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Sustainable fuel wood production and wood ash recycling on acidic forest soils

Vincent Boulanger, Christine Deleuze, Gwénaëlle Gibaud, Noémie Pousse, Claudine Richter, Alain Berthelot, Isabelle Bertrand, Jacques Ranger, Laurent Saint-André

► To cite this version:

Vincent Boulanger, Christine Deleuze, Gwénaëlle Gibaud, Noémie Pousse, Claudine Richter, et al.. Sustainable fuel wood production and wood ash recycling on acidic forest soils. ExpeER International Conference, Sep 2014, Paris, France. hal-01269159

HAL Id: hal-01269159

<https://hal.science/hal-01269159>

Submitted on 5 Jun 2020

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CONFERENCE WEBSITE

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24-25 September 2014
Paris - France

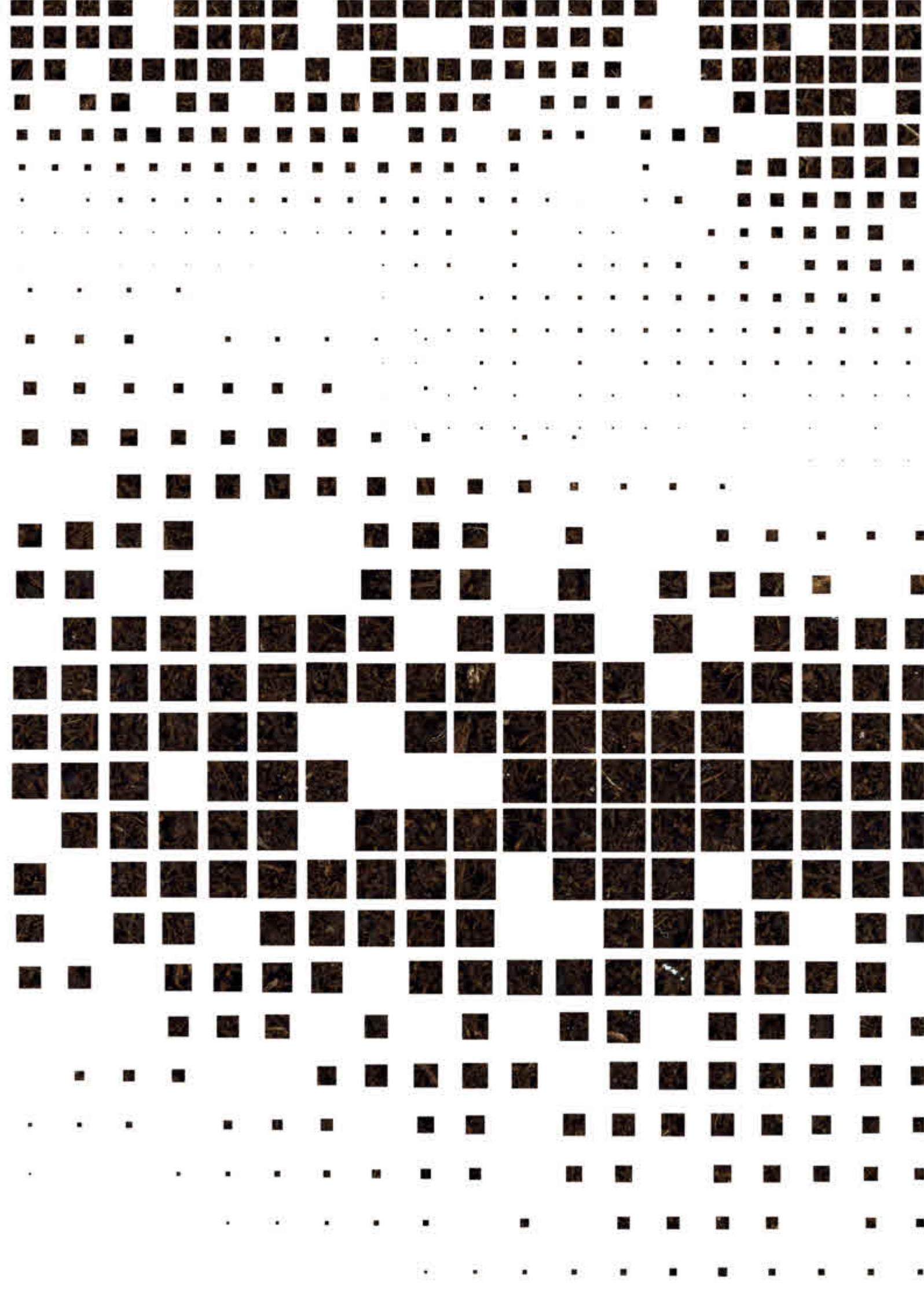
ExpeER INTERNATIONAL CONFERENCE



ON EXPERIMENTATION IN ECOSYSTEM
RESEARCH IN A CHANGING WORLD:
CHALLENGES AND OPPORTUNITIES



This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 262060.





Dear colleagues,
Dear participants,

On behalf of the International Scientific Committee and the Organising Committee of the ExpeER International Conference, it is a pleasure for me to welcome you to this conference in Paris specifically dedicated to experimentation in ecosystem research in a changing world.

The sessions of this conference are principally designed to provide an update on the latest developments on research infrastructures (RIs) in ecosystem science, including new technologies and sound approaches to face environmental challenges in a global context. It will also provide you great opportunities to communicate your ideas on how research infrastructures in the field of ecosystems experimentation can support collaborative research in finding solutions to global challenges.

The conference is bringing together more than 100 participants from 28 countries from all continents. In this regard, I wish to express my gratitude to all delegates for their full contribution to this conference.

I would also like to express my gratitude to the Scientific Committee and the Organising Committee for their diligence and help. My special thanks go to Luke Lauprete, Yuchong Tang, Emilie Guldner, Evan O'Connell, and Isabelle Boissou who have contributed their untiring effort for several months so far in making this conference a success.

Last but not least, I wish to thank the European Commission's Seventh Framework Programme for its financial support of this conference, organised as part of the ExpeER "Experimentation in Ecosystem Research" project.

In closing, I encourage delegates to participate actively in the interesting discussions over the next two days. I wish everyone a successful and fruitful conference.

Conference Chair

A handwritten signature in blue ink, belonging to Dr. habil. Abad CHABBI. The signature is fluid and stylized, written in a cursive script.

Dr. habil. Abad CHABBI
ExpeER coordinator.

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THIS ExpeER PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S SEVENTH PROGRAMME FOR RESEARCH, TECHNOLOGICAL DEVELOPMENT AND DEMONSTRATION UNDER GRANT AGREEMENT NO 262060.

THE CONFERENCE IS ORGANISED BY INRA AND INRA TRANSFERT, UNDER THE FRAMEWORK OF THE EUROPEAN FP7 PROJECT ExpeER (www.expeeronline.eu) ; AND IS FUNDED BY THE EUROPEAN COMMISSION'S FP7 PROGRAMME.



INTERNATIONAL CONFERENCE ON EXPERIMENTATION IN ECOSYSTEM RESEARCH IN A CHANGING WORLD: CHALLENGES AND OPPORTUNITIES

24th and 25th of September 2014

Muséum National d'Histoire Naturelle
Auditorium de la Grande Galerie de l'Evolution
36 rue Geoffroy Saint-Hilaire
Paris, France

CONTEXT

The Earth's rapidly changing environment is putting critical ecosystem services at risk. There are many challenges involved in understanding global environmental changes, and in providing societies with the policy-relevant knowledge base to deal with them. These challenges will reach across many aspects of scientific endeavour. Indeed, the research community requires state-of-the-art research infrastructures (RIs) to have the capability to explain and predict global environmental changes. In this context, the Experimentation in Ecosystem Research conference will provide a platform for discussions on cutting-edge technological tools, large-scale integrative experimental design, technical constraints, data access and last but not least, ecosystem modelling. The conference will attract speakers and delegates from around the world and will offer opportunities to reinforce global cooperation.

MAIN TOPICS

GRAND CHALLENGES: With the current set of Experimental Research infrastructures in ecosystem science, do we have the capacity to tackle the grand challenges of today and tomorrow?

IN VITRO AND IN NATURA: How realistic are they, and how they can be better linked?

TECHNOLOGIES: Which emerging technologies could enhance (or are needed for) the performance and services offered by our RIs?

DATA: Towards an e-infrastructure for ecosystem research - challenges and opportunities.

MODELLING: How accurate is our capacity to forecast and upscale, and what is missing? How can we communicate uncertainty? How do we strike the right balance between modelling and experiments?

PROGRAM OF DAY 1

WEDNESDAY, 24th OF SEPTEMBER 2014

Auditorium de la Grande Galerie de l'Evolution

- 8:45** Arrival and registration.
- 9:15** Welcome address.
Olivier LE GALL, Deputy Director General for Scientific Affairs, INRA, France.
- 9:30** **RESEARCH INFRASTRUCTURE IN ENVIRONMENTAL SCIENCE: LOOKING AHEAD TO THE NEXT TWO DECADES.**
Abad CHABBI, INRA, France.

PLENARY SESSION 1

[RESEARCH INFRASTRUCTURE: OPPORTUNITIES TO ADDRESS THE IMPACT OF GLOBAL CHANGE?](#)

Chairperson: Abad CHABBI, INRA, France.

- 9:45** **KEYNOTE 1: THE CHALLENGE OF RIS IN A CHANGING WORLD.** [p. 8](#)
Russ LEA, NEON, Boulder, CO, USA.
- 10:15** **KEYNOTE 2: LONG-TERM ECOLOGICAL SITES: LISTENING FOR COMING CHANGE IN ECOSYSTEMS.** [p. 8](#)
Henry JANZEN, Agriculture and Agri-Food Canada, Lethbridge, Canada.
- 10:45** **KEYNOTE 3: NOVEL TECHNOLOGIES TO ADAPT PLANTS TO FUTURE CLIMATES: BREEDING, PHENOTYPING AND BEYOND.** [p. 9](#)
Ulrich SCHURR, Forschungszentrum Jülich, Germany.
- 11:15** Coffee break and poster session 1 (p. 25).

ExpeER SELECTED OUTPUT

- 11:45** **ExpeER CAPACITIES AND A WAY FORWARD FOR A EUROPEAN INTEGRATED INFRASTRUCTURE.** [p. 9](#)
Helen FRENCH, Bioforsk, Ås, Norway.
- 12:05** **TRANS-NATIONAL ACCESS IN ExpeER: SUCCESS STORIES AND FORWARD LOOK.** [p. 10](#)
Franco MIGLIETTA, CNR, Florence, Italy.
- 12:25** Lunch.

PLENARY SESSION 2

[LINKING *IN NATURA* TO *IN VITRO* EXPERIMENTATION: TOOLS TO UNDERSTAND, HANDLE AND SOLVE PROBLEMS OF A PLANET UNDER PRESSURE.](#)

Chairperson: Franco MIGLIETTA, CNR, Florence, Italy.

14:00 KEYNOTE 1: LARGE CONTROLLED-ENVIRONMENT FACILITIES FOR STUDYING ECOSYSTEM RESPONSE TO CLIMATE CHANGE: EXPENSIVE TOYS OR LEGITIMATE SCIENTIFIC TOOLS?

Paul VERBURG, University of Nevada, Reno, NV, USA. p. 11

14:30 KEYNOTE 2: NEW CHALLENGES FOR EXPERIMENTAL ECOLOGY: RELEVANT SCALES FOR THE INVESTIGATION OF ECOSYSTEM RESPONSES TO GLOBAL CHANGE. [p. 12](#)

Martin SCHÄDLER, UFZ, Leipzig, Germany.

ExpeER SELECTED OUTPUT

15:00 SPECIFIC CONTRIBUTIONS OF ECOTRONS TO ECOSYSTEM SCIENCE: FROM ECOSYSTEM FUNDAMENTAL PHYSIOLOGICAL PROCESSES TO IMPACT OF BIODIVERSITY AND CLIMATE CHANGES. [p. 13](#)

Jacques ROY, CNRS, Montpellier, France.

15:20 IMPROVED ENVIRONMENTAL CONTROL TECHNIQUES AND NEW EXPERIMENTAL APPROACHES FOR GLOBAL CHANGE ECOLOGY. [p. 13](#)

Ivan NIJS, University of Antwerp, Belgium.

15:40 Coffee break and poster sessions 2 and 3 (p. 28).

PLENARY SESSION 3

[NEW TOOLS TO MEET NEW CHALLENGES: EMERGING TECHNOLOGIES FOR EXPLORING THE UNKNOWN PROCESSES IN ECOSYSTEM SCIENCE.](#)

Chairperson: Henry JANZEN, Agriculture and Agri-Food Canada, Lethbridge, Canada.

16:10 KEYNOTE 1: FROM ATOM TO PEDON: THE ROLE OF NANO- AND MICROSCALE APPROACHES FOR THE UNDERSTANDING OF THE FUNCTIONING OF SOILS. [p. 14](#)

Kai TOTSCHE, University of Jena, Germany.

16:40 KEYNOTE 2: NEXT GENERATION 'OMIC' TECHNOLOGIES - WHAT CAN THEY DO FOR ECOSYSTEMS RESEARCH? [p. 15](#)

Gail TAYLOR, Southampton University, UK.

ExpeER SELECTED OUTPUT

17:10 CHARACTERISATION OF BIOGEOCHEMICAL PROCESSES AT THE MICRO-SCALE - CONCEPTS AND APPLICATIONS OF NanoSIMS. [p. 15](#)

*Carsten MÜLLER, Technical University of Munich, Germany,
& Cornelia RUMPEL, IESS, CNRS, Grignon, France.*

17:30 CHARACTERISING LANDSCAPE-HYDROLOGY FEEDBACKS - NEW SENSOR TECHNOLOGIES AND MONITORING APPROACHES. [p. 16](#)

Steffen ZACHARIAS, UFZ, Leipzig, Germany.

17:50 End of day 1.

19:30 Conference dinner.

PROGRAM OF DAY 2

THURSDAY, 25th OF SEPTEMBER 2014

Auditorium de la Grande Galerie de l'Evolution

8:45 Arrival.

PLENARY SESSION 4

[DATA ACCESS AND MODELLING.](#)

Chairperson: Russ LEA, NEON, Boulder, CO, USA.

9:00 **KEYNOTE 1: DATA ACCESSIBILITY AND THE ROLE OF INFORMATICS IN PREDICTING THE BIOSPHERE.** [p. 17](#)

Alex HARDISTY, School of Computer Science and Informatics, Cardiff University, UK.

9:30 **KEYNOTE 2: ÆKOS: A NEW PARADIGM ENABLING ACCESS TO AND REUSE OF COMPLEX ECOLOGICAL DATA.** [p. 18](#)

David TURNER, ÆKOS, Adelaide, Australia.

ExpeER SELECTED OUTPUT

10:00 **TOWARD LINKING DATA FROM EUROPEAN MONITORING & EXPERIMENTAL SITES TO A GLOBAL OBSERVATORY.** [p. 19](#)

John WATKINS, CEH, Lancaster, UK & Johannes Peterseil, Umweltbundesamt, Vienna, Austria.

10:20 Coffee break and poster session 4 (p. 33).

PLENARY SESSION 4 CONTINUES

Chairperson: Scott COLLINS, University of New Mexico, USA.

10:50 **KEYNOTE 3: ECOSYSTEM MODELLING AND CLIMATE CHANGE: WHAT IS WRONG?** [p. 19](#)

Pete SMITH, University of Aberdeen, UK.

11:20 **KEYNOTE 4: CROP IDEOSYSTEMS: IN SEARCH OF RESOURCE USE EFFICIENCIES IN THE PRIMARY PRODUCTION OF FOOD.** [p. 20](#)

John Roy PORTER, University of Copenhagen, Denmark.

ExpeER SELECTED OUTPUT

11:50 ECOSYSTEMS STATES AND FLUXES: FROM OBSERVATION TO PREDICTION. [p. 21](#)

Harry VEREECKEN, Forschungszentrum Jülich, Germany.

12:10 CONFRONTING ECOSYSTEM MODELS WITH REAL WORLD EXPERIMENT: A TWO WAY FEEDBACK LOOP. [p. 22](#)

Nimai SENAPATI, INRA, Lusignan, France.

12:30 INTEGRATING MODELLING AND EXPERIMENTAL PLATFORMS IN RESEARCH INFRASTRUCTURE: DESIGN AND APPROACH IN AnaEE-FRANCE. [p. 23](#)

André CHANZY, INRA, Avignon, France.

12:50 Lunch.

PARTICIPATORY PLENARY

[HOW TO ENSURE ECOSYSTEM SCIENCE RESPONDS TO THE CHALLENGES OF TOMORROW.](#)

*Moderated by Scott COLLINS, University of New Mexico
& Evan O'CONNELL, INRA, AnaEE Communication Officer.*

14:25 **Topics to be dealt with:**

EXISTING AND NEEDED INFRASTRUCTURES: WHERE ARE THE GAPS AND HOW CAN WE FILL THEM TO RESPOND TO THE GRAND CHALLENGES?

BRINGING TOGETHER *IN NATURA*, *IN VITRO*, ANALYSIS AND MODELLING: A 360-DEGREE APPROACH TO EXPERIMENTATION ON ECOSYSTEMS.

ENCOURAGING INNOVATION IN EXPERIMENTAL APPROACHES: WHY AND HOW?

BIG DATA: HOW TO DEAL WITH DATA, HOW TO MANAGE IT AND HOW TO MAKE IT USEFUL.

MODELLING: HOW DO WE BUILD FLEXIBLE BUT SOLID MODELS FOR THE ENTIRE COMMUNITY?

COOPERATION: STRENGTHENING AND GROWING TIES ACROSS BORDERS AND CONTINENTS.

RELEVANCE: BEYOND THE SCIENTIFIC COMMUNITY, HOW DO WE MAKE OUR WORK AND RESULTS RELEVANT, INTERESTING, USEFUL AND ACCESSIBLE TO OTHER AUDIENCES: POLICY MAKERS, INDUSTRIES, GENERAL PUBLIC?

16:25 Closing speech.

Abad CHABBI, INRA, France.

16:30 Cocktail.

17:30 End of day 2 and conference.

ABSTRACTS: ORAL PRESENTATIONS

THE CHALLENGE OF RIS IN A CHANGING WORLD.

24th of September - 9:45 Plenary Session 1. Research infrastructure: opportunities to address the impact of global change?

Russ LEA [rlea@neoninc.org]

National Ecological Observatory Network, Inc. (NEON, Inc.), Boulder, CO, United States of America.

We consider that Europe and the US as very strong partners in ecological and environmental observing and there are numerous examples in which this is the proven path forward in the development of unique infrastructure. True advances in ecological theory, applying these understandings to benefit society, and developing new frontiers in science - have all come about through the open, transparent exchange of ideas, infrastructures and data. We fully encourage this approach in all our collaborative endeavors. We would encourage road map activities of how best work collaboratively with colleagues mutually concerned about the benefits of interoperability.



Dr. Russ Lea is CEO of NEON, Inc. (National Ecological Observatory Network). In his capacity over the last two years, he has worked with the science community and the sole sponsors, the National Science Foundation, to deliver an observatory designed to detect and enable forecasting of ecological change at continental scales over multiple decades. Dr. Lea is a professor *emeritus* at North Carolina State University.

LONG-TERM ECOLOGICAL SITES: LISTENING FOR COMING CHANGE IN ECOSYSTEMS.

DAY 1 - 10:15 Plenary Session 1. Research infrastructure: opportunities to address the impact of global change?

Henry JANZEN [henry.janzen@agr.gc.ca]

Agriculture and Agri-Food Canada, Lethbridge, Canada.

In the face of impending biospheric stresses and upheavals, we need to know whether our ecosystems and their many services are being sustained or diminished. Ecosystem responses, however, are often subtle and slow, and cannot always be discerned in a typical funding cycle or even a human lifespan. Thus, the only way to see directly how unfolding global stresses affect evolving ecosystems is to monitor their functions patiently and persistently in long-term experimental sites. These "listening places", however, require long, continuing commitment, so their design and execution require careful creativity and foresight. What ecosystems (lands) should be studied; and which management variables within them? How do we ensure their continuing relevance in changing times? What should be measured to monitor critical functions and services; and at what scale? How can long-term sites be linked to other ecological approaches, from process-level laboratory studies to global models? Who are the primary audiences for their output, and how should the findings be conveyed to them? In this paper, I ponder these and related questions, using examples from long-term experiments, mostly as seeds to elicit further conversation. From such collective thought, may sprout new ways of amplifying the role of long-term ecological sites for understanding how changes influence the ecosystems on which we and our successors depend. If well-designed, long-term experiments may serve as a connective, integrative approach, binding together researchers over space, among disciplines, and over time itself.



Henry Janzen is a Soil Biochemist with Agriculture and Agri-Food Canada in Lethbridge, Alberta, Canada. His research focuses on the cycles of carbon and nitrogen in agricultural ecosystems, with emphasis on preserving resilience, maintaining productivity, and reducing net greenhouse gas emissions. In exploring the links between farmlands and the global carbon cycle, he has participated in various national and international research activities.

NOVEL TECHNOLOGIES TO ADAPT PLANTS TO FUTURE CLIMATES: BREEDING, PHENOTYPING AND BEYOND.

24th of September - 10:45 Plenary Session 1. Research infrastructure: opportunities to address the impact of global change?

Ulrich SCHURR [u.schurr@fz-juelich.de]

Forschungszentrum Jülich, IBG-2: Plant Sciences, 52425 Jülich, Germany.

Lack of adequate solutions for quantitative analysis of plant architecture and function as well as their interaction with the dynamic and heterogeneous environment hampers progress in basic sciences as well as in breeding-related research. In recent years significant interdisciplinary approaches have been started to overcome this "phenotyping bottleneck". Techniques were developed to quantify the dynamics and the heterogeneity of plant structure and function as well as of environmental cues. These mostly non-invasive technologies are developed and implemented into biological concepts that allow novel insights in the dynamic characteristics of plants above- as well as belowground. The technologies include high-resolution analysis for mechanistic understanding (like MRI and PET for structure, growth and activity of roots and shoots), the high-throughput approach for analysis of large numbers of genotypes and environmental conditions as well as field approaches, which are the reference to indicate the relevance. The talk will provide an overview on recent developments in technologies as well as conceptual approaches as the basis for a quantitative understanding of plant-environment-dynamics and its application for plant breeding and plant management. The talk will also present recent developments in infrastructure platforms that have been and will be established in Germany, in Europe and globally.



Prof. Uli Schurr is director at the Institute for Bio- and Geo Sciences - IBG-2: Plant Sciences at Forschungszentrum Jülich. He is coordinating several large national and international projects - like the Bioeconomy Science Center (BioSC), the European (EPPN) and the German (DPPN) and the International (IPPN) Plant Phenotyping Network. Uli Schurr is member of the Executive Board of the European Technology Platform Plants for the Future and was Vice-President of EPSO (European Plant Science Organisation) for 6 years.

ExpeER CAPACITIES AND A WAY FORWARD FOR A EUROPEAN INTEGRATED INFRASTRUCTURE.

DAY 1 - 11:45 Plenary Session 1. Research infrastructure: opportunities to address the impact of global change?

Helen FRENCH¹ [helen.french@bioforsk.no]

Andy MACDONALD², Katrin KNOTH DE ZARRUK¹, Jacques ROY³, Abad CHABBI⁴

¹Bioforsk, Ås, Norway - ²Rothamsted Research, Harpenden, United Kingdom - ³CNRS - Ecotron in Montpellier, France - ⁴INRA, Lusignan, France.

Climate and land-use changes are major drivers behind many current environmental problems. Sustainable management of ecosystems requires understanding the full dynamics of how drivers

influence the processes and fluxes within the different ecosystems. This requires good descriptions of meteorological and hydrological conditions, gas fluxes and bio-geochemical conditions, including flora and fauna. Strengthened linkages between disciplines, researchers and end-users are desirable to reduce duplicative efforts and to achieve maximum return on public investment in research infrastructures. The ExpeER research infrastructure for ecosystem research, consisted of 33 facilities within 13 European countries, including Highly Instrumented Experimental and Observational Sites (HIES & HIOS, 29), Analytical Facilities (2) and Ecotrons (2). To respond to global and complex problems, there is a need for more integrated experimental manipulations and range of measurements within hydrology, local atmosphere and biodiversity. Improved collaboration and scientific capacity of the ExpeER infrastructure, and within a future integrated infrastructure such as AnaEE could be obtained by: enhancing scientific capacities of prioritised sites facilitated by national or European investments and by forming groups of facilities with similar areas of expertise. Resources could be targeted to increase their joint capacity and quality. Ecotrons should provide facilities at such an advanced level that they cannot exist in every country. New and existing ecotrons should be complementary. The experimental approach should be built around manipulation, measurements, modelling, mitigation and management. Distributed experimental facilities are needed to expose ecosystems to future conditions to quantify the role of each of the drivers of change and to identify their interactions. Experimental facilities should be equipped with state-of-the-art instrumentation and information technology tools, and incentives for continuous upgrade should be put in place. Common standards of measurements and systems for safe and efficient data sharing are also important. Facilities should be highly flexible and open to new experiments in order to be able to address the research questions of the future. There should be coordinated funding mechanisms between EU and nations, and incentives to promote international collaboration at the distributed research infrastructure.

TRANS-NATIONAL ACCESS IN ExpeER: SUCCESS STORIES AND FORWARD LOOK.

24th of September - 12:05 Plenary Session 1. *Research infrastructure: opportunities to address the impact of global change?*

Franco MIGLIETTA [f.miglietta@ibimet.cnr.it]
ibimet-CNR, Firenze, Italy.

ExpeER (Distributed Infrastructure for Experimentation in Ecosystem Research), through its coordinated programme of Transnational Access (TA), facilitated access to state-of-the-art research facilities throughout Europe, promoting observational, experimental, analytical, and modelling approaches in ecosystem research. This presentation will highlight the most important achievements of ExpeER TA programme, with emphasis on the most interesting and novel results that were obtained. The organization and the mechanisms used for TA management will also briefly be illustrated to provide a tangible work plan that will enable future and scalable access roadmap for the ESFRI (European Strategy for Research Infrastructures) infrastructures.

LARGE CONTROLLED-ENVIRONMENT FACILITIES FOR STUDYING ECOSYSTEM RESPONSE TO CLIMATE CHANGE: EXPENSIVE TOYS OR LEGITIMATE SCIENTIFIC TOOLS?

24th of September - 14:00 Plenary Session 2. *Linking in natura to in vitro experimentation: tools to understand, handle and solve problems of a planet under pressure.*

Paul VERBURG [pverburg@cabnr.unr.edu]

University of Nevada, Reno, NV, United States of America.

To effectively study effects of climate change on terrestrial ecosystems, a wide range of experimental and modeling approaches are used to obtain mechanistic understanding at a range of spatial and temporal scales. Mesocosm facilities can help bridge the gap between small-scale experiments conducted on individual plants or small soil samples and large-scale field manipulation studies since these facilities allow for studying systems containing multiple plant individuals/species and intact soils while maintaining tight climate control. An additional advantage is that these facilities often have the ability to measure net ecosystem CO₂ exchange (NEE) that allows for directly quantifying C sequestration which can be challenging under field conditions. The EcoCELL mesocosm facility was built in the early '90s and most recently, the facility was used to assess the effects of interannual climate variability on NEE in tallgrass prairie ecosystems. The project used a combination of mesocosm and field studies. For the mesocosm study we excavated intact soil monoliths and their native plant communities from a tallgrass prairie site in Oklahoma and transported these to the EcoCELL facility in Reno, NV. We subjected these monoliths to a one-year increase in air temperature and measured the immediate and lagged responses in NEE and water fluxes to this perturbation. A similar temperature manipulation was conducted at a field site from which the monoliths were extracted and this study was aimed at providing a reality check for the mesocosm studies in terms of ecosystem response to the climate manipulations. The EcoCELL study allowed us to do a rigorous assessment of the effects of climate anomalies on NEE in this system and determine which factors contributed to the overall ecosystem response. Plant communities responded differently in the EcoCELLs than at the field site because of differences in climate conditions between the EcoCELLs (constant ambient interannual temperatures and rainfall regimes) and field (varying ambient interannual ambient temperature and rainfall regimes), and absence of grazing and insect herbivory in EcoCELLs. While some of the ecosystem responses differed between EcoCELLs and the field, the EcoCELLs (and similar mesocosm facilities) represent a powerful tool to obtain detailed mechanistic information on how whole ecosystems and their components may respond to environmental perturbations.



Dr. Paul Verburg is a soil scientist who has been involved in large-scale, whole ecosystem manipulation studies for more than two decades. He has worked on effects of changing climate variables including atmospheric CO₂ concentrations, temperature, precipitation, and N deposition on boreal forests, tallgrass prairie and Mojave desert ecosystems. He currently is a faculty member at the University of Nevada, Reno in the United States.

NEW CHALLENGES FOR EXPERIMENTAL ECOLOGY: RELEVANT SCALES FOR THE INVESTIGATION OF ECOSYSTEM RESPONSES TO GLOBAL CHANGE.

24th of September - 14:30 Plenary Session 2. Linking in natura to in vitro experimentation: tools to understand, handle and solve problems of a planet under pressure.

[Martin SCHÄDLER](mailto:martin.schaedler@ufz.de) [martin.schaedler@ufz.de]

[Helmholtz Centre for Environmental Research - UFZ, Leipzig, Germany.](#)

A major scientific challenge is to assess the impact of global change on ecosystems and on the services they provide. Climatic change and changes in land use are main components of global change and are ranked as the most important threats to biodiversity. Despite the increasing number of global change experiments worldwide, we still lack a comprehensive understanding of the underlying key processes of changes in ecosystem functions across different land use systems. This understanding does not only require a comparative approach across different land use systems but also the consideration of appropriate temporal and spatial scales. For instance, trophic interactions between species are known to be important drivers of community structure but are also known to sensitively react to environmental change and biodiversity loss due to land use changes. The dynamics of these interactions, however, cannot adequately be investigated on small spatial and temporal scales. Second, soil processes have been shown to influence the ability of ecosystems to respond to environmental change. Due to their buffering capacity, soil systems react on longer time scales and the corresponding changes have in turn long-term effects on ecosystems. Third, whilst changes in the species composition of ecosystems have been in the focus of most studies, micro-evolutionary changes within species are a neglected component of biodiversity change. These changes are known to importantly affect species traits which might have given functions in ecosystems. Thus, new experiments have to be designed which address appropriate scales of these processes in different ecosystems. We designed an experiment (the Global Change Experimental Facility - GCEF) where we will investigate the consequences of a climate change scenario on five different land use types on large field plots. A complex technical equipment allows observations across a planned duration of the experiment of 15-20 years. This experimental facility is intended to serve as an interdisciplinary research platform for all aspects of climate change on agro-ecosystems and grasslands.



Martin Schädler is an experimental ecologist focusing on trophic interactions between plants, herbivores, detritivores and soil microbiota. For this, he combines a wide spectrum of methods ranging from molecular techniques to large field experiments. Currently, he coordinates the establishment of the Global Change Experimental Facility at the Helmholtz-Centre for Environmental Research (UFZ). In this project the consequences of climate change and land use change on ecosystem functions will be investigated using a complex experimental infrastructure on large field plots.

SPECIFIC CONTRIBUTIONS OF ECOTRONS TO ECOSYSTEM SCIENCE: FROM ECOSYSTEM FUNDAMENTAL PHYSIOLOGICAL PROCESSES TO IMPACT OF BIODIVERSITY AND CLIMATE CHANGES.

24th of September - 15:00 Plenary Session 2. *Linking in natura to in vitro experimentation: tools to understand, handle and solve problems of a planet under pressure.*

Jacques ROY¹ [jacques.roy@cnrs.fr]

Olivier RAVEL¹, Jean-François LE GALLIARD², Stephan HÄTTENSCHWILER³, Alexandru MILCU¹, Catherine PICON-COCHARD⁴, Victor RESCO DE DIOS⁵

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Ecotrons are experimental platforms allowing a wide control of the environment and at the same time online measurements of ecosystem processes. Sets of replicated units are necessary to compare levels of a given factor and interactions between factors. The confinement chambers vary in size (grams to tons) and other characteristics (*e.g.* natural or artificial light) and can receive intact or reconstructed, terrestrial or aquatic ecosystems. Automated process measurements are currently limited to canopy and whole ecosystem gas exchanges, but future development should include canopy and soil structures changes as well as specific soil activities and diversity. After a first generation in the '90s (Reno, Nevada; Silwood Park, UK) a new generation of ecotrons is now being built, particularly in France and Belgium.

Ecotrons' scientific objectives are wide-ranging and not a priori defined, especially when they are open to the international scientific community through calls for projects. The presentation will focus on the results of recent experiments exemplifying such a range, from the evidence of the role of circadian rhythm on ecosystem CO₂ and H₂O fluxes to ecosystem responses to future extreme drought and heat events under elevated CO₂. Using the example of a study on the mechanisms underlying the impact of biodiversity on ecosystem processes, we will show the strong complementarity between long-term field experiments and ecotron short- or mid-term experiments.

IMPROVED ENVIRONMENTAL CONTROL TECHNIQUES AND NEW EXPERIMENTAL APPROACHES FOR GLOBAL CHANGE ECOLOGY.

24th of September - 15:20 Plenary Session 2. *Linking in natura to in vitro experimentation: tools to understand, handle and solve problems of a planet under pressure.*

Ivan NIJS¹ [ivan.nijs@uantwerpen.be]

Hans DE BOECK¹, Klaus BUTTERBACH-BAHL², Ralf KIESE², Stefan KLOTZ³, Alexandru MILCU⁴, Franco MIGLIETTA⁵, Jacques ROY⁴, Joke VAN DEN BERGE¹

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Experimental ecologists who investigate the impact of global change on ecosystems face two major methodological challenges. One is the fact that techniques to create future environmental conditions are subject to artefacts. Artefacts are a reality in most experimental approaches, but they can be especially critical in setups where the microclimate (*e.g.* air temperature, rainfall, etc.) is modified,

as it is difficult to alter a single abiotic factor without compromising others. Only significant artefacts necessitate methodological improvement, so the first step is to quantify them. A second major challenge for experimental global change ecology is to develop entirely novel methods and designs that allow progress leaps in insight rather than incremental advancement. This presentation includes examples of both. Specifically, we analyze possible artefacts of climatized enclosures and highlight several novel approaches in global change ecology including approaches with biotic drivers, while emphasizing that the exploration of artefacts can also give rise to new opportunities.

FROM ATOM TO PEDON: THE ROLE OF NANO- AND MICROSCALE APPROACHES FOR THE UNDERSTANDING OF THE FUNCTIONING OF SOILS.

24th of September - 16:10 Plenary Session 3. *New tools to meet new challenges: emerging technologies for exploring the unknown processes in ecosystem science.*

Kai U. TOTSCHKE [kai.totsche@uni-jena.de]

Chair of Hydrogeology, Institute for Geosciences, FSU Jena, Germany.

The functions of soils are intimately linked to its three dimensional structure and the unique and emergent properties that co-evolve during pedogenesis. The physical structure of soils can be considered a dynamic, frequently hierarchic organized system of porous aggregates that provide a diverse habitat and platform for the biogeochemical and biophysical interactions and reactions. Together with the chemical variability of the organic and inorganic components, the continuum of inner and outer surfaces forms an extremely large, interconnected and heterogeneous, yet patchy biogeochemical interface. The processes active at these interfaces are fundamental for the immobilization, storage, and transformation of matter, energy and information. The mechanisms that control these processes are operative at the molecular scale of individual surface moieties and range to the scale of macro-aggregates and beyond to the pedon scale. With the advent and development of cutting edge, complementary spectroscopic, spectromicroscopic and tomographic techniques we are able to explore the architecture with up-to-now unknown detail and interrogate the interior dynamics, activity and ecology starting from the smallest building blocks up to the scale of whole aggregates and even undisturbed soil cores. The joint application of such techniques bears the potential to fundamentally understand the mechanistic basis of soil processes and the emergent functions. Yet, as the different techniques, *e.g.*, XAS, AFM, XPS, TERS-, SERS-spectromicroscopy, NanoSIMS, TEM, REM or μ -Xray tomography operate at different spatial scales and require specific sample preparation and operation, we face the demanding problems associated with sampling, isolation and preparation, synscaling and synlocation, *i.e.*, the co-localisation of mapping information from diverse instrumental sources and the scaling to the reference scale. With this talk, the exciting progress which has been made with the application of advanced cutting edge techniques to soil science will be presented, while the bottlenecks and emerging challenges will be critically discussed.



Dr. habil. Kai Uwe Totsche, Professor (Chair) of Hydrogeology, Friedrich Schiller University Jena, Germany. Studies of Geocology (Environmental sciences), University of Bayreuth, Germany; PhD in Soil Science, Habilitation in Soil Science, University of Bayreuth, Germany. Speaker DFG Priority Program PP 1315 Biogeochemical Interfaces in Soil. Main research interests: Carrier and carrier-assisted reactive transport in soils, sediments and aquifers (natural porous media). Formation, fate and effect of nanoparticulate, colloidal and microparticulate matter in natural porous media. Neoformation, growth and decay of mineral-organic mixed particulate phase from complex solutions in natural systems ("Sub-micron-scale soil science"). Soil remediation and development of "soil-based" technologies for soil and groundwater protection and reclamation.

NEXT GENERATION 'OMIC' TECHNOLOGIES - WHAT CAN THEY DO FOR ECOSYSTEMS RESEARCH?

24th of September - 16:40 Plenary Session 3. *New tools to meet new challenges: emerging technologies for exploring the unknown processes in ecosystem science.*

Gail TAYLOR [g.taylor@soton.ac.uk]

Joseph JENKINS, Alex WATSON-LAZOWSKI

Centre for Biosciences, University of Southampton, United Kingdom.

Next Generation Sequencing (NGS) has opened up numerous new possibilities in almost every field within biology. NGS is becoming an increasingly cost-effective method due to the massive amount of data it provides per dollar spent. This has made non-model organisms extremely accessible and open to genomic study. Additionally, metagenomics and amplicon sequencing can now also utilise the rapid sequencing and low cost of NGS technology to mass sequence environmental samples, providing a means to study environmental DNA. This delivers a novel method for analysis of biodiversity and gene abundance within a substrate.

Utilising NGS coupled with targeted metagenomics, we are studying shifts in soil microbial communities under carbon sequestration practices (biochar addition). Results for 16S rRNA bacterial amplicon surveys suggest a minimal impact on soil community composition after 1 month of application, whilst a more dramatic shift is detectable after 1 year.

Additionally, in a separate study of the effects of elevated CO₂ on plants, it has been possible to utilise NGS transcriptomics to understand the adaptations of the non-model organism *Plantago lanceolata* to the elevated CO₂ concentrations present within natural CO₂ springs in Italy. Using this approach we have identified a set of novel genes for stomatal patterning in elevated CO₂ and confirmed previously observed acclimation responses.

In an age where understanding how organisms will respond to our changing environment has become extremely important, NGS has brought the field of metagenome and transcriptome analysis to the forefront as a tool for discovery.



Pr. Gail Taylor is leader of the "Plants and Environment" laboratory and Chair of the multi-disciplinary "Energy" group that draws members from across the University of Southampton. She has more than 100 peer-reviewed publications and an H index in excess of 29, and has trained 35 students to doctoral status. She was founding subject editor of the journal *Global Change Biology Bioenergy* and editorial board of *Biofuels* and *Biotechnology for Biofuels*. She has participated in several EU projects working on bioenergy and environment.

CHARACTERISATION OF BIOGEOCHEMICAL PROCESSES AT THE MICRO-SCALE - CONCEPTS AND APPLICATIONS OF NanoSIMS.

24th of September - 17:10 Plenary Session 3. *New tools to meet new challenges: emerging technologies for exploring the unknown processes in ecosystem science.*

Carsten W. MUELLER¹ [carsten.mueller@wzw.tum.de]

Laurent REMUSAT², Carmen HOESCHEN¹, Cordula VOGEL¹, Karen BAUMANN³, Florian WERNER¹, Marie-France DIGNAC³, Jörg PRIETZEL¹, Pierre BARRÉ⁴, Abad CHABBI⁵, Cornelia RUMPEL³, Ingrid KÖGEL-KNABNER¹

¹Lehrstuhl für Bodenkunde, TU München, Germany - ²IMPMC, UMR CNRS 7590, Sorbonne Universités, MNHN, UPMC, IRD, France - ³CNRS, INRA, (IEES/Écogéochimie isotopique/UMR CNRS, INRA, UPMC, UPEC/IRD), France - ⁴CNRS, ENS Geologie, Paris, France - ⁵INRA, UR P3F, Centre INRA Poitou-Charentes, Lusignan, France.

Soils comprise highly heterogeneous systems over a wide range of spatial and temporal scales. However, processes controlling the stabilization of soil organic matter especially happen at submicron scales within soil aggregates (spatial inaccessibility) or on mineral surfaces (organo-mineral associations). Although the knowledge about the factors controlling the preservation of soil organic matter has substantially improved over the last years, these processes are still hard to evaluate in situ. The specific features of the nano-scale secondary ion mass spectrometry (NanoSIMS) technology, which allows the simultaneous analysis of up to seven ion species with high sensitivity and lateral resolution, make it an unprecedented tool for the analysis of biogeochemical processes and properties of soils. Using Cs⁺ as primary ions, negatively charged ions, e.g. ¹²C⁻, ¹³C⁻, ¹²C¹⁴N⁻, ¹²C¹⁵N⁻ but also ²⁷Al¹⁶O⁻ or ⁵⁶Fe¹⁶O⁻ and ²⁸Si⁻, are collected with a lateral resolution of up to 100 nm. Thus, the NanoSIMS enables us to explore the elemental and isotopic composition of soil organic matter at a previously unresolved lateral resolution.

We will present examples for the application of NanoSIMS ranging from primary particles and micro-aggregates to intact soil aggregates and whole soil core sections. Therefore, we present a full set of possible applications for the study of organic matter stabilization at the relevant spatial scale.

CHARACTERISING LANDSCAPE-HYDROLOGY FEEDBACKS - NEW SENSOR TECHNOLOGIES AND MONITORING APPROACHES.

24th of September - 17:30 Plenary Session 3. *New tools to meet new challenges: emerging technologies for exploring the unknown processes in ecosystem science.*

Steffen ZACHARIAS [steffen.zacharias@ufz.de]

Helmholtz Centre for Environmental Research - UFZ Leipzig, Germany.

Soil moisture is a main controlling factor in hydrological processes and triggers the landscape-water cycle feedback both in the short and the long term. Knowing the spatial distribution of soil moisture is critical to revealing and understanding emergent behavior of catchment scale processes. Even though an enormous amount of effort is being made to establish and operate respective monitoring systems, many of them are ineffective in addressing scientific challenges at scales which are critical for behavior of the hydrological system. Today, satellite-borne data are the best available data source to operate complex, cross-regional or global environmental model systems. Despite the immense progress achieved in the use of satellite-borne data in environmental science, there are still several obstacles preventing an effective use. This is particularly true for monitoring and measurements approaches describing watershed patterns at an intermediate scale. Often data are gathered at scales (in space and time) which are not suited to be linked in an interdisciplinary or cross-disciplinary way, to be used for calibration/validation of remote sensing data, or to fulfil the needs of modern modelling systems. Over recent years, several new technologies and methods for soil moisture monitoring became available that may help to bridge the gap between point and catchment scale measurements. The talk will give an overview of advances in technologies for soil moisture measurements, particularly distributed sensor networks, mobile geophysical methods and cosmic ray moisture sensors.

DATA ACCESSIBILITY AND THE ROLE OF INFORMATICS IN PREDICTING THE BIOSPHERE.

24th of September - 9:00 Plenary session 4. Data access and modelling.

Alex HARDISTY [hardistyar@cardiff.ac.uk]

Director of Informatics Projects, School of Computer Science and Informatics, Cardiff University, United Kingdom.

The variety, distinctiveness and complexity of life - biodiversity in other words and by implication the ecosystems in which it is situated - is our life support system. It is absolutely essential and more important than almost everything else but it is typically taken for granted. Today's big societal challenges - food and water security, coping with environmental change and aspects of human health - are beyond the abilities of any one individual or research group to solve. Solving them depends not only on collaboration to deliver the appropriate scientific evidence but increasingly on vast amounts of data from multiple sources (environmental, taxonomic, genomic and ecological) gathered by manual observation and automated sensors, digitisation, remote sensing, and genetic sequencing. In April 2012 we called the biodiversity and ecosystems research communities to arms to formulate a consensus view on establishing an infrastructure to improve the accessibility of the ever-increasing volumes of biological data. We published the whitepaper: "A decadal view of biodiversity informatics: challenges and priorities" that has since been viewed more than 24,000 times. We envisage a shared and maintained multi-purpose network of computationally-based processing services sitting on top of an open data domain. By open data domain we mean data that is accessible *i.e.*, published, registered and linked. BioVeL, pro-iBiosphere, ViBRANT and other FP7 funded projects have all explored aspects of this vision.

In this talk we will think about the role that accessible data and informatics plays in the grand challenge of predicting the biosphere, which after all is about measuring and predicting ecosystems behaviours from local to global scale.



With more than 10 years' experience of research infrastructures for biodiversity and ecosystems research, Alex Hardisty leads the €5m FP7-funded BioVeL (Biodiversity Virtual e-Laboratory) project (www.biovel.eu), as well as work packages in the ENVRI project (www.envri.eu) on common challenges facing research infrastructures for environmental sciences and the CReATIVE-B project (www.creative-b.eu) - a coordination action on international virtual environments environments for biodiversity and ecosystem research.

He is a lead co-author setting out the community's decadal vision for biodiversity informatics (BMC Ecology, doi:10.1186/1472-6785-13-16) and co-chair of the highly successful 2013 Biodiversity Informatics Horizons conference (<http://conference.lifewatch.unisalento.it/index.php/EBIC/BIH2013>). Alex is Director of Informatics Projects in the School of Computer Science and Informatics at Cardiff University and has extensive industrial experience of product development, software engineering and architectural design, international standardisation, and distributed computing systems for research support.

ÆKOS: A NEW PARADIGM ENABLING ACCESS TO AND REUSE OF COMPLEX ECOLOGICAL DATA.

25th of September - 9:30 Plenary session 4. Data access and modelling.

David TURNER [d.turner@adelaide.edu.au]

ÆKOS, Adelaide, Australia.

ÆKOS - The Australian Ecological Knowledge and Observation Service reduces the time spent by researchers who use third party data to create new science. It does this by integrating source data nationally at a site level, which leads to faster discovery and provides well-described metadata to enable exploration of the suitability of data - a must for scholarly reuse of third party data. ÆKOS has adopted best practice and innovative approaches from a diverse range of disciplines to produce a "first cut" system and position for future enhancement and collaboration.

Challenges facing ecology as a data-intensive science: Ecological data are inherently complex, not only because of the underlying complexity and context dependency of natural systems but also due to the way that ecology as a discipline operates. Most data collection activities are relatively small-scaled and focused on a particular objective, meaning there are a myriad of different collection protocols, measurement standards and classification systems in use. From the perspective of data reuse, this creates challenges around integration and interpretation, especially where there is a need to incorporate data from multiple sources.

For data reuse to be effective, information needs to be stored and presented in a manner that facilitates examination and manipulation. Current barriers that restrict re-use by third party researchers include poor discoverability and access constraints. While there are many examples of systems that attempt to address these, we argue that this is only part of the solution.

Well-described data leads to robust science: ÆKOS places significant emphasis on the provision of detailed contextual information. In particular, information about sampling design, data collection, measurement protocols and classification systems employed, are required to enable researchers to make an informed assessment of the data. This minimises the chance of inappropriate interpretation and helps guard against misuse.

ÆKOS has been designed to expose the richness of plot data rather than a narrow subset, and presents this in a fully integrated way to the user. This means that it is mapped to common ontological concepts where possible without distorting the underlying knowledge. Data are stored at the individual plot level meaning the user can directly search against, view results at, and freely download at this level.

More information is available at <http://www.aekos.org.au>



David has a broad ecological background working on projects ranging from empirical studies in temperate marine environments, through to terrestrial vegetation modelling as well as adaptive environmental management. For the last few years he has worked as an ecological data subject matter expert with the Eco-informatics facility which is part of the Terrestrial Ecosystem Research Network, based at the University of Adelaide. The work of the facility has focused on the challenges associated with storing, manipulating and providing access to diverse and complex data. This has led to the creation of a number of novel solutions including the Australian

TOWARD LINKING DATA FROM EUROPEAN MONITORING AND EXPERIMENTAL SITES TO A GLOBAL OBSERVATORY.

25th of September - 10:00 Plenary session 4. Data access and modelling.

John WATKINS¹, [jww@ceh.ac.uk]

Johannes PETERSEIL²

¹Centre for Ecology and Hydrology, Lancaster, United Kingdom - ²Umweltbundesamt, Vienna, Austria.

Within the ExpeER project, work was undertaken to integrate and publish data from a wide range of experimental and long-term monitoring sites. Given the range of international standards available for web delivery of integrated geospatial data, several good candidates seemed to be available to deliver this. Having conducted a survey of the capabilities and requirements of the ExpeER partners, the heterogeneity of the data being collected demonstrated the weaknesses of seeking a universally valid common data model approach. The level of granularity and particular characteristics of data represented in storage models are inevitably dependent on the needs of the particular analysis to be supported. Common vocabularies can however help to fully describe data and compare similar but different data, enabling researchers to gain the best value from the range of data available. This is particularly true when considering how to link data from the ExpeER partners into other networks such as the Long Term Research Network (LTER Europe), AnaEE (Analysis and experimentation on Ecosystems) or other future networks with new measurement methods. The ExpeER project has addressed such issues through extension of the EnvThes vocabulary, delivered through a Linked OpenData services such as a SPARQL endpoint. These definitions have also been linked to the DEIMS catalogue used by LTER for the description of sites and data sets to aid the comparison of these data. The development of common vocabularies provides a flexible accommodation of the heterogeneity of data networks and provides links to new networks by linking of vocabularies through Open Linked Data techniques. Within ExpeER the establishment of links to AGROVOC, GEMET, EUROVOC, codelists of EEA has been started, and will hopefully be continued to other vocabularies, enabling use-case dependent semantic harmonization for bringing together data from inside and outside the ExpeER partners.

ECOSYSTEM MODELLING AND CLIMATE CHANGE: WHAT IS WRONG?

25th of September - 10:50 Plenary session 4. Data access and modelling.

Pete SMITH [pete.smith@abdn.ac.uk]

Scottish Food Security Alliance-Crops & Institute of Biological and Environmental Sciences, School of Biological Sciences, University of Aberdeen, Scotland, United Kingdom.

There are many reasons why ecosystem models might not live up to expectation. These include inappropriate use of models, poor models, or poorly tested models. The inappropriate use category includes a) use of models for a purpose for which they were not designed, b) inexperienced users, c) poor documentation, and c) inadequate driving data. In the poor model category, models could be a) too simple (and omit important processes), too complex (so they are too difficult to run, require data that is not available, or need to run with all variables set to default values), c) poorly parameterised, or d) incorrectly coded / bug-ridden. In the poorly tested model category models can be a) inadequately tested against data, b) without a known sensitivity profile (due to lack of sensitivity analysis), or c) without known uncertainty propagation (due to lack of uncertainty analysis). In the same way that any tool can be used inappropriately, so can models. And the oft repeated statement that "all models are wrong, but some are useful" should always be borne in mind.

Despite the many pitfalls in selecting or developing the appropriate model, models are often useful. They can help us test hypotheses, explain data, integrate and interpolate data, extrapolate data in space and time, project into the future and spatially, and can test our understanding of processes and interactions. In this respect, they can be regarded simply as a mathematical formulation of a series of interconnected hypotheses. It is worth spending the time selecting the right model, and getting to understand it, as the rewards can be great, but models are only as good as the understanding they represent. Models should never be used in place of empirical science; rather they should be seen as a representation of our best understanding, and as a complement to our experimental endeavours. Modellers and empirical scientists should find many useful ways to collaborate together.



Pete Smith is the Professor of Soils and Global Change at the Institute of Biological and Environmental Sciences at the University of Aberdeen (Scotland, UK), Science Director of the Scottish Climate Change Centre of Expertise (ClimateXChange) and Director of Food Systems for the Scottish Food Security Alliance-Crops. He leads the University of Aberdeen multi-disciplinary theme on Environment & Food Security.

CROP IDEOSYSTEMS: IN SEARCH OF RESOURCE USE EFFICIENCIES IN THE PRIMARY PRODUCTION OF FOOD - A NEED FOR INTEGRATED EXPERIMENTAL APPROACH ACROSS EUROPE.

25th of September - 11:20 Plenary session 4. Data access and modelling.

John R. PORTER^{1,2} [jrp@plen.ku.dk]

Hamish BROWN³, Edmar TEIXEIRA³, Derrick J MOOT⁴

¹Faculty of Sciences, University of Copenhagen, Denmark - ²Natural Resources Institute, University of Greenwich, United Kingdom - ³New Zealand Institute for Plant and Food Research, Private Bag 4704, Christchurch, New Zealand - ⁴Faculty of Agriculture and Life Sciences, Lincoln University 7647, Canterbury, New Zealand.

The concept of the crop "ideotype" (Donald, 1968) represented a conceptual breakthrough in crop physiology by defining a quasi-Aristotelian theoretical "ideal" for the structure and function of a crop plant. An ideotype would be high yielding, be resistant to weeds and maximise the use of environmental resources such as water, nutrients, light and temperature. The mantra of sustainable intensification remains at the level of its possible premises. We need a structural and theoretical framework for understanding how factors might trade-off at the plot or field level, in a similar manner to defining the components of yield. The point of the analysis is to show that there are a plethora of points in crop and fodder production cycles that are amenable to intensification. For the concept to be meaningful requires an insightful deconstruction of the elements and identities involved. Borrowing from C.M. Donald (19678) who tried to define the "ideotype" for an ideal crop plant, we can describe quantitatively using deconstruction and how an ideal cropping system and it would function. This concept is termed an "ideosystem". For instance, NUE could be improved by increasing the amount of biomass per unit of nutrient input, which is the main current and narrow definition of how to improve NUE. However, at the cropping, and perhaps the farming, system level NUE could be made both more sustainable (by reducing losses) and more intensive (by increasing production) by raising the ratio of nutrient uptake per unit of nutrient available in the soil. Sustainable intensification needs an operational definition that recognises that sustainability and intensification applies to the whole crop producing agro-ecosystem. In addition, ideosystems can be partitioned into components that are influenced by genotype environment and management

separately or in combination.

The presentation will explore how these ideas can be used to define promising experimental approaches notably under the future AnaEE (Infrastructure for Analysis and Experimentation on Ecosystems) that link to the debate about food security in Europe and at the same time focus on the main ecosystem of Europe - that is the agro-ecosystem.



John Roy Porter is an internationally known scientist in crop ecology and physiology, biological modelling and agricultural ecology. Main contribution has been multi-disciplinary and collaborative work in the response of arable crops, energy crops and complex agro-ecosystems to their environment with an emphasis on climate change and ecosystem services. John Roy Porter has published more than 110 papers in reviewed journals out of a total of about 350 publications and has personally received three international prizes for his research and teaching. His H index is 39 and with 80 papers receiving over 10 citations, giving an average citation number per paper of ca. 140. Recently he has led the writing of the critically important chapter for the IPCC 5th Assessment in Working Group 2 on food production systems and food security. He has recently expanded his interest into food systems and food security.

ECOSYSTEMS STATES AND FLUXES: FROM OBSERVATION TO PREDICTION.

25th of September - 11:50 Plenary session 4. Data access and modelling.

Harry VEREecken, [h.vereecken@fz-juelich.de]
Harrie-Jan HENDRICKS-FRANSEN, Hanna POST
Forschungszentrum Jülich, Germany.

The availability of remote sensing and non-invasive measurement technologies has greatly improved our potential to observe states and fluxes in terrestrial ecosystems in the last decades. These techniques allow us to obtain a high spatial and temporal resolution and provide at the same time a large spatial coverage from the regional to the global scale. Yet, we have not fully explored the potential of these methods as analyses are often limited to qualitative evaluations limited to single states, and as the interdependences between different data types are difficult to capture. Multi-scale, multi-variate data assimilation approaches provide a unique opportunity to integrate different data types in a data assimilation framework that allows prediction of states and fluxes of terrestrial ecosystems. We will present examples of data assimilation approaches used to improve the prediction of soil moisture, energy fluxes and biogeochemical fluxes in ecosystem research. Specifically we will present results on how to use remotely sensed land surface temperature in combination with cosmic ray sensors to improve the estimate of ET. We will demonstrate the value of using brightness, temperature and parameter estimation to improve the characterization of soil water fluxes. In addition, we comprehensively studied and quantified the uncertainty of carbon fluxes measured at eddy covariance towers within the research catchment. The eddy covariance data observations were then assimilated with the Community Land Model (CLM). Model parameters were estimated for single sites with an adaptive Markov Chain Monte Carlo (MCMC) method. For catchment scale predictions of the biogeochemical fluxes we estimated CLM states with an Ensemble Kalman Filter (EnKf).

CONFRONTING ECOSYSTEM MODELS WITH REAL WORLD EXPERIMENT: A TWO WAY FEEDBACK LOOP.

25th of September - 12:10 Plenary session 4. Data access and modelling.

Nimai SENAPATI¹ [nimai.senapati@lusignan.inra.fr]

Abad CHABBI^{1,2}, Pete SMITH³

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Real world experimental data may help in reducing model uncertainty and modelling can help to identify new research questions for real world experimentation. In ecosystems, vegetation growth, transpiration, photosynthesis, carbon allocation, respiration and water, heat, carbon and nitrogen fluxes all are interconnected. Therefore, investigation of all ecosystem processes together could improve our understanding of underlying processes, their interactions and any feedbacks. However, field-integrated experimentation is not only costly and time-consuming, it also usually allows the study of only a few variables/parameters/processes at one time. Different ecosystem models encompass state-of-the-art knowledge to represent different ecosystem processes together, and could provide an additional tool to investigate/explore several phenomena which connect atmosphere-plant-soil systems. Models also help us test hypotheses and understand the systems they represent.

Confronting ecosystem models with well-integrated real-world experiments is a win-win situation for model improvement as well as improvement of our current knowledge and understanding. There are uncertainties in different model parameters and also within model structures. Whereas the parameter uncertainty in most cases is smaller, model structural uncertainty is often larger. Experimental data sets test the ability of models to explain the underlying systems. On the other hand, these real-world experimental data may help estimate different site-specific model parameters, for example through data assimilation, and could reduce parameter uncertainty and total error in the model simulation. This may finally lead to improving model efficiency in projections. Poor model agreement with experimental values could highlight the gap in current knowledge to explain a system within the model structure, and thus may help define new areas for further experiments, to improve system understanding. On the other hand, the main advantage of the ecosystem models is that they can simultaneously simulate different processes, which may otherwise be difficult or nearly impossible to measure together. Simply, models supplement real world experiments. Thus, models could also help in identifying the gaps in our knowledge which require more attention for real world experimentation, in order to understand the system in a better way. In summary, models and real world experiments are ultimately a two-way feedback loop, and they should go together, side-by-side for the improvement of models as well as our current scientific knowledge.

INTEGRATING MODELLING AND EXPERIMENTAL PLATFORMS IN RESEARCH INFRASTRUCTURE: DESIGN AND APPROACH IN AnaEE-FRANCE.

25th of September - 12:30 Plenary session 4. Data access and modelling.

André CHANZY¹ [andre.chanzy@avignon.inra.fr]

Christian PICHOT², Cécile CALLOU³, François LAFOLIE¹, Michel LOREAU⁴, Hélène RAYNAL⁵, Lucile GREIVELDINGER¹

¹UMR INRA/UAPV Environnement Méditerranéen et Modélisation des AgroHydrosystèmes, Avignon, France - ²UR INRA Ecologie des Forêts Méditerranéennes, Avignon, France - ³UMS CNRS Bases de Données sur la biodiversité, écologie, environnement et sociétés, Paris, France - ⁴UMS CNRS Station d'Ecologie Expérimentale du CNRS à Moulis, France - ⁵UR INRA Mathématiques et Informatique appliquée, Toulouse, France.

Bridging experiments with models is a key issue for research infrastructure. Models can contribute to the experimental process for protocol design or data quality control. Moreover, they offer an efficient way of promoting data reuse, thus giving a strong added value to data bases. Therefore, building interoperability between models and experimental platform data bases is an important task to improve the quality of experimental infrastructures and provide users with seamless and integrated information systems. The research infrastructure AnaEE-France is taken as an example illustrating the required steps to achieve such an objective. In AnaEE-France, models are gathered in four thematic modelling platforms (RECORD, VSOIL, CAPSIS and the Centre for Biodiversity Theory and Modelling). They offer services as a repository for modules and models, tools for simulation pre-processing and post-processing and coupling technology to develop new models by taking advantage of existing modules. The coupling capacities will be extended in AnaEE-France to the experimental data bases. As the infrastructure is distributed among 21 experimental services, data base frameworks are proposed i) to facilitate the integration of core measurements provided by the experimental platforms and measurements made by users, ii) to standardize data annotation with metadata, and iii) to manage data access rights. To control semantic usage, a common referential for both modelling platforms and data bases is under development based on the existing thesauri and the specific AnaEE-France vocabularies. It will provide a thesaurus and simple ontologies to describe the data (traits or parameter, sites, units, spatial and temporal characteristics, methods). Web-services are being developed to access the data bases from the modelling platforms. In a first step, the web-services will be parameterized on a case-by-case basis. However, in a second step, the development of automatic filters is foreseen, and they will take advantage of data annotation to match model inputs and outputs with experimental data.

ABSTRACTS: POSTER PRESENTATIONS

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ABSTRACTS

***PINUS SYLVESTRIS* AS A SOURCE OF METHANE AND NITROUS OXIDE.**

24th of September - 11:15 > 11:45 Poster Session 1. Research infrastructure: opportunities to address the impact of global change?

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Methane (CH₄) and nitrous oxide (N₂O) are important greenhouse gases contributing to global climate change. The boreal forests represent 29% of the total world forests. Based on soil chamber measurements, boreal upland forests have been considered a significant natural sink of methane (CH₄) and a natural source of nitrous oxide (N₂O). Our study showed for the first time that mature Scots pine trees (*Pinus sylvestris*), a typical representative tree of boreal forests, can emit both, N₂O and CH₄ from its aboveground surfaces (stem and shoot) under field conditions. The shoot emissions of CH₄ and N₂O considerably exceeded the stem emissions thus underlining an important role of shoots in the trace gas exchange between forest ecosystems and the atmosphere. The stem and forest floor emissions of CH₄ were significantly positively affected by soil water content. Moreover, the forest floor emissions of CH₄ exceeded the stem emissions at the wet conditions (mean soil volumetric water content (VWC): 0.75 ± 0.016 m³m⁻³), whereas the stems emitted small amounts of CH₄ at the dry conditions (mean VWC: 0.33 ± 0.030 m³m⁻³) while the forest floor showed CH₄ deposition. This suggests that CH₄ emission from studied plots of the boreal upland forest occurs predominantly *via P. sylvestris* under low soil water content. This study highlights the necessity to include CH₄ and N₂O emissions *via* plants into the estimations of trace gas fluxes from forest ecosystems.

This research was financially supported by the ExpeER project (Experimentation in Ecosystem Research, European Community_Seventh Framework Programme), project ENVIMET (CZ.1.07/2.3.00/20.0246), The Academy of Finland Centre of Excellence (project 272041), Emil Aaltonen Foundation and Helsinki University Centre for Environment, HENVI.

KEYWORDS: methane, nitrous oxide, Scots pine, boreal upland forest, shoot emission, stem emission, soil emission.

IMPACTS OF AGRICULTURAL MANAGEMENT ON CROP PRODUCTIVITY, SOIL QUALITY AND CLIMATE CHANGE MITIGATION.

RESULTS OF THE EU FP 7 CATCH-C PROJECT

24th of September - 11:15 > 11:45 Poster Session 1. Research infrastructure: opportunities to address the impact of global change?

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Soils are the main basis for the production of food and feed. Furthermore, the production of biomass for energy and material use is becoming increasingly important. Goals for an optimal management of agricultural soils are, on the one hand, the maintenance or improvement of high crop productivity and, on the other hand, soil quality and climate change mitigation (reduction of GHG emissions and C sequestration). Thus, the EU project CATCH-C aims to evaluate current management practices concerning these three goals based on indicators derived from results of long-term field experiments managed by project partners or published in scientific and grey literature.

The indicator-based evaluation of agricultural management practices was carried out comparing a set of improved ("best") and often applied ("current") management practices. Positive and negative effects when best management practices are adopted were highlighted. As expected, none of the investigated practices could comply with all objectives simultaneously, *i.e.* maintaining high yields, mitigating climate change and improving chemical, physical and biological soil quality.

The studied soil management practices "non-inversion tillage", "organic fertilisation" (application of farm yard manure, slurry, compost) and "incorporation of crop residues" represent important tools for farmers to increase soil carbon content and stock, thus improving physical, chemical, but also biological soil quality. However, CO₂ and, especially, N₂O emissions may rise as well. Despite the slightly negative overall yield responses, the range extends from yield losses to yield increases. Yields are more affected by other factors, such as climate conditions, soil texture and duration of a specific management practice (Spiegel *et al.*, 2014).

Since the results were obtained on the basis of long-term field experiments, their importance for agricultural practice and for science must be emphasised.

CATCH-C is funded within the 7th Framework Programme for Research, Technological Development and Demonstration, Theme 2 - Biotechnologies, Agriculture & Food. (Grant Agreement N° 289782).

REFERENCE: Spiegel H., Zavattaro L., Guzmán G., D'Hose, T., Pecio A., Schlatter N., ten Berge H., Grignani C., 2014. Impacts of soil management practices on crop productivity, on indicators for climate change mitigation, and on the chemical, physical and biological quality of soil. Catch-C "Compatibility of Agricultural Management Practices and Types of Farming in the EU to enhance Climate Change Mitigation and Soil Health", www.catch-c.eu.

KEYWORDS: soil management, climate change, tillage, fertilisation.

SUSTAINABLE FUEL WOOD PRODUCTION AND WOOD ASH RECYCLING ON ACIDIC FOREST SOILS.

THE ICIF (ITINERAIRES DE CULTURES INNOVANTES EN FORET) EXPERIMENTAL SITE IN THE FRENCH ARDENNES.

24th of September - 11:15 > 11:45 *Poster Session 1. Research infrastructure: opportunities to address the impact of global change?*

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Fuel wood is a critical component of the sustainable French energy development plan. To anticipate the demand, foresters have to consider innovative silvicultures that ensure an increased and sustainable biomass supply. On fertile agricultural soils, biomass-dedicated plantations proved efficient. Their transposition on more acidic forest soils requires studies targeting soil chemical and physical fertility management, adapted tree species selection, silvicultural developments adaptation along with assessments of both technical feasibility, economic efficiency and short- to long-term ecosystem impacts. These developments suppose focused experiments on planting techniques (soil preparation and liming), a prerequisite for enhancing productivity.

An 11 ha experiment was initiated in the French Ardennes by a partnership between FCBA, INRA and ONF. It compares the effects of various soil mechanical preparation and fertility management techniques on the productivity of biomass-dedicated (hardwood) and semi-dedicated (coniferous) silvicultures. More specifically, we tested the use of wood ash from heating plants for soil protective liming, one option for a closed-loop and sustainable forest soil fertility management.

In order to establish a baseline for long-term ecosystem monitoring, just after tree plantation (in 2013) soil from the 48 experimental plots was sampled and measured for chemical properties, and ground flora was surveyed on a subset of 30 experimental plots, crossing soil-preparation technique (deep or superficial soil decompaction), liming type (none, commercial or wood ash/dolomite mixture) and two tree species (1 coniferous, 1 hardwood).

A few months after soil liming, wood ash/dolomite mixture supply increased soil exchangeable cations contents similarly to commercial liming and soil preparation technique interacted with liming type. Both liming types impacted similarly plant community composition, but the type of soil preparation technique had no effect.

Project funded by Futurol-BPI France and ADEME.

KEYWORDS: biomass, experiment, wood fuel, monitoring, wood ash.

A NEW MICROCOSM CONCEPT FOR EXPERIMENTAL RESEARCH ON AQUATIC MICROBIAL ECOSYSTEMS.

24th of September - 15:40 > 16:10 Poster Session 2. Linking in natura to in vitro experimentation: tools to understand, handle and solve problems of a planet under pressure.

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We present a new microcosm designed to simulate and predict the behaviour of natural aquatic communities under highly controlled environmental conditions during global change experiments. The microcosm is designed to recreate in situ temperature, irradiance, water mixing, dissolved O₂ and CO₂ and nutrient system of a wide range of natural aquatic environments. Marine and freshwater microbial communities are housed in a stainless steel tubes (6L of volume) installed inside a mesocosm itself filled with water and located in a climate chamber. A second tube used as medium reservoir can be connected to the microcosm by a peristaltic pump when phytoplankton is cultured in continuous mode (chemostat). Aquatic communities can be illuminated with sodium lamps generating photosynthetically active radiation (PAR) irradiances of up to 1000 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ either with plasma lamps closely reproducing the solar spectrum (up to 600 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$). Temperature is regulated in a bain-marie fashion. Water chemical parameters (pH, total alkalinity, temperature, salinity and dissolved nutrients) are monitored by a series of specific sensors and samples can be analysed continuously. The metabolic activity of the aquatic communities (respiration and photosynthesis) can be quantified by means of an airtight cover lid which enables the monitoring of gas exchanges between the water and the air inside the microcosm. Several freshwater and marine communities (phyto- and zooplankton) have already been maintained successfully in the microcosm for several weeks. This equipment will be part of the open-access Ecotron IleDeFrance facility nearby Paris and will be available through calls for projects starting from 2015.

REFERENCE: Verdier, B., Jouanneau I., Simonnet B., Rabin C., Van Dooren T.J.M., Delpierre N., Clobert J., Abbadie L., Ferrière R., and Le Galliard J.-F. 2014. "Climate and atmosphere simulator for experiments on ecological systems in changing environments". *Environ. Sci. Technol.* 48(15): 8744-8753.

KEYWORDS: microcosm, aquatic microbial ecosystems, experimental environment control, microbial metabolism.

A CLIMATE AND ATMOSPHERE SIMULATOR FOR EXPERIMENTS ON ECOLOGICAL SYSTEMS IN CHANGING ENVIRONMENTS.

24th of September - 15:40 > 16:10 *Poster Session 3. New tools to meet new challenges: emerging technologies for exploring the unknown processes in ecosystem science.*

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Grand challenges in global change research and environmental science raise the need for replicated experiments on ecosystems subject to controlled changes in multiple environmental factors. We designed and developed the Ecolab as a variable climate and atmosphere simulator for multi-factor experimentation on natural or artificial ecosystems. The Ecolab integrates atmosphere conditioning technology optimized for accuracy and reliability. The centerpiece is a highly contained, 13 m³ chamber to host communities of aquatic and terrestrial species and control climate (temperature, humidity, rainfall, irradiance) and atmosphere conditions (O₂ and CO₂ concentrations). Temperature in the atmosphere and in the water or soil column can be controlled independently of each other. All climatic and atmospheric variables can be programmed to follow dynamical trajectories and simulate gradual as well as step changes. We demonstrate the Ecolab's capacity to simulate a broad range of atmospheric and climatic conditions, their diurnal and seasonal variations, and to support the growth of a model terrestrial plant under two contrasted climate scenarios. The adaptability of the Ecolab design makes it possible to study interactions between variable climate/atmosphere factors and biotic disturbances. Developed as an open-access, multi-chamber platform, this equipment is available to the international scientific community for exploring interactions and feedbacks between ecological and climate systems.

KEYWORDS: ecosystem, global change, multifactor experiment.

USING IMAGING SPECTROSCOPY TO ASSESS SOIL QUALITY IN HARZ MOUNTAINS GERMANY.

24th of September - 15:40 > 16:10 *Poster Session 3. New tools to meet new challenges: emerging technologies for exploring the unknown processes in ecosystem science.*

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Imaging Spectroscopy (IS) is a promising tool for studying natural and artificial materials in general and soil properties in particular. Recent studies have proposed several conceptual frameworks for monitoring soil quality by spectroscopy mainly at small scale. To upscale from a point to image spectrometry is not just to move from micro to macro scales, it is also to face problems such as low signal-to-noise level, contamination of the atmosphere, large data sets and more. The overall aim

of this research is twofold: (1) to evaluate the ability of mapping soil properties by IS to detect changes in soil properties with different treatments in Harz Mountains Germany, and (2) to assess soil properties values for Spectral Soil Quality Index (SSQI) by IS as an integrated model. We apply remote sensing and geographic information system (GIS) techniques, to map and analyze soil quality with IS. To fulfill these objectives, 14 soil physical, biological, and chemical properties and their derived soil quality index (SQI) were computed. Several mathematical/statistical procedures, consisting of a series of operations, including a principal component analysis (PCA), a partial least squares-regression (PLS-R), and a partial least squares-discriminate analysis (PLS-DA) were used. The correlations between the predicted spectral values of the calculated SQI ranged $0.65 < R^2 < 0.85$ with regression point displacement (RPD) > 2 . The PLS-DA model which was used to develop the SSQI showed high classification accuracy. The classification of soils into spectral definitions provides a basis for a spatially explicit and quantitative approach for developing the SSQI. This study underscores the potential application of imaging spectroscopy as a diagnostic screening tool for assessing soil quality at large scale. It is concluded that soil quality can be effectively monitored using the spectral-spatial information provided by the IS technology. This study demonstrates that the spectral information is useful and has added values to traditional field-mapping capabilities.

KEYWORDS: imaging spectroscopy, spectral soil quality index, soil quality index, soil reflectance, soil applications, and geo-statistic models.

PROJECT WETFORSIG - SPATIO-TEMPORAL VEGETATION SIGNALS OF GLOBAL CHANGE IN SOUTHERN EUROPEAN WETLAND FORESTS.

24th of September - 15:40 > 16:10 Poster Session 3. *New tools to meet new challenges: emerging technologies for exploring the unknown processes in ecosystem science.*

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Monitoring riparian plant communities is a critical conservation activity, not only to track biological responses to local and global environmental changes but also to identify early warning signals of prospective changes in the ecosystem functioning which might affect other species and habitats and ultimately the services they provide (Cardinale *et al.* 2012; Ström, Jansson & Nilsson 2012; Stella *et al.* 2013). Doñana National Park (SouthWestern Spain) harbours the largest Ibero-Atlantic wetland forest under Mediterranean climate (Rodríguez-González *et al.* 2008). In 2002 we started a long-term monitoring protocol of riparian vegetation at Arroyo de la Rocina, Soto Chico and Soto Grande, at landscape scale using Landsat TM images. In 2004, the project added a permanent plot network where community (species composition, structure) and environmental data are being recorded in the field every five years. In parallel, we are studying the spatial patterns of functional and phylogenetic herbaceous diversity across environmental gradients and the dendroecology of the main tree species.

The general objectives of our research are characterizing the spatial and temporal variation trends in the community structure and in the ecophysiological processes occurring in Southern European wetland forests in order to identify indicators of the whole ecosystem vulnerability. Specifically the ExpeER project WETFORSIG aims at: (i) developing and testing a novel methodology for the intermediate scale remote sensing of vegetation across the Doñana wetland forests, using the unmanned aerial vehicle (UAV) recently acquired at Doñana infrastructure, (ii) identifying NDVI

temporal signatures of NDVI variation for the main tree species (iii) continue the quinquennial long-term monitoring of community composition and structure in the established network of permanent plots and sampling procedures to be used as ground-truth for the remote sensing images, (iv) exploring and tracking plant community responses and functional relationships of trees to environmental change, and (v) reinforcing and enlarging the collaboration with local researchers in the long-term monitoring program development.

Preliminary results of the Normalized Vegetation Difference Index (NDVI) through time revealed shifts in the riparian cover and suggest species-specific temporal signatures for the dominant trees. At the local scale (permanent plots), our data indicate increasing senescence of wetland population structure in La Rocina stream, associated to the particular persistence strategy maintained by the dominant trees (*Salix sp.*). So far, our results give rise to new questions about the importance of the hydrologic dynamics, the regeneration patterns and the demogenetic structure of these forest populations if we are to understand their driving processes and to preserve their viability on the long term. Therefore, it is of utmost importance to keep up the riparian vegetation monitoring protocol in the long term, maintaining the remote sensing approach combined with the field sampling.

REFERENCES: Rodríguez-González, P.M., Ferreira, M.T., Albuquerque, A., Espirito Santo, D. & Ramil Rego, P. (2008) Spatial variation of wetland woods in the latitudinal transition to arid regions: a multiscale approach. *Journal of Biogeography*, 35, 1498-1511.

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Stella, J.C., Rodríguez-González, P.M., Dufour, S. & Bendix, J. (2013) Riparian vegetation research in Mediterranean-climate regions: common patterns, ecological processes, and considerations for management. *Hydrobiologia*, 719, 291-315.

KEYWORDS: ecosystem monitoring, ecosystem vulnerability, NDVI, remote sensing, riparian.

PLANT BIODIVERSITY AND AIRBORNE POLLEN: NEXT-GENERATION SEQUENCING OF ENVIRONMENTAL DNA.

24th of September - 15:40 > 16:10 Poster Session 3. *New tools to meet new challenges: emerging technologies for exploring the unknown processes in ecosystem science.*

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Airborne pollens reflect differences in the species composition of the local flora and may capture the spreading of alien species. The air biomonitoring may also detect the flowering season of anemophilous taxa as well as the reproductive response of plants to environmental changes at a temporal and spatial scale.

Aim of this research is to characterize the air biodiversity of different habitats - as coded by Natura 2000 and Corine Land Cover - through a DNA metabarcoding approach on environmental samples collected at ground level. The metabarcoding of environmental DNA will allow the taxonomic identification based on specific genetic markers, leading to an estimation of the biodiversity.

The information gathered, complemented with results from traditional approaches, will eventually lead to a characterization of functional and compositional biodiversity in the study area, Eastern Italian Alps. This area can be considered as a case study for Alpine regions where land is exploited for different purposes: residential, cultural (including leisure, recreation and amenity) and natural environment quality (conservation and management).

KEYWORDS: metabarcoding, Natura 2000, Corine Land Cover, Alps.

A PLAN TO IMPLEMENT AN ECO-FRIENDLY AGRICULTURE IN ADOUR-GARONNE WATERSHED (SOUTH WEST OF FRANCE): AGROFORESTRY AND COVER CROPS.

24th of September - 15:40 > 16:10 Poster Session 3. New tools to meet new challenges: emerging technologies for exploring the unknown processes in ecosystem science.

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The objective is twofold: fewer inputs, less tillage, less water pollution, but also more plant, more service provided by agriculture to environment. To achieve this, it uses techniques based on the preservation of soil capital: permanent crop and tree cover.

- A PROJECT SIMPLE, FLEXIBLE, BUT AMBITIOUS AND WITHIN REACH... Reimplanting soil and plant at the heart of agronomy sciences and associating them with a collective water saving represents a double challenge that fills many cross-purposes. The idea is to take the initiative and to experiment a diffuse and preventive action in order to have a sustainable and transposable reply to the challenges we face at all territorial scales. By valuing achievements, by enhancing the existing tools, and by betting on the large capacity of agro-ecosystems to regenerate naturally, we can radically transform our territories without costly investments, just by changing our point of view and our practices.
- UNITING FARMING APPROACHES. Agr'eau is a multi-partner program, built to develop soil cover in Adour-Garonne through knowledge dissemination and through support of local actors, and communication. Agr'eau is the first development program aimed at soil cover and built across a watershed as large as Adour-Garonne. Born from farmers' initiative, this major operation spreads over years and offers a multi-stakeholder approach while it crosses sustainable development practices coming from agroforestry and plant cover techniques. Thus, in order to amplify the existing large-scale movement, this program aims to create a development dynamic by relying on the diversity of experiences, creating reliable technical and economical references, and by valuing and disseminating technical knowledge in which farmers are key players.
- A PROJECT WITH, FOR AND BY FARMERS. Beyond an important information program, Agr'eau is a recovery operation of technical and economic references, open to all farmers and putting farmers at the heart of the plan. The idea is to connect different actors of the territory, and implement Agricultural knowledge transfer. This knowledge-sharing approach is opened to all forms of agriculture. To highlight the initiatives of farmers, a network of over 125 pilot farms will be used to create a monitoring tool and acquire new technical references.

KEYWORDS: water resource and quality management, agroforestry, non tillage, biomass, biodiversity, vegetative cover.

THE WILD TREE AND PLANT COVER TO PROTECT BEES.

24th of September - 15:40 > 16:10 Poster Session 3. *New tools to meet new challenges: emerging technologies for exploring the unknown processes in ecosystem science.*

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Modern agroforestry's overall approach combines, in the same space, wild trees species, vegetative covers (clover, trefoil, sainfoin, alfalfa, buckwheat, etc...) and cash crops. Whenever possible, it uses existing old trees and young wild trees naturally grown. It relies on synergies between various elements to solve some major agricultural issues, such as pollinators' (especially bees) population decline.

During its life, a bee will consume sixty times its weight of honey. Obviously, feeding bees with natural nectar is a key element to their survival. Starting the season with willow, ending it with chestnut, bees have access to maple, acacia, mountain ash or lime, not forgetting ivy. Tree flowers, shrubs and lianas offer, over seasons, their nectar and pollen to pollinators. Others, such as oak and some conifers are exclusive sources of honeydew that bees are very fond of. Buds of poplar and beech are main propolis providers. Cash crops, vegetative covers and diversified hedges composed of blackthorn, hawthorn, quince, elderberry, wild roses or brambles complete the production of nectar and pollen from late winter to the end of summer.

Beyond the honey resource, agroforestry creates habitats for wild pollinators, moderates the adverse climatic variations that bring prejudice to crops and insects. It avoids setting aside fallow lands for flowers and doesn't need EU subsidies to be maintained.

Agroforestry is a promising way to tackle bee population decline and more generally help pollinator survival. In a complementary loop, solving bee issues may bring back trees in our countryside and fostering trees' insertion may help prevent bees decline.

KEYWORDS: bees, biodiversity, agroforestry, vegetative cover, biomass, hedges, pollination.

PARAMETER ESTIMATION AND DATA ASSIMILATION WITH THE COMMUNITY LAND MODEL (CLM) TO UPSCALE NET CARBON FLUXES FROM PLOT TO CATCHMENT SCALE.

25th of September - 10:20 > 10:50 Poster Session 4. *Data access and modelling.*

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High-resolution, catchment scale application of land surface models can help to unveil the complex myriad of interactions between regional climate, land use, hydrology and ecological processes. This is important for many different research fields, and will help to develop effective climate change mitigation and adaptation strategies. Some results will be presented of the application of CLM

version 4.5 (CLM4.5) to simulation of net ecosystem exchange of CO₂ (NEE) of the 2454 km² Rur catchment located in the border region of Belgium, Germany, and the Netherlands. We used the DREAM(ZS) algorithm (Laloy and Vrugt, 2012; Ter Braak and Vrugt, 2008) to derive, for individual sites, the posterior distribution of the most important parameters that control simulated carbon fluxes. These parameters were selected based on sensitivity analysis, and their posterior distribution was estimated using time series of NEE (net ecosystem exchange of CO₂) measured with eddy covariance (EC) towers during 2012 at different sites within the Rur catchment. The parameter estimates were evaluated using data from 2013. Our results demonstrate that most of the CLM4.5 parameters exhibit quite a large uncertainty, unless a seasonal (3-month) calibration is performed. Then, we used the Ensemble Kalman Filter (EnKF) within DART (Anderson *et al.*, 2009) to correct those simulated state variables that correlate most with NEE (leaf area index, leaf nitrogen, etc.) by assimilating NEE and remotely sensed leaf area index data from a moderate resolution imaging spectroradiometer. This analysis accounted explicitly for the uncertainty in the initial states, atmospheric forcing, parameter estimates and calibration data.

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KEYWORDS: carbon fluxes, NEE, upscaling, CLM, data assimilation, parameter estimation.

MODELLING ECOSYSTEM FLUXES OF CARBON AND HEAT TO CONSTRAIN PARAMETERS UNCERTAINTY FOR A GRASSLAND SITES.

25th of September - 10:20 > 10:50 Poster Session 4. Data access and modelling.

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In order to interpret current C pools, fluxes and future trends in grassland ecosystems, it is important to understand the major abiotic and biotic regulating processes. Plant-soil interactions and climatic influences on these interactions are big challenges in current research when models and data should be merged.

The main objective of this study was to use data from the Rollesbroich grassland ecosystems study to understand the carbon dynamics in relation to physical and biological processes using an ecosystem simulation model (CoupModel) (Jansson, 2012).

Possible changes during the study period and differences between years were detected by Monte Carlo based calibration method. Various criteria to obtain the behavioural ensembles were applied to observed and simulated data on both eddy-flux and state variables in the soil during in the period of 2011 - 2013. Reasonably good performance was obtained for carbon, latent heat and sensible heat flux covering a wide range of soil and climate conditions. Single criteria for carbon flux improved also the performance on other variables like heat and water fluxes, showing a consistency between

the observations and the model. During one winter period the model failed to describe the soil conditions with respect to both temperatures and moisture, but still the dynamics in the flux variables were good. As a contrast, good performance with respect to soil moisture during a long drought spell was obtained during the summer but in this case large discrepancies were obtained for the carbon and latent heat fluxes. The strong reduction of the evaporation and carbon uptake simulated because of shortage of soil moisture in the model was not evident in the measured atmospheric fluxes.

The differences in the spatial scales for the soil moisture measurement compared to the eddy flux system may be one reason for the discrepancy find. The ensemble representation of both the flux and soil data helps to understand the uncertainty in the process descriptions for the soil-plant-atmosphere interface.

REFERENCE: Jansson PE (2012) Coupmodel: Model use, calibration, and validation. *Transactions of the ASABE*, 55, 1335-1344.

KEYWORDS: grassland ecosystems, abiotic, biotic, Rollesbroich, Monte Carlo, eddy-flux, carbon, latent heat, sensible heat, flux, soil moisture.

COMPARISON OF WATER BALANCE COMPONENTS SENSITIVITY AND ENVIRONMENTAL CHANGES IN GRASSLAND AND FOREST WATERSHED BASED ON HYDROLOGICAL MODELLING (COUP & HBV) .

25th of September - 10:20 > 10:50 Poster Session 4. Data access and modelling.

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For a better understanding of the role of land cover on the impact of climate change, this study focused on the runoff response to climate variations in Plynlimon in Wales, UK.

The main objective is to compare two in line but different hydrological modelling, and to know to what extent the impact of land-use changes can be identified and supported by the long-term monitoring data of runoff from two neighbouring watersheds with different land covers. The CoupModel platform (Jansson, 2012) was used to set up two different models originating from Richards equations, or from a simplified compartment structure.

Regional Climate Model's inputs for the 1992-2010 time-frame are considered as observation data and runoff data considered as validation that used as inputs to the models.

Both models indicated that the grass land showed higher runoff and lower evapotranspiration compared to the forested watershed. These results are in line with (Marc & Robinson, 2007) who identified increasing runoff along with decline of vegetation cover.

Possible comparison during the study period and differences between years were detected by Monte Carlo based calibration method. Various criteria to obtain the behavioural ensembles were applied to observed and simulated daily discharge data in the period of 1992 - 2010. Good performance was obtained for both the Coup and HBV approaches with respect to the dynamics and mean values. Three categories were considered as comparison for both models that considered all components above and under surface. One specific for (HBV) Model that are runoff rate coefficient and storage capacity for 3 soil compartments. One specific for Richards equation, CoupModel, that are physically based representation of water retention curve and hydraulic conductivity (Brooks-Corey). Additional

parameters for surface runoff and soil evaporation and one is common between two soil representations, plants, that includes canopy height, leaf area index, root depth, interception, transpiration and snow.

Differences in the obtained parameter distributions suggested that changes between the models were with respect to both plant cover and soil related factors. Both model approaches used the same sub-models for transpiration and interception. In addition, the Coup approach takes into account soil evaporation. The actual evaporation was regulated by the field capacity parameter in the HBV model, and in the Coup model by the water availability and root distribution in the root zone. The surface runoff, soil evaporation, interception and drain space showed a tendency to be constrained by the data in the Coup approach, whereas the field capacity and discharge Alfa, ground water flow and evaporation showed similar tendencies for the HBV approach.

The discrepancies between the simulated and measured values showed high performance in HBV regarding to R2 with respect to the time. The suggested explanation for the lower runoff from the forested watershed that both models indicated depends to a large extent on the model used and the assumptions made for the criteria. Similar difference in the modelling could be suggested by actual evaporation, declining markedly in both main and sub-catchments.

REFERENCE: Jansson PE (2012) CoupModel: Model use, calibration, and validation. *Transactions of the ASABE*, 55, 1335-1344.

KEYWORDS: climate Model, Plynlimon, Richards equation, HBV, Coup, Brooks-Corey, performance.

COST EFFECTIVE GREENHOUSE GAS MITIGATION IN THE ONTARIO DAIRY SECTOR.

THE IMPACT OF A FARMER'S FEEDING DECISIONS ON GREENHOUSE EMISSIONS FROM MILK PRODUCTION.

25th of September - 10:20 > 10:50 Poster Session 4. Data access and modelling.

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Growing awareness of the environmental impact of greenhouse gas (GHG) emissions is leading researchers to search for low cost strategies for mitigation. The crop-livestock sector contributes about one third of global anthropogenic GHG emissions (Vermeulen *et al.*, 2012), and due to the potential for agricultural soils to act as carbon (C) sinks, represents a significant source of low cost GHG mitigation (Smith *et al.*, 2007). This study develops a bio-economic optimization model to identify the impact of a farmer's feeding decisions (*i.e.* the ration) on the GHGs emitted from milk production in the Ontario dairy sector. The model accounts for all GHG emissions from milk production, which includes farm level emissions as well as emissions upstream from the production of feed and other inputs. The objective function of the model is to maximize annual farm gross margin for a simulated dairy-crop farm in south-western Ontario. Varying restrictions on GHG emissions intensity (CO₂eq GHG emissions per kg of milk produced) are imposed to determine the extent to which changing the ration can be used as a strategy to mitigate GHGs, and to anticipate the impact on farm gross margin. A total reduction of over 34% from the base level of emissions is

obtainable. The reductions in GHGs occur primarily due to the increase in land allocated to perennial forages, which leads to an increase in C stored in land. The findings of this study are relevant for intensive dairy production systems that rely on corn silage as a major source of "roughage" for dairy animals. The findings suggest that perennial forages are a GHG friendly feed, due to the higher C storage potential of grass/forage land, and the lower N requirements compared to corn. The similarity in nutrient properties of the two feeds implies that replacing corn silage with perennial forages will lead to lower GHG emissions without impacting milk yield or animal health. Indirect effects of replacing corn silage with forages not accounted for in the model include lower N leachate in water, improved soil quality, and a favourable effect on biodiversity. Obtaining the non-concentrate component of dairy rations in intensive dairy systems such as in North America and Europe may therefore have the dual benefit of reducing GHG emissions and improving other environmental indicators.

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KEYWORDS: greenhouse gases, land use change, enteric fermentation, livestock, dairy, mitigation, climate change, carbon, abatement.

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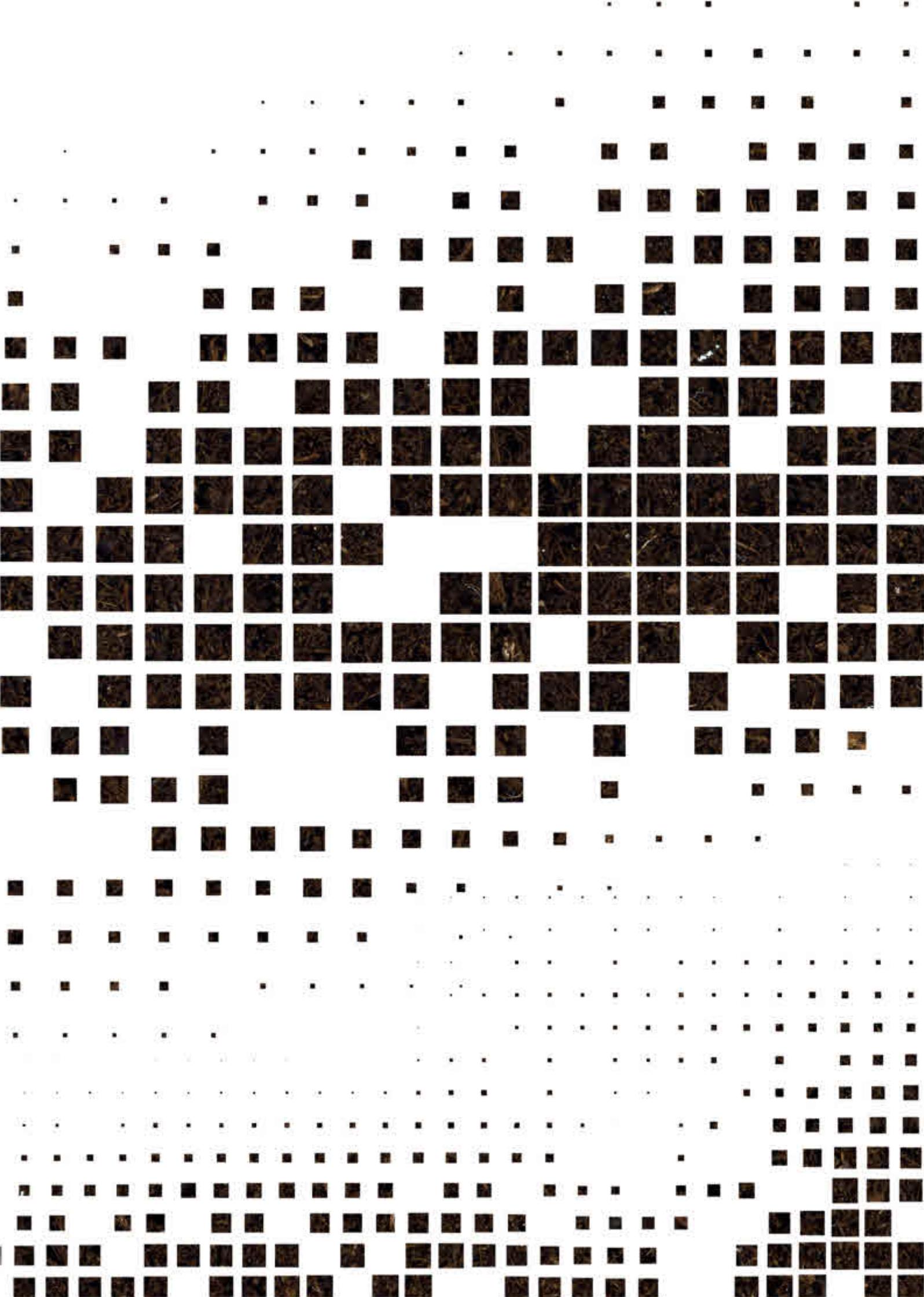
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