive forest monitoring network (ICP Forests Level II) show a carbon storage sink. Soil organic carbon stocks (SOC) increased significantly (P <0.05), particularly 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. For the most acidic soils (pH H_2O <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.

Prof. Dr. Yusuf Serengil, Istanbul University, Faculty of Forestry. Department of Watershed Management.

Coordinator of IUFRO Working Group 7.01.08 “Hydroecology” under Impacts of Air Pollution and Climate Change on Forest Ecosystems.

UN Expert on LULUCF (Land Use Land Use Change and Forestry) sector. Since 2010, advisor of Turkish Delegation.

- Served as a Lead Author at IPCC Wetlands Guideline Task Force between 2011-2013.
- Advisor of General Directorate of Agriculture Reform (TRGM) under the Ministry of Food, Agriculture and Livestock on Climate Change and GHG Inventories
- Served as an advisor of General Directorate of Forestry under the Ministry of Forestry and Water on LULUCF and UNFCCC between 2010-2012.
- Editorial board member of IJES (International Journal of Environmental Science), Int. Journal of Faculty of Forestry and national scientific journals.
- Served at the Management Commitee of COST FP601 (Forest Management and Water Cycle) and COST FP903 (Climate Change and Adaptation of Forest Ecosystems at a Polluted Environment).
- Served as an expert in Climate Change Action Plan of Turkey-LULUCF sector in 2011.

Dr. Mark E. Fenn, is a research plant pathologist at the United States Department of Agriculture (USDA) Forest Service - Pacific Southwest Research Station.

Coordinator of IUFRO Working Group 7.01.03 "Atmospheric deposition, soils and nutrient cycles Hydroecology".

- Synergistic activities: development of methods for measuring N deposition, particularly "passive" ion exchange resin column based samplers.
- P.I. with Linda Pardo and others in developing a review of empirical critical loads for effects of N in major ecoregions of the U.S. Synthesis publication (Fenn coauthored several chapters) and journal review paper published in 2011.
- Leader in developing N critical loads for the major ecosystem types in California. Review of CLs and maps of CL exceedance areas published in 2010.
- Lead author of overview publication on setting air pollution thresholds for protection and restoration of U.S. ecosystems: Issues in Ecology, Ecological Society of America series, volume 14 (Fall 2011).
- Editor, Springer-Verlag, Ecological Studies Series volume 156 on air pollution effects on forests in the Mexico City Air Basin, published in 2002; Member of the Mexican Academy of Sciences since 2006.

The impact of deforestation on the localization of springs and their chemistry on Skrzyczne in the Beskid Śląski Mts

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Abstract

Studying localization of springs and their chemical features is complicated - deforestation, logging, new forest generation, tree species, soil, geology as well as water amount in their alimentation areas can affect them . The study concerns springs located on the slopes of the Skrzyczne in the Silesian Beskid Mountains mainly in Norway spruce monocultures exposed to air pollution for many decades from Silesia and Ostrava-Karvina regions. Samples were collected in 2009, 2011 and 2012 during 3 different weather conditions: during snow melt (high water level), after rainfall (medium water level) and after dry period (low water level). Chosen chemical properties were examined: EC, pH reaction, concentration of: Na^+, K^+, Ca^{2+}, Mg^{2+}, NO_x^{-}, Cl^-, SO_4^{2-}, NH_4^+. Terrain analysis was based on the LIDAR data. Examined springs were located in different conditions due to bedrock, soil, type of forest stand and time of deforestation. All these features were tested statistically using Principal Component Analysis (PCA) alongside factors like: exposition, height above sea level, declivity, location on the landslide. The previous crenology research shows, the primary importance have bedrock and precipitation, however we wanted to define of what importance was the forest type and deforestation. The research confirmed the key role of precipitation and bedrock not only for chemical properties but also for location of springs, however deforestation influenced the basic chemical composition of springs by temporary increase of single cations. In further years after deforestation the decrease of basic cations in springs showed their absorption by newly planted forest. The results show that chemical features of shallow supplied springs are modified by forest activity. The present research was funded by the Grant No. NSC - 2011/01/B/NZ9/04615 - The impact of deforestation caused by the ecological disaster on spatial variations and changes in the chemistry of spring water and surface water in the Silesia Beskid.

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A hydrological evaluation of forest fragmentation along urban-rural transition using SWAT model

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Abstract

Fragmentation of forests around cities due to sprawl is a major hydro-ecological concern. Many adverse effects can be observed on the quality, quantity and regime of streams due to increased road density and imperviousness in addition to forest fragmentation. In this study we concentrate on average and maximum flows and try to explain the hydrologic changes with forest fragmentation and land use change. We used SWAT (Soil and Water Assessment Tool), a sophisticated hydrological model to combine hydrology with land use. We selected three collateral watersheds lying on the European side of Istanbul. The 541 km² study area was divided into 36 sub-watersheds and streamflow data of Molova creek was used for calibration of the model. The correlation coefficient between observed flows and the SWAT results was 0.84 ($p<0.05$). To verify this we used Kagithane catchment flow data. Correlation was 0.72 ($p<0.05$) in this case. After the calibration and verification phases, the model was applied to the entire study watersheds. We evaluated the model results in relation with the forest fragmentation and land use changes between 2000 and 2010. Our results supported that fragmentation and land use change affects streamflow in sprawling areas. For example, in sub-watershed-35 average streamflow increased from 1.24 to 3.48 cms in 10 years period. In this watershed, mostly semi-rural areas and pastures converted to high density urban areas. In sub-watershed-23 average streamflow increased about 61% because of urban development and forest fragmentation. This study is supported by TUBITAK (The Scientific and Technological Research Council of Turkey) with project numbers of 112Y096 and 2214/A – 1059B141300853.

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Influence of conversion of spruce monocultures into mixed beech –spruce forests on the river basin runoff

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Abstract

In Central Europe, many pure Norway spruce stands, established on primary beech sites, were converted into mixed stands over the last 60 years. The conversion of forest management from Norway spruce monocultures into mixed deciduous-coniferous forests changed the forest structure dramatically. This changes could influence the hydrological processes on the river basin scale, associated with major river flooding following extreme precipitation events. In this study, the effect of forest management on the runoff in mixed deciduous-coniferous stands on Pohorje mountains in NE Slovenia were investigated. Two small forested experimental basins of Oplotnica River on Pohorje were compared with similar size and shape but different share of Norway spruce *Picea abies* (L. Karst) and European beech *Fagus sylvatica* (L.). Measured stream flows, throughfall, stemflow and the mixture of forests were compared in the period 2008 till 2013 for both river basins. Hydrological models in the HEC-HMS program were built for both river basins, calibrated and validated using measured data. Precipitation losses were estimated by the Soil Conservation Service (SCS) method, while precipitation was converted into surface runoff using the SCS synthetic unit hydrograph procedure. The measured seasonal throughfall and stream flow was lower in the basin with higher share of spruce in the mixed spruce-beech forest. Modeled precipitation losses in the river basins were 92% and 95% of total precipitation, respectively. The results indicate higher interception, infiltration and accumulation of precipitation in the river basin with higher share of spruce in the mixed spruce-beech forest. Forest management practices should aim towards decreased surface runoff in alpine climates. Therefore implementation of hydrology-oriented sylvicultural measures via a more accurate prediction of the impacts of tree species conversion on stream flow in this type of alpine forest is discussed.

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Long term impacts of biomass harvesting on hydrology and nutrient leaching of boreal forests

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Abstract

Nowadays in the boreal forests, the intensive biomass harvesting is strongly increasing and likely to cause progressive change in the character of the forests addressing the need to better understand hydrological cycle. For this reason, developing the best forest management practices to protect water quality is becoming more and more important. The aim of this paper is to evaluate effects of different forestry practices (shelderwood cut, clear-cut with the different status of soil preparation including stump removal and the whole-tree harvest) on water quality. Since 1985, the data concerning the groundwater impacts of different harvesting methods have been collected by the Muhos Research Unit of the Finnish Forest Research Institute. To get more understanding about possible risks of intensive biomass use to groundwater quality, the new stump harvesting project including also catchment areas was launched during 2007. Nitrate nitrogen is the foremost nutrient leached into the groundwater as a consequence of forestry operations. All the tested treatments contribute to the rise of nitrate-nitrogen concentration in the water. Leaching from the natural regeneration was negligible compared with that observed after the clear-cut and soil preparation: the rising concentrations of nitrate nitrogen for 5-7 years, reaching the maximum of 500-700 µg/l. However, the increased concentrations of nitrogen were still high over 20 years after that treatment. After the natural regeneration concentrations of nitrogen were increasing within the period 3-5 years, reaching only maximum 120-400 µg/l in the study site. According to our most recent results, stump removal cause leaching but it is comparable or less compared with conventional clear cutting. In the conference the need to implement of integrated forest and water sustainable management in relation to climate change will be discussed.

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Long-term patterns of deposition, soil solution and stream water chemistry in an Alpine forest ecosystem

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Abstract

Alpine ecosystems, both terrestrial and aquatic, are particularly sensitive to climate change and alteration of biogeochemical cycles. With the aim of understanding the potential effects due to the combination of climate change and atmospheric deposition, we evaluated the temporal evolution of some climatic factors and the chemical composition of atmospheric deposition, surface water and soil solution in an alpine LTER station. Monitoring data from for deposition (1995-2013), stream water (1997-2013), and soil solution (2006-2013) chemistries were statistically analyzed for long-term trends and seasonal patterns by using Seasonal Kendall test (SKT). Similarly to several European and North America sites we observed a sharp decline in sulfur concentrations, and a subsequent increase of pH values in all the analyzed environmental matrices. A less pronounced reducing has been detected for nitrate, but not for ammonia. These results are examined considering the seasonal variations of temperatures (min, max and mean), the amount of rain and snow, and the hydrological regime.

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Inorganic nitrogen deposition in China's forests: Status and characteristics

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Abstract

Nitrogen (N) deposition in China has been dramatically enhanced by anthropogenic emissions and has aroused great concerns of its impacts on forest ecosystems. This study synthesized data on ammonium (NH_4^+) and nitrate (NO_3^-) contents in bulk precipitation and throughfall from 38 forest stands in published literature to assess the status and characteristics of N deposition to typical forests in China between 1995 and 2010. Our results showed that ammonium dominated N deposition in this period, with a mean NH_4^+-N:NO_3^--N ratio of ~2.5 in bulk deposition and throughfall. Mean throughfall N deposition in China's forests was as high as 14.0 kg N ha-1 yr-1 for ammonium, 5.5 kgN.ha^{-1}.yr^{-1} for nitrate and 21.5 kgN.ha^{-1}.yr^{-1} for total inorganic N (TIN), respectively. Mean bulk deposition was 9.4 kgN.ha^{-1}.yr^{-1} for ammonium, 3.9 kgN.ha^{-1}.yr^{-1} for nitrate and 14.0 kgN.ha^{-1}.yr^{-1} for TIN, respectively. Canopy captured dry deposition, calculated as the difference between throughfall and bulk deposition, was thus approximately half of the bulk deposition. Spatial patterns of N deposition were in accordance with our urban hotspot hypothesis, showing a strong power-law reduction of ammonium with increasing distance to large cities but only slightly lower nitrate deposition. Our results suggest that high N deposition, especially of ammonium, exceeds critical N loads for large areas of China's forests.

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Atmospheric concentration and deposition of nitrogen in four Mediterranean holm oak forests

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Abstract

Recent studies have shown that atmospheric nitrogen (N) deposition in Spain could be threatening the biodiversity and functioning of Spanish ecosystems. However, information is still limited for quantifying N deposition, particularly dry deposition, and effects. Four holm-oak (*Quercus ilex* L.) forests have been monitored in the Centre and North of the Iberian Peninsula throughout two years (2011-2013). Atmospheric concentration of N pollutants and wet and dry N deposition were assessed in open field and below the canopy. Concentration of N pollutants (NH_3, NO_2, HNO_3, NH_4^+, NO_3^-) was measured, together with the wet deposition of dissolved N (NO_3^- and NH_4^+). Dry deposition was estimated seasonally using rinsing techniques combined with an inferential method including stomatal conductance modelling. Several variables were measured in order to evaluate the potential effects of N inputs. Annual atmospheric NO_2 average concentrations varied between 3.4 and 11.9 µg m^{-3} depending on the urban and traffic influence. Annual NH_3 average concentration was 2.4 µg m^{-3} in the site with highest agricultural influence. HNO_3 average varied from 1.5 to 4.1 µg m^{-3}. Pollutant concentrations were higher in the open-field areas than under the canopy, particularly for NH_3. Bulk N deposition ranged from 1.5 to 8.2 kg N ha^{-1} $year^{-1}$. The $N\text{-}NO_3^-/N\text{-}NH_4^+$ ratio in bulk deposition varied among sites (from 0.6 to 1.2) following the same pattern as NO_2 concentration. The deposition of NH_4^+ was maximum (5.3 kg N ha^{-1} $year^{-1}$) at the same site with highest NH_3 concentration. Net throughfall values indicated that N canopy uptake occurs during most part of the year. Nitrogen dry deposition in the most arid site represented up to 78% of total N deposition. Loss of NO_3^- in soil water was detected when atmospheric N inputs occurred in periods of low biological activity, highlighting the importance of synchronicity between N deposition and biological demand.

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A novel approach for spatial quantification of Nitrogen deposition: A case study for Czech forests

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Abstract

The nitrogen biogeochemical cycle is still poorly understood (Fowler et al., 2013). Human contribution to release of reactive nitrogen (N_r) is comparable to natural and has many negative consequences, including the loss of biodiversity (Bobbink et al. 2010). Nitrogen loads still remain high in Europe (Lorenz et al., 2008), thus as accurate as possible quantification of atmospheric deposition flux is essential for assessment of its impacts on ecosystems. In contrast to sulphur, throughfall measurements are considered inadequate for quantification of nitrogen, due to complicated exchange processes between biosphere and atmosphere (Flechard et al., 2013). Our contribution presents an advanced approach to improved quantification of atmospheric deposition of nitrogen over Czech forests, merging available measured data and model results. The aim was to develop a new methodological approach for deriving a more reliable spatial surface of atmospheric nitrogen deposition. So far, nitrogen deposition over Czech forests (Hůnová et al., 2014) is quantified based on data measured in precipitation (N/NO_3^-, N/NH_4^+) and air (N/NO_x). The novel approach presented for year 2008, includes components affecting significantly dry deposition (N/NH_3, N/HNO_3 (g), gained as model CAMx outputs. Furthermore we included DON, and derived contribution of fog to nitrogen deposition using geostatistical modeling. Limitation of our results is the fact that model results could have been verified only partly, as the measured data for verification are mostly lacking. Nevertheless, it is obvious that including the unmeasured species enhances significantly the estimate of annual deposition flux of nitrogen, and provides a more realistic estimate as compared to current approach.

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Concentrations of heavy metals in moss and natural surface soil sampled in Norway from 1990 to 2010

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Abstract

Assessing ecological effects of air pollution needs 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. In Norway, since 1985 nation-wide moss surveys have been carried out and complemented by soil sampling. By example of Cd, Hg and Pb, this study aimed at investigating correlations between heavy metal (*HM*) concentrations in moss and natural surface soil collected in a spatial dense network covering tree-dominated ecosystems throughout Norway and 10 environmental factors. Moss was sampled from 1990 to 2010 every 5 years and natural surface soil in 1995 and 2005 at about 500 sites. Next to descriptive and correlation statistics, geo-statistics (Variogram Analysis, Ordinary Kriging *OR*, Regression Kriging *RK*) and multivariate statistical techniques (Regression Trees *RT*, Generalized Linear Models *GLM*) were applied. HM-deposition was proved as the strongest predictor for HM concentrations. Land use showed significant correlations with Pb and Cd concentration in moss and Hg concentration in natural surface soil. Elevation was identified as a factor for accumulation of Pb and Hg in moss and Cd in natural surface soil, precipitation as predictor for Cd in moss and Hg in natural surface soil. The combination of *GLM* and *RK* enabled calculating maps on *HM* concentrations at 5 km by 5 km. The spatial patterns of Cd and Pb concentrations in moss and natural surface soil in 1995 and 2005 were similar. *HM* concentrations in moss and natural surface soil were correlated significantly with high coefficients for Pb, medium for Cd and moderate for Hg. From 1995 up to 2010 the modelled moss and natural surface soil estimates indicated a decrease of Pb concentration in both moss and natural surface soil. With respect to the moss data the decrease of HM accumulation was more pronounced. By contrast, the modelled Cd and Hg concentrations did not exhibit any significant temporal trend.

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Where no forest has gone before: New forest stress response patterns and adaptive management options

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Abstract

Insect outbreaks, wildfire, and drought have directly or indirectly impacted forest health, productivity and water use long before the advent of modern forestry practices. However, climate change may be acerbating these impacts, causing land managers to reconsider the use and timing of management tools. However, even as new methods are being devised to combat negative drought impacts, the forest response to chronic and increasingly severe episodic drought may be changing. Historically, the weakest (e.g., suppressed, understory) trees were the first to succumb to stress while the strongest (e.g., dominant, fast growing). However, recent studies have suggested that a combination of chronic and increasingly extreme episodic stress may be causing hereunto unobserved patterns in forest mortality with the more vigorously growing trees having higher rates of mortality than slower growing, more generally stressed individuals. We suggest that the forests have not altered their response to stress, but only that the level of stress, and the forest response to that stress has not previously been observed in recorded history. This extension of the forest stress response continuum has very significant implications to forest management under drought and associated disturbance. Therefore, this paper explores the causes, implications and management options for maintaining forest resilience and sustainability under an increasingly variable climate.

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Impact of base cation deposition trends on exceedances of critical load of acidity in French forests

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Abstract

Maps of atmospheric deposition provided by EMEP models are submitted to large uncertainties (Hamaoui-Laguel, 2014). These maps play a key role in evaluating the potential sensitivity to acidification of forest ecosystems. Moreover, the atmospheric deposition is the main source of neutralization for acid forest soils with low buffering capacities (Moncoulon et al., 2004). This communication aims to present an objective assessment of atmospheric deposition and their impacts on forest ecosystems in France. This work was done within the PRIMEQUAL research project SESAME. A geostatistical approach was used to estimate the spatial distribution of sulfate, ammonium, nitrate and base cation deposition measured in 43 sites (three monitoring networks) between 1993 and 2008. A corrective factor (using the Cl^- ratio open field / throughfall) was applied to the geostatistical maps in order to consider the influence of forest canopy on dry deposition. In comparison to EMEP models, the geostatistical maps of atmospheric deposition were consistent for sulfates and nitrates but significant differences were found for ammonium. Indeed EMEP models overestimate ammonium deposition for western France. Critical loads of acidity and their exceedances were determined using empirical models and the geostatistical maps of atmospheric deposition. The spatial estimates of atmospheric deposition to acid forest soil greatly influence the critical loads as well as their exceedances. Also the use of a corrective factor to deposition involved non negligible changes. As a consequence, the part of forest ecosystems subject to exceedances of critical loads of acidity ranged from 5% to 20%. Trends in atmospheric deposition chemistry influenced the ecosystem sensitivity. Although deposition of acidifying compounds has decreased for the last 20 years, exceedances of critical loads of acidity were reported in a growing number of ecosystems due to a concomitant decrease in the base cation deposition.

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Response of urban Oak species to flooding and elevated CO_2 in the Gulf Coast region of USA

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Abstract

Many literatures/studies have indicated that the Gulf Coast of Mexico region of the USA has been and will continue be impacted by climate change. The climate records in the region documented an increased precipitation, extreme climatic events, and flooding. Recent flooding events in New Orleans induced by hurricanes Katrina and Rita demonstrated the urgent need for research addressing urban flooding and how urban trees cope with the stress. Understanding the responses of urban tree species subjected to flooding is crucial for management of the natural resources in general and urban forests in particular. How urban tree species response to combined effect of flooding and elevated CO_2 may influence the full range of ecological processes that operate in urban forest systems, including sapling survival. The objective of this study is to assess the physiological responses of three commonly planted urban oak species to flooding and elevated CO_2. Saplings of live oak (*Quercus virginiana*), sawtooth oak (*Q. acutissima*), and Shumard oaks (*Q. shumardii*) were subjected to flooding and elevated CO_2 treatments (400, 500, 600, 700, and 800ppm). Data on photosynthesis (Ps), stomatal conductance (Sc), transpiration (Tr), and respiration (Rs) were collected during both the flooding (flood cycle) and the recovery period (dry-down cycle) using a Licor-6400 Portable Photosynthesis System. Independent T-tests, paired T-tests, and two-way ANOVAs were used to analyze data with R software. During the flooding cycle, live oaks were not affected by flooding significantly until the CO_2 level was elevated to 800ppm. Flooding affected sawtooth oak Ps, Tr, and Sc significantly at 400pm and 500ppm CO_2 levels. Shumard oak Ps and Tr were significantly affected at 500 and 600ppm levels. In general, live oaks were least affected and Sawthooth oak was most effected. During the recovery cycle there were no significant difference between flood treated and control for all physiological parameters of all three species at all CO_2 levels.

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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. 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 repeated 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 H_2O <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.

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Posters session and Best Poster Award

The posters sessions are in room Azur. Corresponding authors have to attend the session in order to answer questions.

The Best Poster prize will be awarded to the best poster presentation given by a young scientist (≤35 year old) as corresponding author. Scientists willing to apply can download the mark here to be included into their poster. All attendees are eligible for voting during the traditional poster session. Selections will be based on the level of the research (originality, quality of methodology, execution and interpretation), quality of the poster (graphical presentation), and clarity of the presentation (ability to convey the research to the audience, presenter's quality of communication).

The award consists in a certificate and will be assigned during the closing remarks at the end of the conference on Thursday 4th June, 2015.

Corresponding author	Country	Title
Abdollahi K.	USA	Impact of hurricane Gustav on the urban forest ecosystem services in the Gulf Coast of the United States
Agathokleous E.	Japan	Growth responses of a willow to free-air-O_3 fumigation and EDU: A preliminary report
Andersons R.	Latvia	Evaluation of the growth course of young stands of Scots pine (*Pinus sylvestris L.*) in Latvia
Augustaitis A.	Lithuania	The role of genetic diversity and inbreeding of Scots pine stands surviving the effect of unfavourable environmental factors under the presses of climate changes: 3 steps Lithuanian case studies
Balazy R.	Poland	Changes of deforestation patterns in the Western Beskidy and Sudety Mts. in the context of terrain morphology
Baležentienė L.	Lithuania	Contamination and relevance of sooty mold prevalence in urban greeneries
Baležentienė L.	Lithuania	Phenolics identification and affect of herbaceous dominant‘s of pine forest clear-cuts
Bičárová S.	Slovakia	Deposition of ozone to Norway spruce forest for extreme dry and wet rainfall seasons
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Jolivet Y.	France	Responses of poplar to the combination of ozone and drought: special focus on glutathione metabolism
Kam D.G.	Japan	Growth of Japanese larch and its hybrid saplings grown under different O_3 levels
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Kosmowska A.	Poland	Variability of the streamwater chemical composition in catchment with different anthropopressure in Southern Poland
Lihavainen J.	Finland	Metabolite responses of silver birch to elevated humidity
Lim J.H.	Republic of Korea	Climate change induced dieback of evergreen conifers and needs of proactive adaptation measures in Korea
Maignant G.	France	Air pollution modelling and tree health monitoring: A new approach of *health and space*
Meyer M.	Germany	Estimating nitrogen deposition within and outside the peripheral tree canopy from concentrations in moss sampled across Europe
Ning Z.H.	USA	Modeling air pollutant removal, carbon storage, and CO_2 sequestration potential of the urban forest in Scotlandville, Louisiana, USA

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Novotný R.	Czech Republic	N deposition and its impact on forest ecosystems in the Czech Republic – Change in soil chemistry and ground vegetation
Paoletti E.	Italy	Impacts of soil moisture on de-novo monoterpene emissions from European beech, Holm oak, Scots pine and Norway spruce
Parfenova E.I.	Russia	Potential change in forest stand heights based on inventories in Central Siberia in a warming climate
Pavlendová H.	Slovakia	Exceedance of critical levels of ozone along vertical profile in High Tatra Mountains
Pearlmutter D.	Israel	Microclimatic moderation in the urban forest: Assessing the cooling efficiency of trees under hot-arid conditions
Popa I.	Romania	Climate change effects on forest health and growth in the southern and eastern Romania
Rusu E.	Romania	Recent drying of some areas of coniferous forests from Romanian Carpathian Mountains
Sellin A.	Estonia	Growth retardation of trees growing under increased atmospheric humidity: probable mechanisms
Shang H.	China	Responses of antioxidant system in leaves and roots of two endemic broadleaved woody species to elevated ozone and N fertilization in subtropical China
Shi C.	Japan	Re-translocation of foliar nutrients of deciduous tree saplings in different soil condition under free-air O_3 fumigation
Shi Z.	China	Seasonal dynamics of soil respiration and nitrification in subtropical plantations in China
Sitková Z.	Slovakia	Drought-related physiology and growth of mature European beech: linking measurements and model
Šrámek V.	Czech Republic	Rooting pattern of N. spruce and E. beech influence the sensitivity to Al toxicity, nutrient deficiency or drought
Straigytė L.	Lithuania	Urban influence effect of dominant native tree species growth
Ugolini F.	Italy	From special waste into products: polluted canal sediments as substrates for plant nursing cultivation
Vilhar U.	Slovenia	Influence of meteorological conditions and forest crown defoliation on tree phenology in intensive forest monitoring plots in Slovenia
Watanabe M.	Japan	Relationship between cumulative stomatal ozone uptake and photosynthetic parameters of *Fagus crenata*
Westergren M.	Slovenia	Development of forest genetic monitoring system – Delineation of monitoring regions
Ye H.	China	Attack pattern and reproductive ecology of the pine shoot beetle *Tomicus brevipilosus* on Yunnan Pine (*Pinus yunnanensis*) in southwestern China
Ye H.	China	Preliminary study on ophiostomatoid fungi associated with bark beetle Tomicus species in Southwestern China
Zaragoza-Hernández A.Y.	Mexico	O_3 and NO_2 estimated levels in three parks of Mexico City
Zhiyanski M.	Bulgaria	Carbon accumulation in components of mountain ecosystems after forestry – related activities in selected regions of Bulgaria

Impact of hurricane Gustav on the urban forest ecosystem services in the Gulf Coast of the United States

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Abstract

Hurricane Gustav was the second most destructive hurricane of the 2008 Atlantic hurricane season. In Baton Rouge, Louisiana the wind damage from Gustav was the worst of any storm in memory. Thousands of urban forest trees were uprooted and snapped in half by Gustav's fierce winds. The damage was severe enough to effectively shut the city down for over a week. A post hurricane analysis of the Baton Rouge's urban forest ecosystem was conducted using i-Tree Eco software application and based on the Urban Forest Effects Model (UFORE). The analysis revealed that this area has about 1,036,175 trees with tree canopies that cover 44.6 % percent of the city. The analysis reveals a significant tree canopy reduction. The city has more than 45 tree species. The most common tree species are Quercus virginiana (9.5%), *Liquidambar styraciflua* (8.8%), *Pinus taeda* (7.0%), *Carya spp*. (6.5%), *Taxodium distihum* (5.9%), *Quercus nigra* (5.6%), *Quercus phellos* (5.1%), *Magnolia grandiflora* (5.1%), and *Lagerstroemia indica* (5.4%). Trees are currently store about 2 million tons of carbon per year with an associated estimated value of $ 41 million per year. In addition, these trees remove about 178,354 tons of CO_2 per year with an associated estimated value of $1.1 million per year. Baton Rouge's trees are estimated to reduce annual residential energy costs by $8.0 million annually and reduce air pollution (ozone, particulate matter, sulfur dioxide, and nitrogen dioxide) by 860 tons per year with an associated estimated value of $6.2 million per year. The structural value of the trees is estimated at $ 6.2 billion. With the increase in climate variability, increased frequency and intensity of storms, and urbanization pressure, more trees need to be planted and maintained to sustain the current level of structural values and ecological services.

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Growth responses of a willow to free-air-O_3 fumigation and EDU: A preliminary report

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Abstract

Ground-surface ozone (O_3) is a greenhouse gas and a major problem for flora that requires countermeasures. The antiozonant ethylenediurea (N-[-2-(2-oxo-1-imidazolidinyl) ethyl]-N'-phenylurea]), abbreviated EDU, has been widely used as a protectant of plants against O_3. Willow (*Salix sachalinensis*) is an important species for energy production in northern Japan. However, its sensitivity to O_3 is unknown. We established a free-air-O_3-fumigation experiment with this willow in the Sapporo Experimental Forest, Japan. Willow cuttings planted in pots (filled with commercial volcanic ash soils free of organic matter) were placed in three free-air O_3-enrichment rings and three ambient rings, in May 2014. From late July and until middle October, plants were treated by either 0 or 200 or 400 mg dm^{-3} EDU (200 ml $plant^{-1}$) every nine days, in average (10 applications in total). From middle August, the three of the rings were daily enriched with O_3 at a targeted concentration of 80 nmol mol^{-1}, during daytime, until the end of October when the final measurements and the harvest were conducted; the other three served as ambient air (control). Elevated O_3 reduced dry masses of the cuttings, branches, leaves, and roots, separately, and the total biomass, per plant. Furthermore, the added O_3 reduced the average leaf size and dry weight, the number of leaves, and the total leaf area per plant, and accelerated the senescence as was indicated by a higher proportion of senescing leaves per plant. The average specific leaf area was not significantly affected by the elevated O_3. There was a high variability in the EDU treatments. This study is ongoing, and we report here mainly the analyses' results of the biomass data.

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Evaluation of the growth course of young stands of Scots pine (*Pinus sylvestris* L.) in Latvia

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Abstract

Changes in the climate, as well the development of seedling growing technology affects further growth of these trees in the forest. The research aim was to evaluate dendrometric indices and to model growth course of young stands of Scots pine (*Pinus sylvestris* L.). The main objective was to compare obtained data with previous growth course tables. Young stands of pine were selected in several regions of Latvia in year 2014. Dendrometric indices were measured in four forest site types – *Myrtillosa, Vacciniosa, Hylocomniosa* and *Vacciniosa mel.* In southwest region of Latvia were selected 9 and 10 years old Scots pine stands, which were regenerated with bare root seedlings (2+0), bare root plants (1+1) and container seedlings (2+0). Average height in young *Pinus sylvestris* L. stands, which were regenerated with bare root plants, was 3.03±0.07 meters, but in stands which were grew from container seedlings the height was 3.24±0.13 meters. Stands which were regenerated with bare root seedlings showed better result than the other stands reaching average height of 3.58±0.08 meters. There was obtained significant ($p<0.05$) difference between bare root seedlings and bare root plants but not significant between container seedlings and bare root seedlings ($p=0.053$).

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The role of genetic diversity and inbreeding of Scots pine stands surviving the effect of unfavourable environmental factors under the presses of climate changes: 3 steps Lithuanian case studies

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Abstract

Genetic diversity of tree populations most likely play a key role in tolerating the forest pest attacks, air pollution including surface ozone, and acid deposition induced damage when more diverse genotypes better tolerate these stresses than the less diverse genotypes. Therefore in the presented study we attempted to detected variation in the genetic diversity and inbreeding of Scots pine population in Lithuania surviving attacks of needle eating forest pests and high level of local environmental pollution under the presses of climate change. To genotype 150-200 sample trees with highly polymorphic nuclear SSR markers multiplexed with EST SSRs in each stand were chosen. 12 nuclear microsatellite loci were studied. DNA was extracted from wood using the ATMAB-method. Tree resistance to the unfavourable environmental factors was detected by applying long-term data set on tree crown defoliation and stem increment dendrochronology. The objective of the I case study was to detect genetic diversity and inbreeding of 3 Scots pine populations growing in different regions of Lithuania surviving the effect of unfavourable climatic condition, regional pollution load of acidifying compounds and surface ozone. The obtained data revealed that tree competition indices have more significant effect on tree condition and productivity than their genotype and inbreeding. The objective of the II case study was to detect the role of the genetic diversity and inbreeding of 3 Sots pine stands located at different distances from nitrogen fertilizer plant "Achema" surviving the changes in emission load from high to low level under the presses of climate changes. The obtained data showed no consistent trend in inbreeding shift when moving from the nitrogen fertiliser plant. However the stands with high inbreeding level were more damaged by the emissions than those with lower level of inbreeding. Competition indices had a significant effect on tree health deterioration over the period of high pollution level as well as on recovery over the period of reduced pollution level. The objective of the III case study was to assess differences in the genetic diversity and inbreeding in 2 neighbouring Scots pine stands one of which suffered a damage by needle eating forest pests. These findings indicated that the harm of insect damage was greater for the trees with higher degree of inbreeding than for the trees with lower degree of inbreeding. In general, the environmental stresses may reduce the genetic diversity when groups of genetically similar trees are eliminated leaving less genotypic variants in the stands after the injuries. Pine stands with low inbreeding level were found to be more tolerant to the impact of the unfavourable environmental factors than the stands with high level of inbreeding. Competition index plays there a predisposing or even triggering role for the trees surviving the impacts of unfavourable environmental factors.

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Changes of deforestation patterns in the Western Beskidy & Sudety Mts. in the context of terrain morphology

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Abstract

The Western Sudety Mountains is an area affected by a large-scale deforestation in the 1980s, which occurred on approximately 15,000 hectares. That was the largest phenomenon of this type in Europe, named an "ecological disaster". The effects of deforestation were fought for the following twenty years, which involved extensive resources and measures. It is assumed that the main cause of the disaster was air pollution from Germany, Czech Republic, and Poland. It has been found that also other factors had an impact on deforestation, such as transformation of native mixed forests into spruce monocultures in the 19th Century, intensive harvesting, and insect pests. All these factors which influenced deforestation were named "the disease spiral". However, it has not been definitely resolved to what extent each of them has contributed to the process. A similar phenomenon is presently observed in the Western Beskidy Mountains (Western Carpathians). Although the reasons are not exactly the same, the final effects are similarin both areas. Until now, spatial distribution of losses has not been investigated, most likely due to the lack of digital terrain models. Presented study analysed the relationships between deforestation and the topography. Among others, the following factors were examined: exposure, slope, altitude above sea level, and the topographic index, generated based on the airborne laser scanning. Identification of deforested areas at different stages of the calamity was carried out based on the archived aerial and satellite imagery, as well as data obtained from the State Forests GIS. At the final stage of this work, interdependencies between deforestation in both areas (Western Sudety & Western Beskidy) were compared. Our results show that deforestation firstly occurred at 850 m asl, afterwords over 950 m and mortality was especially intensive on western and south-western slopes. Below 750 m asl forest survived quite well.

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Contamination and relevance of sooty mold prevalence in urban greeneries

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Abstract

The empirical evidence of decreased urban tree health condition has been steadily accruing. The sooty mold prevalence on urban tree was assessed during period of 2009-2014 in different greeneries of Kaunas and Vilnius. Together with pathogens which injured urban woody plants, the prevalence of saprotrophic fungi, e.g. the fungal disease agents of sooty mold was estimated in street protective and recreational greeneries. These fungi were detected on 16 species belonging to 13 genus. The *Tilia cordata* remains the most popular among urban deciduous trees in Lithuanian urban greeneries. 3 fungi species belonging to 2 genus, 2 families, 2 classes and 2 phyla, also 12 anamorphic fungi species were were isolated and identifies from the leaves of *Tilia cordata*. *Aspergillus brasiliensis* and *Cladosporium herbarum* prevaled between sooty mold disease agents.

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Phenolics identification and effect of herbaceous dominant's of pine forest clear-cuts

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Abstract

As regards afforestation management, it is important to ascertain whether the dominants of clear-cuttings do biochemical influence the latter regeneration process. Therefore the research aim was to evaluate and to compare the total concentration of phenolic compounds and allelopathic activity of the aqueous extracts produced from both shoots and roots of 1-yr and 2-yr old plant-dominants of clear-cut pine forests (*Pinetum-vacciniosum*). The highest content of total phenolic compounds was observed in the shoots of *Vaccinium vitis-idaea* L., *Calluna vulgaris* (L.) Hull in the 1-yr and *Vaccinium vitis-idaea* L. of 2-yr old clear-cuts. High-performance liquid chromatography (HPLC) was used to identify and quantify the allelochemicals presence in the active fraction in order to ascertain their possible role in the phenomenon of allelopathy. The highest quantity and concentration of phenolic compounds were observed in dominant plant shoot extracts of both 1-yr and 2-yr old clear-cuttings. Significant negative correlation was detected between *ρ*-coumaric and sinapic acids and Scots pine seed germinations, seedlings growth, and also between ferullic, coffeic and hydroxicinnamic acids and Scots pine seedlings growth. The aqueous extract of *Calluna vulgaris* of 1-yr old clear-cut of pine forests and *Rumex acetosella* L. of 2-yr old clear-cuts exerted stronger phytotoxicity on seed germination of Scots pine. The morphometric parameters of seedlings of Scots pine were most sensitive to the shoots of both 1-yr and 2-yr old clear-cuts aqueous extracts of *Vaccinium vitis-idaea* L. and 2-yr old clear-cuts aqueous extracts of *Rumex acetosella* of 2-yr old clear-cuts.

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Deposition of ozone to Norway spruce forest for extreme dry and wet rainfall seasons

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Abstract

Sensitivity of temperate coniferous forests to ozone (O_3) air pollution in relation to weather and climate extremes in mountain environment of the High Tatras, Slovakia was analyzed. Deposition velocity (v_d) and O_3 fluxes to Norway spruce forest calculated by model DO3SE (Deposition of Ozone for Stomatal Exchange) indicate phytotoxic effect of O_3 on mountain forest vegetation both for extreme dry (2003) and wet rainfall (2010) season. In addition, substantially higher Phytotoxic Ozone Dose ($POD_{1.6}$) under heat and water stress conditions than for rainfall abundance was identified. Model results show that Vapour Pressure Deficit (VPD) as well as Soil Moisture Deficit (SMD) in 2003 was not crucial for Mean Stomatal Conductance (G_{sto}), Available Soil Water (ASW), and accumulated stomatal O_3 fluxes (F_{st}) in forests of the High Tatra Mts. region. Deposition velocity of O_3 achieved daily maxima in range from 0.008 to 0.012 m s^{-1} and stomatal O_3 fluxes regularly fluctuated between 0 and 8 nmol m^{-2} s^{-1} during vegetation season. Relevant input parameter for model calculation of O_3 fluxes is O_3 concentration. At EMEP site Stará Lesná (SK04) mean annual O_3 concentrations in 2003 (67 µg m^{-3}) and 2010 (68 µg m^{-3}) were quite similar and slightly above long-term average (64 µg m^{-3}). Accumulated O_3 flux above a threshold value of 1.6 nmol m^{-2} s^{-1} ($POD_{1.6}$) exeeded critical level of 8 mmol m^{-2} at the end of June 2003 and in early July 2010, respectively. Excessive exposure of O_3 reduces photosynthesis, growth, and has adverse effects on whole tree biomass. This work was supported by the Slovak Research and Development Agency under the contract No. APVV–0429–12 and by the Grant Agency of the Slovak Republic under the project VEGA No. 2/0053/14.

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Assessment of the socio-economic value of goods and services provided by Mediterranean forests

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Abstract

Mediterranean forests will be increasingly subject to human pressures and the effects of climate change. Therefore, deforestation and forest degradation will be significant in the MENA countries. This is even more evident than population are strongly dependent on forest ecosystems. In this context, the FFEM funded project aims at "maximizing the production of goods and services of Mediterranean forest ecosystems in the context of climate change" in five countries Algeria, Morocco, Tunisia, Lebanon, and Turkey. One part of this project is the evaluation of the economic and social value of goods and services provided by Mediterranean forest ecosystems, through the study of multiple issues related to environmental changes and their potential effects on the socio-economic development of Mediterranean territories. This assessment approach can contribute to increasing recognition of their importance, to fostering dialogue, thus promoting integration between the policies for various sectors, to integrating the value of these services into policies and into macro-economic indicators, facilitating the analysis of the impacts of changes in the provision of goods and services to users depending on political choices that can change this availability. In this framework, a Mediterranean-region state of the art methods and tools for the socio-economic assessment of the goods and services supplied by an ecosystem was developed. These methods were then adapted and implemented in five pilot sites. Goods and services were prioritized, and factors and levers of changes identified. Scenarios were chosen, and a vulnerability analysis performed. The results in these five pilot sites will be capitalized on to get a regional perspective to the issue and the generalization of the approach to the whole region. The direct beneficiaries of this study are populations of rural forest lands, ecosystem managers and forest services.

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Evaluation of atmospheric N and S deposition and effects on subalpine forests and lakes of the Sierra Nevada Mountains

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Abstract

Atmospheric nitrogen (N) and sulfur (S) deposition is an important factor affecting the health and sustainability of aquatic and terrestrial ecosystems. Impacts of N deposition are especially important in the N-limited ecosystems. These include highly sensitive subalpine forest catchments in the Sierra Nevada, the predominant Mediterranean-zone mountain range of California. Little is known of atmospheric N deposition and its potential ecological effects in these ecosystems. In order to improve our understanding of these inputs and to evaluate their potential effects we conducted a study at the Eastern Brook Lake watershed (eastern Sierra Nevada) and the Emerald Lake watershed (western Sierra Nevada) in summer 2014. At these locations we measured: (a) ambient concentrations of the major N pollutants controlling atmospheric N dry deposition (ammonia [NH_3], nitrogen dioxide [NO_2] and nitric acid [HNO_3]) with passive samplers, (b) ambient concentrations of sulfur dioxide (SO_2) with passive samplers; and (c) surface fluxes of nitrate (NO_3^-), ammonium (NH_4^+) and sulfate (SO_4^{2-}) to whitebark pine (*Pinus albicaulis),* lodgepole pine *(P. contorta),* and western white pine *(P. monticola)* using periodic branch rinsing. Dry deposition of NO_3^-, NH_4^+ and SO_4^{2-} to pine branches were compared to those determined in the mid-1980s in the same areas. Nitrogen and sulfur deposition to subalpine forests in the southern Sierra Nevada will be calculated with: (a) the recently developed empirical inferential method (EIM), and; (b) the National Oceanic and Atmospheric Administration (NOAA) multilayer inferential model (MLM). These values will be compared to simulated deposition with the EPA CMAQ model and annual wet + dry deposition measured at Emerald Lake and Ruby Lake located near Eastern Brook Lake. Based on those values possible exceedances of N and S critical loads for the subalpine forests and lakes in the two study sites as well as the southern Sierra Nevada Mountains will be discussed.

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Calculating ozone fluxes from passive sampler measurements

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Abstract

Tropospheric ozone (O_3) is a pressing sanitary problem for ecosystem health. Different critical levels (CLe) have been established to protect plants from O_3 effects. As O_3 is taken through the stomata, it is now widely accepted that a metric based on O_3 uptake by the plants (ozone fluxes) through the stomata rather than on ambient O_3 concentrations is more biologically sound for O_3 risk assessment. For this reason, CLef based on accumulated O_3 fluxes (Phytotoxic Ozone Dose, POD) have been proposed. They take into account the varying influences of air temperature, water vapour pressure deficit (VPD) of the surrounding leaves, light (irradiance), soil moisture, and plant development (phenology) on the stomatal flux of O_3. A serious limitation for calculating O_3 fluxes at forest sites is that measurements of pollutants are usually carried out with passive samplers. These devices provide typically biweekly mean O_3 concentrations, while for O_3 flux calculation, hourly data are required. Another restriction is that meteorological data are sometimes available as daily means, while hourly data are needed for O_3 flux calculation. In this study we test the suitability of using biweekly O_3 averages (simulating typical passive sampler measurements) and daily meteorological data, instead of hourly data, for O_3 flux calculation. Data from 24 Spanish rural air quality stations (with 1 to 3 years per station) with complete O_3 and meteorological data have been used. Ozone fluxes have been calculated with the DO_3SE (Deposition of Ozone for Stomatal Exchange) model, using a combination of species and forest types for its parameterization, enabling and disabling the soil moisture module, and using different flux thresholds (PODy). It can be concluded that calculation of O_3 fluxes based on biweekly O_3 means is good when hourly meteorological data and no POD threshold Y are used. The use of a POD threshold is identified as an important limitation when using this approach. However, as the dataset used is predominantly Mediterranean (climatic conditions and species used for the parameterization of the model), the suitability of using this approach in other areas must be carefully checked before it can be applied.

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Six-year EDU experiment on an O_3-sensitive poplar clone

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Abstract

Effects of ethylenediurea (EDU) after six years of exposure to ambient ozone (O_3) were examined in an O_3 sensitive poplar clone (*Populus maximoviczii Henry x berolinensis Dippel*). Every week over the growing season (annual average AOT40 was 23 ± 6 ppm h), trees were irrigated with either 450 ppm EDU, that is well known to protect plants from O_3 damage, or water. Sap flow, radial growth, plant phenological stage, BVOC emission, height, diameter, biomass allocation to below and above ground, wood density, leaf area and mychorrhizal infection were determined. Preliminary results show that EDU accelerated bud development and delayed early leaf senescence induced by O_3. EDU treatment increased coarse roots density, fine root length and stem diameter but did not increase the ratio of mychorrhizal infection in roots compared to the plants treated with water. In addition, the prolonged treatment with EDU did not induce a significant change in wood density along the stem, while sap flow was higher in plants treated with water. In contrast, the treatment with EDU influenced BVOC emission, by increasing isoprene and monoterpene emission especially at the end of the growing season.

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Interactive effect of extreme climatic event and air pollution load on growth and wood anatomy of spruce

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Abstract

Climatic extremes are expected to increase in frequency and magnitude as a consequence of global warming, threatening the functioning, services and goods of forests in Europe significantly. Climatic stress influences directly physiological processes of trees. Under stress photosynthesis is reduced and carbon allocation is altered. Stem growth may be reduced early on as it is not directly vital to the tree. As dendrochronology allows studying tree response to stress on inter-annual scale, wood anatomy can be used as sensitive stress indicator with intra-annual temporal resolution. The main objective of presented study was to evaluate retrospectively the impact of extreme climatic and pollution stress during the winter 1995/96 on growth and wood anatomy of Norway spruce in the Ore Mountains (Czech Republic). Simultaneously the long-term relationship of radial growth to climatic factors and its dynamic changes over time were investigated. The study was based on permanent monitoring plots established in 1996 within the young spruce stands covering the gradient of forest damage in the Ore Mountains. It took advantage of the data from annual assessment of tree vitality, tree nutrition and pollution load within the plots in the period 1996 – 2013. Hence reliability of radial growth as a stress indicator was evaluated in relation to the routinely assessed parameters such as defoliation, number of needle year classes, length of annual shoots and the content of air pollutants and nutrients in the assimilation organs. The work has been carried out under the framework of the COST FP1106 network STReESS.

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Impacts of acid deposition, ozone exposure and weather conditions on forest ecosystems in Europe derived from long-term monitoring

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Abstract

In 1994, a "Pan- European Programme for Intensive and Continuous Monitoring of Forest Ecosystems" has been started to contribute to a better understanding of the impact of air pollution, climate change and natural stress factors on forest ecosystems. The programme today counts approximately 760 permanent observation plots including near 500 plots with data on both air quality and forest ecosystem impacts. In this presentation, we summarize impacts of trends and geographic variations in nitrogen and sulphur deposition and ozone concentrations in interaction with weather conditions on (i) water and element budgets and nutrient-acidity status, (ii) forest crown condition, (iii) species diversity of the ground vegetation and (iv) forest growth and carbon sequestration, based on both national and European scale monitoring studies. The analyses of large scale monitoring data sets show significant effects of atmospheric deposition on element budgets and nutrient-acidity status but only partly confirmed various hypothesized impacts of different air quality variables (deposition of N and acidity and O3 exposure) and weather variables (temperature and precipitation) on forest health, forest growth and species diversity of the ground vegetation, but this may partly be caused by the problem of confounding factors.

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European white birch (*Betula pendula*): Impact of air pollutions on the allergenic pollen, an overview

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Abstract

Birch pollen is mainly responsible for allergenic diseases in Central and Northern Europe. Climate change and air pollution will affect the allergenic potential of pollen, either by changes of the pollen season or the pollen amount, by affecting the structure of the exine surface, or by directly increasing the transcripts and allergenic proteins, and interactions with biologically important ligands, e.g., flavonoids. This overview reflects the impact of air pollutions (O_3, NO_2) on birch pollen as reported in the literature on the basis of laboratory and field research. Catkins of birch trees were collected in the greater area of München. High environmental O_3 concentrations showed a positive correlation to the allergen Bet v 1 content and a negative correlation was observed for NO_2 [1]. Skin prick tests showed larger wheals indicating an enhanced pollen allergenicity in an O_3-enriched environment [1]. In contrast pollen collected in urban areas compared to rural areas revealed no differences in Bet v 1 content [2]. However, the chemotactic activity of pollen extracts on human neutrophil granulocytes was significantly higher from urban samples to rural samples [2]. This indicates that the allergenicity is determined not only by the allergen [3]. Moreover regional and year-to-year variations in Bet v 1 release were also observed [4]. Fumigation of isolated birch pollen with O_3 + NO_2 or NO_2 alone led to a pronounced increase of nitration over time [5]. This indicates that the nitration of Bet v 1 might be a contributing factor in increasing the pollen allergenicity [6]. Such an impact of air pollutions and climate change on the allergenicity of pollen has also been observed for herbaceous plants, e.g. ragweed (*Ambrosia artemisiifolia*) [7-9].

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The response of intra-annual stem growth of young European beech provenances to the 2012-2014 weather variability

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Abstract

Increasing frequency and severity of extreme weather events, especially droughts, arising from ongoing changes in climate negatively affect the productivity and stability of forest ecosystems, including beech ones. The objective of the study was to quantify relations between intra-annual stem circumference growth of 5 European beech (*Fagus sylvatica* L.) provenances and weather variability during 2012-2014 seasons. The study was carried out in central Slovakia (810 m a.s.l.) on provenance plot established in 1998. From each 5 European provenances (the area of origin ranged from 45°44′N to 53°39′N, 10°40′E to 19°10′E, and 55 to 1100 m a.s.l.) 6 trees were selected for measurement on micro-plots in 2x3 trees experimental design. Measured trees were 16 years old in 2012, ranged from 6.0 to 9.9 cm in dbh and from 2.5 to 3.5 m in height. Continuous measurements of stem circumferences, solar radiation, air temperature, air humidity, precipitation and soil water potential were carried out during the growing seasons 2012-2014. The growing seasons 2012 and 2013 were above average in temperature including heat waves followed by some colder periods, while there were no heat waves during 2014 season. July and August 2014 were abundant in precipitation contrasting to previous growing seasons, especially 2013. This fact was reflected in decreased soil water potential as well as circumference growth which was markedly reduced during July and especially in August of 2013 growing season including all provenances. The whole seasonal increments were higher in 2014 and also in 2012 compared to 2013. During all seasons the lowest increment was recorded at the provenance from the northern Germany (the provenance from the most northern site, the lowest altitude and the most oceanic climate), the highest one at the provenance from the Austrian Alps (the provenance from the highest altitude).

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Responses of poplar to the combination of ozone and drought: special focus on glutathione metabolism

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Abstract

Context. Presently, the impact of drought events on the effect of ozone pollution still needs more investigation. Drought may alleviate the O_3 entrance in the leaf by reducing the stomatal aperture (Matyssek *et al*., 2010). However drought by itself also induced changes in cell redox homeostasis and the behaviour of the cell antioxidative charge in case of stress combination (drought and O_3) is still unknown. **Aims of the work**. Glutathione is well known as antioxidant molecule but also has several roles in plant cell development. In condition of combined stresses (drought and O_3), we intend to decipher the response of detoxification mechanisms in relation with glutathione metabolism. Two euramerican poplar genotypes (*Populus deltoides* x *Populus nigra*), *Carpaccio* and *Robusta*, differing in ozone sensitivity and for which differences in detoxification mechanisms have been stated (Dumont *et al.*, 2014), were investigated. **Results.** We exposed the two poplar genotypes to various treatments for 17 days: a moderate drought, an O_3 fumigation (120 ppb), or the combination of both treatments. Ecophysiological, biochemical and molecular parameters were measured. Both genotypes were drought-tolerant, with higher water use efficiency for Robusta. For this genotype, characterized as ozone-sensitive, gene expression and enzymatic activities of glutathione reductase and dehydroascorbate reductase displayed an early response to oxidative stress. The combined treatment tended to induce nearly an ozone-like response. **Conclusions and Perspectives.** This work constitutes preliminary results and further analyses are in progress to extend the role of glutathione metabolism in ozone / drought tolerance. This work is supported by the French National Research Agency through the Laboratory of Excellence ARBRE (ANR-12- LABXARBRE-01).

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Growth of Japanese larch and its hybrid saplings grown under different O_3 levels

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Abstract

The ground-surface ozone (O_3) has emerged as a major air pollutant affecting to decline the growth of trees and to induce defoliation, the inhibition of photosynthetic activities and reduction of biomass. The high concentration of O_3 in the troposphere has been being detected frequently in Japan and sometimes reached to more than 100 nmol mol^{-1} (ppb). Japanese larch (JL), because of the tolerance to low temperature and rapid growh rates, was introduced in northern Japan as the afforestation species from the central subalpine region. Its hybrid (HL) was developed to overcome a shoot blight disease and grazing by voles. In order to understand responses of 2 larches to the effect of different O_3 levels, we set Open Top Chambers (OTCs) system. The concentration of O_3 in chambers were regulated in control (filtered air by charcoal), ambient air, 40 and 80 ppb with four chamber replications in daytime. Two-year-old seedlings of JL and HL were planted in the brown forest soil in May 2013. To compare the growth of 2 larches, we measuered the diamter and height of all individuals from 2013 to 2014. Based on 2-year observation, we found less sensitivity of JL grown under 80 ppb O_3 treatment as compared with HL. At 80 ppb O_3 treatment, the growth of HL was more inhibited by O_3 than that of JL. And also, the ascorbic acid content in needles of HL grown under 80 ppb were the highest, as compared to JL. Therefore, we should discuss to get plausible understanding of O_3 sensitivity in 2 larch species in association with the antioxidant mechanism and photosynthetic activities.

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Differences among provenances and genotypes in leaf traits of silver birch (*Betula pendula)*

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Abstract

Extent of intraspecific variation defines the ability of a species to acclimate to environmental conditions, such as climate change. We studied differences between southern and northern populations in leaf traits of silver birch (*Betula pendula* Roth.*)* in a common garden experiment established in central Finland (62°N) with a total of 26 genotypes representing 6 provenances (latitudes 60°, 61°, 62°, 65°, 66° and 67°N). Leaf areas, fresh and dry masses, chlorophyll and flavonol indexes were measured from both short shoot and long shoot leaves. Most parameters had clear differences among provenances. The northern provenances, and particularly the most northern one, were characterized by higher leaf area, higher leaf mass and higher chlorophyll content index. However, flavonol content had strong differences among genotypes within each provenance. The parameters had similar response patterns among the provenances and genotypes regardless of whether they had been measured from short shoot leaves or long shoot leaves. The specific leaf area of the leaves correlated positively with tree height growth.

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Variability of the streamwater chemical composition in catchment with different anthropopressure in Southern Poland

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Abstract

Western part of Polish Carpathians was under a strong influence of anthropopressure during the 80's and 90's of the 20 th century. Pollution coming from industrial parts of Upper Silesia and Cieszyn Silesia resulted in the degradation of spruce stand in the ridge zone of Silesia Beskid. The objective of the following study was to identify the factors, which influenced seasonal chemical composition changes of waters draining catchment with various extent of forestation. The study was conducted in 2014 in the region of Skrzyczne massif (1257m) in Malinowski catchment in Silesia Beskid. Water samples were collected on a monthly basis along the main stream in 18 points represented by 12 independent and 6 interrelated catchments. Catchments represented various levels of forestation. Water level and physiochemical qualities (pH, EC, Tw) were measured in the field. The chemical composition of the waters samples was determined using an ion chromatography system DIONEX 2000 for 14 ions (Ca^{2+} , Mg^{2+}, Na^{+}, K^{+}, NH_4^{+}, Li^{+}, HCO_3^{-}, SO_4^{2-}, Cl^{-}, NO_2^{-}, NO_3^{-}, PO_4^{3-}, Br^{-}, F^{-}). 216 samples were collected during 12 measurement series. Waters draining deforested ridge part of are low mineralized and low pH than waters draining the forested part. Characteristic feature of waters draining forested fragments of catchment was multiple concentration of HCO_3^{-} (7,9 mg/L) while in deforested one - 2,3 mg/L. Similar relationship can be observed in case of NO_3^{-}. In forested catchment it amounted to 6,9 mg/L while in deforested one it – 4,9 mg/L. From hydrochemical point of view waters draining different types of catchment (forested and deforested) were characterized by various hydrochemical types. Among anions HCO_3^{-}, SO_4^{2-}, NO_3^{-} were predominant (< 10% mval /L) in the forested catchment, whereas $NO_3^{-}$and SO_4^{2-} were predominant in the forested one. Principal component analysis (PCA) was used in order to identify independent factors: streamflow, seasonal and circulation. The present research was funded by the Grant No. NSC - 2011/01/B/NZ9/04615 - The impact of deforestation caused by the ecological disaster on spatial variations and changes in the chemistry of spring water and surface water in the Silesia Beskid.

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Metabolite responses of silver birch to elevated humidity

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Abstract

Climate change scenarios predict that relative humidity (RH) may increase in northern Europe in association with increasing precipitation, cloud cover, atmospheric water vapor and more frequent wet days. RH affects plant growth and nutritional status; under high RH, plants can assimilate carbon with a relatively small cost of water, but at the same time mineral nutrient uptake is impaired due to decreased transpiration rate and mass flow of water. We studied the effects of elevated RH on the leaf metabolites of silver birch (*Betula pendula Roth*.) in a controlled growth chamber experiment and in a long-term Free Air Humidity Manipulation (FAHM) field experiment. In the chamber experiment, RH was elevated from 60% to 95%, and in the FAHM study RH was elevated by 7-8% over the ambient. Leaves were sampled after 26 days (chamber) and during the 4th growing season (field). Leaf starch content increased under elevated RH in both experiments. Untargeted metabolic profiling with GC-MS revealed that glutamate and aspartate increased, whereas shikimic acid, ribonic acid, glucose, sedoheptulose, glutamine, alanine and valine decreased under elevated RH in both experiments. In addition, elevated RH induced the production of secondary metabolites such as 3-coumaroyl quinic acids and flavonol glycosides in birch leaves in chamber and field experiments.

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Climate change induced dieback of evergreen conifers and needs of proactive adaptation measures in Korea

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Abstract

Obvious changes in phenology of biota, species distribution range shift, and forest disasters and disturbances by extreme weather events due to recent global warming have been observed during the last century. Korean forests which are located in temperate forest zone covered mainly by oaks and pines have also been experienced such impacts of global warming. Recently evergreen coniferous forests in Korea are declining, especially after warm and dry winter season. Mortality of pines including *Pinus densiflora* and *P. koraiensis* were recorded in 1989, 1998, 2002, 2007, 2009 and 2014 which were dry from fall season of previous year with higher temperature in winter and early spring. Mortalities have been more frequently occurred on southern area outside of southern limits of their natural distribution ranges in regional level, and on pure dense stands located on steep southern/western slopes or ridges with poor edaphic conditions in local level. Mechanism of recent pine mortality in Korea is supposed to be carbon starvation due to stomata closure to avoid prolonged drought stress which was intensified by high temperature in winter and early spring. Drought stress also exacerbated the pathogenicity of *Cenangium ferruginosum*, an endophytic fungus, especially more to *P. koraiensis*. Korean climate has distinct four seasons with hot/humid summer and cold/dry winter and IPCC climate change scenarios projected seasonally different patterns. Air temperature increase rate will be more rapid in winter than summer while precipitation is more variable and uncertain. Thus evergreen coniferous forests in Korea will be more vulnerable to future climate due to the increase of winter temperature. To adapt to the future climate for maintaining forest health, productivity and biodiversity as well as resilience of forest ecosystem, early actions thinning and diversifying forest type and stand structure and amelioration of age class distribution are strongly recommended.

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Air pollution modelling and health monitoring in French cities: A new approach of health and space

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Abstract

In urban areas, gathering most of the inhabitants in South-eastern France, ground-level air pollution (such as ozone) can become an increase sanitary problem affecting trees, biodiversity and well-being of citizens. As an example, the ozone concentrations are still increasing in the cities. However, these harmful effects still need to be refined. The main aims will be (i) to explain how it is possible to model the air pollutants dispersion in cities at a fine scale, and (ii) to define the most relevant and important parameters for the modelling. Those types of models require large geo-referenced databases. The secondary aim will be to lay the foundations of a reflection on the Environment-Health links. Starting with an example of the modeling of air pollution effects on vegetation and health in South of France, we will develop a transferable methodology to the whole Mediterranean region. This theoretical analysis will highlight the problems of urban data monitoring, in general, and the health monitoring, in particular, to go beyond traditional epidemiological studies. Those studies attribute mortality to acute short-term exposures, but causality must be established yet. We have to work in terms of environmental factors, in line with morbidity, to find relationships between urban pollution, urban trees and citizen health which are useful for city planning and public decision makers. Starting with a differentiated spatial modeling approach (emissions and concentrations across the street) and addressing the impact on vegetation, the methodology will be explained in some empirical cases.

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Estimating nitrogen deposition within and outside the peripheral tree canopy from concentrations in moss sampled across Europe

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Abstract

Atmospheric deposition of nitrogen (N) might impact several functions of ecosystems. Due to the filtering effect of vegetation canopies and subsequent enrichment of atmospheric N deposition in the biomass, forests are particularly exposed to N deposition and accumulation. Therefore, the study aimed at investigating N deposition in forests and in (neighbouring) open fields by use of moss sampled across seven European countries (Austria, Switzerland, Germany, Spain, Finland, France, and Slovenia). The specimens were collected and analysed chemically according to the guidelines of the European Moss Survey. The ratios between the total N concentration in moss sampled at sites located in open land next to forests and at sites influenced by canopy drip within forests was computed and, then, used to calculate estimates for sites where moss was collected either within or outside of canopies. Furthermore, potentially influencing environmental factors (e.g. precipitation, elevation, population density, modelled N deposition and land use) were analysed by multivariate techniques in order to uncover relationships between the total N concentration in moss and environmental factors. The average N concentration measured in moss was 19.8 $mg.g^{-1}$ within and 11.9 $mg.g^{-1}$ outside the peripheral tree canopy. Thus, the average N concentration in tree stocks is about 67% higher than outside. This value depends from the N concentration level. Highest N concentrations in moss sampled within and outside the peripheral tree canopy were proved for Germany. Wilcoxon-signed rank tests carried out to verify the estimates by measurement data indicated that the estimations did not significantly differ from the measurements. The results of the multivariate analyses confirmed that the sampling site category (site with / without canopy drip) was the factor most associated with the N concentration in moss. The respective models explained more than 70% of the variance in the data sets analysed.

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Modeling air pollutant removal, carbon storage, and CO_2 sequestration potential of the urban forest in Scotlandville, Louisiana, USA

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Abstract

To assess the ecological benefits that urban forests provide, the U.S. Forest Service Northern Research Station created an i-Tree Eco model. Using i-Tree Eco sampling and data collection protocol, a stratified random sample plot map of Scotlandville was generated (stratified by land use type). Field data were collected including tree species, health condition, diameter at breast height, total tree height, height to live top, height to crown base, crown width, crown dieback, crown light exposure, percent impervious surface under the tree, direction and distance to building, etc. Data were then entered into i-Tree Eco v5.0 model and analyzed. Modeling results indicated that there are an estimated 239,000 trees in Scotlandville with a tree canopy cover of 23.7 percent; the three most common species are Black Willow, Water Oak, and American Elm; the overall tree density is 31.2 trees/acre; and trees that have diameters more than 6-inches constitute 56.5 percent of the population. The model estimated that the urban forests in Scotlandville remove 96 tons of air pollutants per year with an associated value of $1.11 million; the gross sequestration is about 3,880 tons of carbon per year with an associated value of $276 thousand; net carbon sequestration in the urban forest is about 3,650 tons. Carbon storage and carbon sequestration values are calculated based on $71 per ton; and trees in Scotlandville are estimated to store 97,900 tons of carbon ($6.97 million). Of all the species sampled, Water oak stores and sequesters the most carbon (approximately 28.7% of the total carbon stored and 23.1% of all sequestered carbon.) Trees in Scotlandville were estimated to produce 9,720 tons of oxygen per year; reduce energy-related costs by $324 thousand annually; and provide an additional $52,595 in value by reducing the amount of carbon released by fossil-fuel based power plants (a reduction of 739 tons of carbon emissions).

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N deposition and its impact on forest ecosystems in the Czech Republic – change in soil chemistry and ground vegetation

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Abstract

Reduction of nitrogen deposition, compared with a decrease of sulphur/sulphate deposition during last twenty years has been much less pronounced in the central Europe. In the Czech Republic the critical load for acidification is still exceeded on about 45 % of forest area (in 2007). For the critical load of nitrogen the exceedance was detected on more than 95 % of forest land (in 2007). This study analyses the data from repeated soil- and ground vegetation survey on ICP Forests level I plots in the Czech Republic. Our results show significant decrease of C/N ratio in the organic layer of forest soils indicating ongoing nitrogen saturation during the period of 1996-2006. The contents of exchangeable base cations and base saturation of mineral layers has decreased, although the significant change has been found just for the depth of 10-20 cm. The stock and accessibility of Ca and partly Mg and K is limited even in stands which are considered as nutrient rich or nutrient medium according to the site index used by forestry practice. In last fifteen years the occurrence and cover of nitrophilous species in the herb layer has significantly increased which corresponds with nitrogen increase in forest floor. The significant relation was found between nitrogen content in soil organic layer and modelled nitrogen deposition in two previous years. There was no significant relation with older deposition data. The results suggest that nitrogen deposition still represents a threat for forest ecosystems in central Europe and their influence on the ecosystem biodiversity and production sustainability has to be taken into account by forest managers.

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Impacts of soil moisture on *de-novo* monoterpene emissions from European beech, Holm oak, Scots pine, and Norway spruce

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Abstract

Biogenic volatile organic compounds (BVOC) are important atmospheric trace gases. They are released from plants and are involved in photochemical ozone and particle formation. The release of BVOC is frequently associated with a range of biotic and abiotic stress factors. On a quantitative basis, the most important BVOC are isoprenoids such as isoprene and monoterpenes. Isoprene and monoterpene emissions from trees originate from the synthesis of complex molecules from simple molecules (*de-novo* biosynthesis) in a light- and temperature-dependent manner and environmental conditions can have a strong influence on their biosynthesis. For this reason, impacts of soil moisture on *de-novo* monoterpene (MT) emissions from Holm oak, European beech, Scots pine, and Norway spruce were studied in the laboratory. The results showed that mild drought caused only slight increases of MT emissions. The increases were explainable by increasing leaf temperature due to lowered transpirational cooling and by recovery from a preceding hard drought. Severe drought decreased MT emissions to almost zero. Re-watering the plants caused increasing emissions until the same levels were reached as before the drought stress, implying that impacts of drought were reversible on a time scale of days. To incorporate impacts of soil moisture on *de-novo* MT emissions into the Model of Emissions of Gases and Aerosols from Nature (MEGAN), the volumetric water content of the soil, Θ, was used as a reference quantity. As long as Θ was > 0.2 m^3/m^3, emissions were not directly affected. With Θ below a certain threshold, MT emissions decreased simultaneously with Θ. The relationship between Θ and MT emissions was to a good approximation linear, allowing the determination of Δ Θ 1 (the range of Θ where the emissions drop from their maxima to zero). As average from 7 independent replicates was found Δ Θ 1 = 0.08 m^3/m^3 with a standard error of 0.02 m^3/m^3. There were no systematic differences of Δ Θ 1 between Mediterranean Holm oak and trees from boreal and temperate forests. The value Δ Θ 1 = 0.08 m^3/m^3 was therefore used in MEGAN. It was also tested whether a factorial approach, such as the one used in MEGAN, was suitable to describe the soil moisture dependence of *de-novo* MT emissions. Using Holm oak the temperature and light intensity dependence of the emissions was measured for well-watered plants and during severe drought stress. No substantial interdependencies were found, indicating that the approach used in MEGAN for isoprene is also suitable for *de-novo* MT emissions. Describing the soil moisture dependence using Θ as a reference was unsuccessful in case of sudden soil moisture changes. Re-watering the plants after severe drought stress caused emissions to increase on a time scale of days. During recovery no relationship between Θ and the emissions was observed.

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Potential change in forest stand heights based on inventories in Central Siberia in a warming climate

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Abstract

Climate-based forest height models (ForHeiM) were developed using regression and forest inventory data (2850 plots) for a large region in central Siberia (85-105°E and 49-75°N). The collinearity was high between the three major climatic variables (heat, cold, moisture). Heat (growing-degree days) was left as the only predictor, explaining 63% of the variation in the northern plains and tablelands, and 38% in the southern mountains. We used SibCliM, our Siberian bioclimatic model, and ForHeiM to predict forest vegetation types and stand heights over central Siberia in current and 2080 climates. Kappa statistic comparing observed and our predicted forest type and stand height maps in current climate showed good and fair matches, respectively. We used the Hadley HadCM3 A2 and B1 climate change scenarios for 2080. Productive forests (30-40 m stand height) are predicted to increase in area in the future climate, while less productive forests (10-20 m) would shrink, especially in the sharp A2 climate. Forest area is predicted to decrease 20%, while the forest-steppe ecotone increases 5-fold; grasslands are predicted to cover about 30% of central Siberia in the A2 climate.

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Exceedance of critical levels of ozone along vertical profile in High Tatra Mts.

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Abstract

Tropospheric ozone is the most important air pollutant to forest trees. Critical levels of ozone set for forest protection are widely exceeded across whole Europe. The poster presents preliminary results of the measurement during the first vegetation season 2014 of ongoing project MapPOD. Ozone concentrations and other environmental parameters related to ozone flux were measured at six research plots with altitudes from 810 to 2634 m a.s.l. along vertical and spatial profile in High Tatra Mts. Cumulative exposure index AOT40 and phytotoxic ozone dose POD_1 were calculated for Norway spruce (*Picea abies* (L.) Karst) using the DO_3SE model (Deposition of O_3 for Stomatal Exchange). Both ozone concentrations and AOT40 values were below the long-term average in 2014. AOT40 increased with altitude and reached values from 3.97 ppm h in Stara Lesna (810 m a.s.l.) to 8.35 ppm h at Skalnate Pleso near the timber line (1770 m a.s.l.) and 16.5 ppm h in Lomnicky Peak above the timber line (2634 m a.s.l.). The critical level set for forest protection 5 ppm h was exceeded only at half of research plots. POD_1 reached values from 10.68 m mol m^{-2} PLA in Kolove Pleso (1550 m a.s.l.) to 17.42 m mol m^{-2} PLA in Skalnate Pleso (1770 m a.s.l.). Critical level 8 $mmol.m^{-2}$ PLA recommended for spruce protection was exceeded at all research plots even in year with low ozone concentrations. Besides the ozone concentrations, the POD is influenced by other environmental factors that affect ozone flux into the plant. While in lower altitudes the main limiting factor for ozone flux is soil water availability, in high altitudes the main limiting factors are the temperature and the duration of vegetation season influenced by the duration of snow cover.

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Microclimatic moderation in the urban forest: Assessing the cooling efficiency of trees under hot-arid conditions

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Abstract

The urban population of the world's arid regions is growing. Climatically harsh conditions, intensified by local heat islands and compounded by regional and global changes, make pedestrian activity thermally stressful and deepen residents' reliance on energy-intensive air conditioning. In this context, urban trees and green infrastructure are vital for climatic moderation – but at the same time, water scarcity together with difficult urban growing conditions highlight the need for "efficient" solutions that provide maximal environmental benefit with minimal natural resources. Our research in the hot-arid Negev desert of Israel has examined the "cooling efficiency" of urban trees, quantifying the potential for moderating pedestrian thermal stress and the irrigation water required to achieve it. In controlled outdoor experiments (Shashua-Bar et al. 2009; 2011), measurements were made in semi-enclosed courtyards with various combinations of mature trees, artificial shading, grass and paving. For each landscape configuration, the Index of Thermal Stress (ITS) was calculated from measured data to evaluate thermal comfort based on pedestrian-environment energy exchanges. The "cooling efficiency" was gauged by comparing the total evapotranspiration with the reduction in thermal stress, both expressed in terms of their equivalent energy. While conditions in a paved, unshaded courtyard were found to be uncomfortable throughout the summer daytime hours, each of the landscape treatments made a clear contribution to the moderation of thermal stress. Shading reduced the duration of discomfort by over half and limited its maximum severity, and when combined with grass yielded comfortable conditions at all hours. The effect of trees was more pronounced than that of the artificial mesh, due to the latter's elevated radiative surface temperature. It was found that a combination of locally adapted shade trees and irrigated ground cover not only creates thermally comfortable conditions in otherwise stressful outdoor environments, but requires less water for irrigation than exposed grass alone.

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Climate change effects on forest health and growth in the southern and eastern Romania

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Abstract

It is well known that climate change and air pollution are the main driving forces behind forest health and growth dynamics. Their effects are more important in forest ecosystems located in marginal or restricted ecological conditions such in south and south-eastern part of Romania. Species located in this part of Romania which is situated under extreme continental and steppe climate (e.g. *Quercus spp.* and *Robinia pseudoaccacia*) are most affected (22-43% share of damaged trees – crown defoliation >25%) comparing with *Fagus sylvatica* (11%) and *Picea abies* (9%) which are situated in hills, mountain and alpine regions. Climate influence on tree health status is relatively low (correlation coefficient r_{max}=0.1-0.2 at national level and r_{max}=0.2 – 0.3 at regional level, mainly in south and south-eastern Romania). Generally precipitation is the main climatic driver on tree defoliation and a negative correlation has been observed for main species. Also a correlation between tree ring index and precipitation was emphasized. For *Quercus spp*. which are in majority located in this part of Romania, the tree growth are limited by the precipitation amount from current growing season. The intensity of monthly correlation varies between species. These analyses of the spatial correlation between tree ring index and seasonal precipitation allowed establishing the representativeness of each monitoring site. The relation between the forest growth and crown defoliation parameter along with climate scenarios allows formulating predictions on potential changes of forest ecosystems. Modeled data on forest growth obtained in the intensive monitoring network are used to estimate hypothetical growth losses, and subsequently the mechanisms of forest acclimatization or in the worst case scenarios an indicator of plausible ecological uncertainty. In this region, it has been found that forest ecosystems reduce their growth with 13-22%, as a consequence to the recent climate fluctuations.

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Recent drying of some areas of coniferous forests from Romanian Carpathian Mountains

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Abstract

It has been noticed that in the last two decades some areas of coniferous forests from Romanian Carpathians have undergone a process of drying determined by several factors like: global warming trends, long heat waves, plantations outside their natural habitat, local thermal inversions caused by limestone bedrock and insects attacks. There are a number of more special causes that have provoked the drying of forest areas. Among these are mentioned the favorite drying of surfaces located on the southwestern limestone slopes, the higher temperatures recorded on limestone peaks than in the lowlands, and forestations conducted during the communist period. These monospecific plantations carried out in the context of rapid industrialization, were made almost exclusively with coniferous species, often outside the favorable habitat conditions. These plantations have become vulnerable to heat waves and recent climate changes.

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Growth retardation of trees growing under increased atmospheric humidity: probable mechanisms

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Abstract

Climate change scenarios predict by the end of the century increases in air temperature by 3.5–5ºC and precipitation by 5–30% in boreal and northern temperate regions of Europe. Increase in atmospheric relative humidity (RH), the inevitable result of more frequent rainfall events, will reduce water fluxes through the forest canopies. This has impact on various physiological processes leading to the slowdown of trees' growth rate observed both in silver birch (*Betula pendula*) and hybrid aspen (*Populus tremula* × *P. tremuloides*) – the species growing at the Free Air Humidity Manipulation (FAHM) site in eastern Estonia. We propose five alternative mechanisms to explain the growth deceleration observed in one or both experimental species. (1) Reduced water flux through the trees diminishes nutrient uptake, leads to lower leaf nutrient status and unbalanced foliar P:N ratio causing a decline in leaf photosynthetic capacity. (2) Retardation of foliage development in response to elevated air humidity (because of oxidative stress?), which is observable at individual leaf and whole-tree foliage levels; the biomass production of trees is directly proportional to their foliage area. (3) Larger investments in vascular tissues in relation to foliage area cause an increase in the ratio of non-photosynthetic to photosynthetic tissues. The change in allocation pattern means larger maintenance respiration costs determined by the volume of living parenchyma cells. (4) A probable increase in proportion of living parenchyma cells in relation to dead xylem elements in sapwood, resulting in higher stem respiration. (5) Reduced hydraulic conductance of stems and leaves becoming a critical factor in case of weather extremes (heat wave, severe drought). Disproportionate changes in sensitivity of stomatal conductance (determining water losses) versus leaf hydraulic conductance (responsible for water supply) to water deficit during sudden weather fluctuations will impose greater risk of desiccation-induced hydraulic dysfunction on leaves.

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Responses of antioxidant system in leaves and roots of two endemic broadleaved woody species to elevated ozone and N fertilization in subtropical China

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Abstract

Two endemic woody species, *Phoebe bournei (Hemsl.)*Yang and *Phoebe zhennan (Hemsl.)*Yang seedlings were supplied with N as NH_4NO_3 solution at 0, 50 and 100 kg/hm^{-2}/$year^{-1}$ and were exposed to ambient ozone (O_3) concentration or charcoal-filtered air or elevated O_3 (100ppb and 150ppb) for one growing season in subtropical China. To assess the responses of antioxidant system of leaves and roots to O_3, photosynthetic parameters were determined by using LI-6400 photosynthetic measurement system, and seven indices were analyzed including chlorophyll, carotenoid, ascorbic acid, malonaldehyde, total phenols, superoxide dismutase and total antioxidant capacity. The objectives of the study were (1) to investigate the individual and synergic effects of O_3 exposure and nitrogen load on the antioxidant system and photosynthetic characters of two tested plants; (2) to establish the linkage between photosynthetic physiological indices and antioxidant indexes; (3) to identify the different response of antioxidant system between leaf and root; (4) to compare the variant response between two species; (5) to explore the possible mechanisms in the response of antioxidant system to O_3. The determination of the samples is now underway.

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Re-translocation of foliar nutrients of deciduous tree saplings in different soil condition under free-air O_3 fumigation

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Abstract

In Northeast Asia, ground-surface ozone (O_3) is continuously increasing even though local precursors of O_3 have been decreasing. At elevated O_3, leaf senescence is usually accelerated and the leaves shed earlier. In general, elements of leaves are usually re-translocated to stem, root, etc. before leaf shedding. Re-translocation can be defined as the amount of an element depleted from older plant components and made available for new growth. Chemical and biological aspects of above-ground leaf nutrient content are important in ecosystem function and dynamics via decomposition process. The re-translocation of foliar nutrients (e.g. N, K, Mn, Mg and P) in broadleaved deciduous trees is influenced by soil nutrient availability or high ozone concentration (O_3). We studied the re-translocation with/without free air O_3 fumigation system for one growing season using seedlings of Birch (*Betula platyphylla* var. *japonica*), Oak (*Quercus mongolica* var. *crispula*), Beech (*Fagus crenata*), Willow (*Salix sachalinensis*) planted on poor (serpentine soil, excluded willow; immature volcanic ash soil) and rich (brown forest soil) fertility soils, respectively. All tree species were grown under 3 replications per each at elevated O_3 (about 80 ppb) and ambient condition (O_3 ranging 25-35 ppb). Upper leaves in growing season (mid-September) and fallen leaves samples in mid-November were collected for chemical composition analysis by ICP and N-C analyzer. We will focus on the net re-translocation and allocation dynamics of foliar nutrients to address the following major questions: 1) Is there any difference in the re-translocation among species with different O_3 sensitivities? 2) Does the re-translocation rate in species differ between soil condition or not? Based on the results, we discussed plausible understanding the ecophysiological meaning of re-translocation of each element in leaves in relation to specific traits of O_3 sensitivity.

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Seasonal dynamics of soil respiration and nitrification in subtropical plantations in China

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Abstract

Carbon and nitrogen cycling show a distinct seasonal dependence in forest ecosystems. The objective of this study was to examine the seasonal patterns of soil respiration and gross nitrification rates in three subtropical plantations (*Pinus massoniana*, *Castanopsis hystrix* and nitrogen-fixing *Erythrophleum fordii*) over a period of 11 months and to elucidate how these two turnover processes were controlled by soil microbial community and environmental factors. Turnover rates were measured with the Barometric Process Separation (BaPS) technique. Microbial community was characterized using phospholipid fatty acid (PLFA) analysis. The results shown that the turnover rates were highest during the wet season and lowest during the dry season in the three plantations. In contrast, maximum values for microbial biomass (MB), total PLFAs, fungal PLFAs and bacterial PLFAs were recorded in all plantations during the dry, not the wet season. Both turnover rates were positively correlated with soil temperature and soil moisture. Moreover, soil respiration and gross nitrification rates of the *E. fordii* plantation were much higher than those of the other two plantations. These differences probably reflect the narrower C/N ratio and higher organic C contents in the soils of the plantation. While respiration and nitrification were related to fungal biomass, there was no relation to the fungi-bacteria ratio. Our findings highlight that C and N turnover rates are mostly controlled by the environmental factors soil temperature and soil moisture in the three plantations. Turnover rates were lowest during the dry season, whereas MB reached its maximum values during that period indicating that microbes were probably in a dormant state during the day season.

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Drought-related physiology and growth of mature European beech: linking measurements and model

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Abstract

Recurrent drought as one of many consequences of climate change may have a significant adverse effect not only on the Mediterranean forests, but also on temperate forests occurring at mesic sites (see e.g. Weber et al. 2013). The presented study addresses the ecophysiological aspects of drought effect on a mature beech forest in central Slovakia (450 m a.s.l.). During the growing seasons of 2012–2014, a number of physiological and growth parameters of the European beech under the two contrasting treatments (drought vs. irrigation) were measured. In our experiment we confirmed the impact of atmospheric and soil drought on the growth and physiological performance of adult beech trees. Reduced water availability (at soil water potential of about –0.6 MPa) significantly limited the transpiration rate and induced stem contraction. The following phases of diurnal stem circumference changes were identified: i) the contraction period, from the morning maximum to the afternoon minimum, ii) the expansion period, from the afternoon minimum to the morning maximum of the next day, and 3) the stem circumference increase, defined as the degree to which the stem circumference exceeded the previous morning maximum on the cumulative curve of circumference changes. Within the physiological measuring campaigns which were commenced during the irrigation we revealed tight dependence of CO_2 assimilation rate on stomatal conductance. Under low precipitation conditions, leaf water potential in trees exposed to drought was found to decrease substantially, and their assimilation rate was several-fold lower than the rate of the irrigated trees. The effect of atmospheric drought on stomatal conductance was more pronounced in drought-stressed trees. In the second part of our work, the usage of the diurnal data from detailed physiological measurements, namely sap flow and stem circumference changes, for the validation of a process-based forest growth model was tested. The results revealed that physiological measurements represent valuable data sources for model validation.

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Rooting pattern of N. spruce and E. beech influence the sensitivity to Al toxicity, nutrient deficiency or drought

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Abstract

The composition of Aluminium ionic species in forest soils has been studied at ICP Forests plots with prevailing Norway spruce or European beech in the Czech Republic. General soil chemistry was characterized by the results of ICP Forests BioSoil survey; the interaction of trees and soil was described by the measuring of quantity and vitality of fine roots (20 cores per plot) and their chemical composition (Al, Ca, Mg, K); vitality of trees was provided by the regular defoliation assessment. Results show that the potential aluminium toxicity has significant effect on forest health in European beech stand. Norway spruce is more influenced by the availability of nutrients – mainly base cations in forest soil. These – somewhat surprising – results can be explained by the different root distribution of two studied species. Norway spruce grows at more acidified sites but it creates extremely surface root system with the majority of fine roots located at the border zone between organic layer and mineral soil. In this part of soil aluminium is prevailingly situated in organic bounds and the concentration of its potentially toxic ionic forms as Al^{3+} is very low. On the other hand trees can suffer from the limited nutrient supply from the thin rooting zone, especially in periods of drought. European beech, on the other hand, is planted at more favorable forest sites. It has deeper root system with important share of fine roots in the depth between 20 and 40 cm where the concentration of Al^{3+} can be significant.

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Urban influence effect of dominant native tree species growth

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Abstract

Urban climate are different from wildlife. These differences made some influence on tree growth. Do urban environment affect the morphological, dendrometrical parameters of trees, phenology phases, chemical composition of leaves, intensity of leaf litter decomposition, soil acidification? To answer this question, we have analyzed the growth of the four dominant native deciduous tree species *Tilia cordata*, *Acer platanoides*, *Betula pendula* and *Quercus robur*. Research has focused on different environments. Measurement were made in urban parks, street trees and forest stands in Kaunas, Lithuania. The results show that the all our observable parameters in urban trees were differed from forest stand trees. Charges are differences depending on tree species. We conclude that the urban microclimate affect growth of native trees.

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From special waste into products: polluted canal sediments as substrates for plant nursing cultivation

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Abstract

When canals are dredged, enormous amounts of polluted sediments are stocked and then transported to the landfill with incredibly high costs of management. Agriport methodology, developed by ISE-CNR, has been tested as effective and cheap remediation process based on phytoremediation and land farming technique, with the purpose to decrease the concentration of hydrocarbons and heavy metals, converting eventually sediments into products. Further, CleanSed project (LIFE12 ENV/IT/00652) aiming at identifying a possible use destination of these remediated sediments, assesses their use in plant nursing with the purpose to reduce the agronomic soil need in open field plantations. Plots simulating an open field plantation with mix of sediments and agronomic soil at 33% and 50% were compared to control plots (100% agronomic soil, slightly silty). Three evergreen species (*Viburnum tinus L.*, *Photinia x fraseri* var. red robin, *Eleagnus macrophylla* L.) have been planted and monitored in physiological parameters, biomass and leaf chemistry. Preliminary results of the first year experimentation suggest the potentiality of the remediated sediments: mixed substrates show greater water infiltration and moisture retention without stagnation. Concerning the species, putting special attention to the Mediterranean species V. tinus, it showed adaptability to the treatments for leaf gas exchanges: generally no difference between the treatments was found for photosynthesis and evapotranspiration, despite the trend of minimum water potential reached significant lowest values in T33. However, comparing the three treatments plants did not show difference for growth and final biomass and in root deepening and growth capacity though high variability within the treatments. On one side, T33 and T50 treatments showed a lower percentage of thin dead roots and better lateral elongation of new roots, on the other side the presence of sediments decreases the root ball cohesion especially in T50 (less compaction and resistance to penetration) needing soon to wrap soil in *burlap*. These results open further perspectives for the use of canal sediments in plant nursing as well as in other contexts and for other purposes.

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Influence of meteorological conditions and forest crown defoliation on tree phenology in intensive forest monitoring plots in Slovenia

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Abstract

Data from the 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 coloring, 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 coloring and longer growing season of oak in next year. We found no correlation between crown defoliation and phenology for beech nor spruce. Our detailed sub-regional data from a relatively small area with high geographic variability showed that temperature and precipitation sensitivity of tree phenology was highly species-dependent with beech, oak and spruce exhibiting contrasting responses. In order to assess the influence of crown defoliation and meteorological conditions on tree phenology, longer time series are needed, involving a larger number of sites.

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Relationship between cumulative stomatal ozone uptake and photosynthetic parameters of *Fagus crenata*

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Abstract

Atmospheric carbon dioxide (CO_2) is absorbed by forest tree species through leaf photosynthesis, which is expected to avoid global warming. However, ozone (O_3), a phytotoxic gaseous air pollutant, would decrease leaf CO_2 uptake. Thus, we must investigate the effects of O_3 on leaf CO_2 uptake of forest tree species. The effects of O_3 on trees have been assessed based on the accumulated exposure of atmospheric O_3 concentration. However, because O_3 absorbed into the leaf through stomata has adverse effects on trees, the effects of O_3 on trees should be evaluated based on stomatal O_3 uptake. To clarify the effects of O_3 on leaf CO_2 uptake of Japanese forest tree species, in the present study, we investigated the relationships between cumulative stomatal O_3 uptake (COU) and photosynthetic parameters of *Fagus crenata* seedlings. Two-year-old seedlings were exposed to charcoal-filtered air (CF treatment) or O_3 at 1.0 and 1.5 times the ambient concentration (1.0 × O_3 and 1.5 × O_3 treatment, respectively) from May to October 2014. The COU of the seedlings was estimated by combining Farquhar photosynthesis model and Ball-Berry stomatal conductance model. During the latter half of growing season, maximum carboxylation rate (V_{cmax}) and maximum electron transport rate (J_{max}) were reduced by the exposure to O_3. The V_{cmax} was linearly reduced with increasing accumulated ozone exposure over a threshold of 40 nl l^{-1} (AOT40) or COU. The R^2 value in the relationship between AOT40 and V_{cmax} was 0.490. On the other hand, R^2 value in the relationship between COU and V_{cmax} and that between COU above O_3 uptake rate threshold of 1.1 nmol m^{-2} s^{-1} and V_{cmax} were 0.577 and 0.593, respectively. These results suggest that the effects of O_3 on photosynthetic parameters of forest tree species should be assessed based on not AOT40 but cumulative stomatal O_3 uptake.

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Development of forest genetic monitoring system – Delineation of monitoring regions

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Abstract

Forest trees are long-lived sessile organisms that need to withstand a wide range of climatic and biotic stressors posing risk to their survival. Conservation and management of forest genetic resources for sustainable use is essential, but not an easy task and special tools, such as forest genetic monitoring are needed to recognise the state and changes in their composition. 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. The six-year LIFE + implementation 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 forest genetic monitoring on the transect from Germany to Greece, forming a regional implementation baseline for any future Pan-European forest genetic monitoring programme. The main objective is to contribute to long-term conservation of adaptability of forests to environmental changes. One of the elementary requirements needed for implementation of forest genetic monitoring is delineation of monitoring regions. Within the project, this has been done for seven species or species complexes differing in their biology and distribution (*Fagus sylvatica, Abies alba / A. borisii regis complex, Fraxinus excelsior, Populus nigra, Pinus nigra, Prunus avium, Quercus robur / Q. petraea complex*). Monitoring regions within the transect from Bavaria to Greece were delineated based on (i) the distribution of the species in question, (ii) available environmental zonations/stratifications of Europe, (iii) available genetic data and local expert knowledge. On average, five to six monitoring regions per species / species complex were recognised.

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Preliminary study on ophiostomatoid fungi associated with bark beetle Tomicus spceiesin southwestern China

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Abstract

Species in the genus of *Tomicus* include a number of important forest pests. In southwestern China, *Tomicus minor*, *T. brevipilosus T. yunnanensis*, and *T. armandii* have been reported, while the latter two species are unique to the region. Since 1970s, they have destroyed thousands of hectares of *Pinus yunnanensis* there, resulting in significant economic loss. Ophiostomatoid fungi associated with bark beetles are known to contribute to host tree death. The fungi are vectored by insects, and enter the phloem of the infested tree stems. The fungi are also able to utilize the tree's nutrition and grow rapidly within and between phloem and xylem cells. As a result, the fungi-infected pine trees become seriously weakened, and die in case of severe damage. Therefore, it is important to characterize the fungal species and their relationship with bark beetles for better understanding of the insect invasive mechanism as well as the process of the tree death. Field surveys on above four *Tomicus* species attacking *Pinus yunnanensis*, *P. armandii* and *P. kesiya var. Langbianensis*, were conducted in the provinces of Yunnan, Guizhou and Chongqing, southwestern China, during the course of 2014. Bark beetles and their galleries were collected respectively for fungal isolation and characterisation. Fungal preliminary identification was done using both morphological characteristics and sequence data of the ITS region of the rRNA operon. Our results indicated that *Ophiostoma canum, O.* sp.1, *O.* sp.2, *Leptographium procerum* and *L. truncatum* are associated with *Tomicus* species in southwestern China. For geographical distribution, *O. canum* was widely distributed in Dali, Shilin of Yunnan, and Panxian of Guizhou, *O.* sp.1 and *O.* sp.2 were mainly recorded in Dali of Yunnan, *L. truncatum* occurred in Panxian of Guizhou, Wushan of Chongqing and Simao of Yunnan, *L. procerum* was found in Panxian of Guizhou. For host preference, it seems that *O. canum* mainly occurred on *P. yunnanensis*; *L. truncatum* and *L. procerum* were isolated from in *P. armandii* and *P. kesiya var. Langbianensis*. We'll carry on field surveys and the pathogenicity of the selected fungal species will be tested for a comprehensive understanding of the fungal associates with the beetles and their role in tree death. This research was funded by the National Science Foundation Committee n°31360183.

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Attack Pattern and Reproductive Ecology of the Pine Shoot Beetle *Tomicus brevipilosus* on Yunnan Pine (*Pinus yunnanensis*) in Southwestern China

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Abstract

Tomicus brevipilosus (Eggers) (Coleoptera: Curculionidae, Scolytinae) was recently discovered as a new pest of Yunnan pine (*Pinus yunnanensis* ***Franchet)*** in Yunnan province in southwestern China. However, little was known on its reproductive biology and pattern of trunk attack on Yunnan pine. The objectives of the present study were to better understand the reproductive biology of *T. brevipilosus* by investigating the seasonality of trunk attacks by parent adults for the purpose of reproduction (i.e., breeding attacks) and the within-tree pattern of these attacks. Our results showed that *T. brevipilosus* breeding attacks in *P. yunnanensis* generally started in early March and ended in early June in Anning County, Yunnan. *Tomicus brevipilosus* exhibited two general patterns of infestation. From early March to mid-April, *T. brevipilosus* bred preferentially in the trunks of Yunnan pine trees that were already infested by *Tomicus yunnanensis* Kirkendall and Faccoli and *Tomicus minor* (Hartig), colonizing spaces along the trunk that were not already occupied by the other two *Tomicus* species. Later, from about mid-April to early June, when there were no Yunnan pine tree newly infested by *T. yunnanensis* and *T. minor*, *T. brevipilosus* attacked Yunnan pine by itself, infesting the lower parts of the trunk first and then infesting progressively upward along the trunk into the crown. Infestation by *T. brevipilosus* extends the total period that *P. yunnanensis* trees are under attack by *Tomicus* beetles in southwestern China, which helps explain why Yunnan pine has suffered high levels of tree mortality in recent decades.

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O_3 and NO_2 estimated levels in three parks of Mexico City

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Abstract

Ozone (O_3) is one of the main air pollutants, and its concentrations within the Mexico City are mainly caused by high temperatures and high ultraviolet (UV) radiation levels combined with nitrogen oxides (NO_x) as precursors produced throughout the year. The objective of this research was to assess O_3 and NO_x levels and spatial distribution within three parks of Mexico City known as Alamedas Norte, Sur and Oriente, in order to try to establish a relationship between pollutant levels, sampling season and park location. Passive samplers (3 to 5 Radiello® samplers for both O3 and NO_x) were used in both parks and continuous monitoring stations within the urban area. Three campaigns were carried out: cold-dry season (November 2011 and December 2012) and hot-dry season (June 2011). Geostatistics were applied to define both spatial distribution and estimated pollutants levels (parts per billion or ppb) through Inverse Distance Weighting (IDW) and Ordinary Kriging interpolation methods. Spatial distribution pattern of O_3 and NO_2 tended from north to south-southwest. Highest O_3 concentrations were registered during the hot-dry season in Alameda Sur, and the highest NO_2 concentrations were registered during both cold-dry seasons in Alameda Norte. O_3 concentrations during the cold-dry season were related to thermal inversion, whereas the highest O_3 formation was promoted by high temperatures and solar radiation. Winds mobilized large masses of precursors (NO_x) south-southwest confirming the role of these pollutants as substrate for O_3 formation, since a higher concentration and spatial distribution of O_3 corresponded to the lowest concentration and distribution of NO_2 and vice versa.

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Carbon storage in components of mountain ecosystems after forestry–related activities in selected regions of Bulgaria

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Abstract

Forest ecosystems have the potential to mitigate climatic changes. Forests sequester carbon and store it in different components of ecosystems and forest-related activities play role in mitigating climate change. Present study focuses on analyzing the general characteristics of different components of mountain ecosystems in Stara Planina and Western Rodopes Mountains (Bulgaria) in respect to their potential to store carbon. The major forest-related land-uses in the high mountainous regions in Bulgaria were investigated: mountainous pasture, coniferous plantations (planted on previous pasture and beech forests between four and five decades ago) and natural beech forests. The experimental data of aboveground tree vegetation, forest litter and soils were used in determining the variations in organic carbon storage under different land-use patterns. We summarize that the effect of aboveground coverage determined by the different land-use types in mountainous region of Western Rhodopes and Stara Planina Mountains is one of the main drivers of changes in soil characteristics. Soil organic carbon content and its profile distribution, together with nitrogen content in 0-10 cm of soils, are very sensitive to land-use and coverage changes and could be used as indicators for studying the long-term effects of land-use changes on soil. Mineral soil is the main accumulator of stable form of organic carbon. Together with tree vegetation and forest floor the forest ecosystems accumulate a significant part of carbon among the studied mountainous land uses. In the processes of land-use changes the forest land-use type has positive effect on soil carbon accumulation and preservation, but even after 70 years of the conversion from arable abandoned land to forest land this effect is slightly expressed and can not compensate the organic carbon losses. The land cultivation in mountainous region of Western Rhodopes showed a decrease in soil carbon in superficial soil, which requires special management recommendations.

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