





ExpeER

Infrastructures for Experimentation in Ecosystem Research




CONTENT

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In a context of considerable uncertainty fuelled by global change, building an integrated set of research infrastructures in ecosystem science has become more essential than ever. These infrastructures will help us better understand and forecast the impacts of climate change, land use changes and loss of biodiversity in continental ecosystems.

The key to anticipate and predict long-term ecosystem changes lies in better understanding complexity. Building on and expanding our knowledge of ecosystem functioning is a prerequisite for assessing and modelling this complexity. This can only be achieved by federating the numerous distributed experimental and observational research infrastructures across the EU within a pluridisciplinary partnership. Responding to this challenge is a key priority for all ExpeER consortium members.

In this regard, ExpeER's major goal is to bring together a variety of sites and platforms to enable collaboration and integration of observational, experimental, analytical and modelling approaches. This includes developing techniques for creating future environmental conditions, designing new approaches for experiments, new methods for upscaling and providing solutions to close gaps in environmental monitoring. ExpeER will help in developing synergies, approaches and tools across platforms and sites and exploring services that these infrastructures need to provide to researchers to achieve excellent, cutting-edge science.

The ExpeER project has progressed extremely well, with an increasingly strong cohesion between scientists involved in experimental platforms and long-term observational research sites, with a now improved understanding of how to integrate and harmonise these elements in the long term. Many technological developments have been achieved, with several publications already completed and several in progress. Communication with stakeholders about the high priority of funding ecosystem experimental platforms and the need to integrate them on a European level is starting to bear fruit, with several countries already investing in new or upgraded facilities. ExpeER's profile has grown on the European and global scene thanks to many presentations from ExpeER partners in international fora.

ExpeER also serves as a building block for the future pan-European infrastructure AnaEE (www.anaee.com) currently in a preparatory phase of the ESFRI roadmap. The ExpeER consortium is working hard to build a dynamic research community around complementary infrastructures to connect major approaches necessary to forecast ecosystem change and its consequences and we are pleased to present this work in the brochure.

Dr. Abad Chabbi
ExpeER coordinator.

What is ExpeER?

ExpeER (Experimentation in Ecosystem Research) is a European project (2010-2014) which aims to bring together the major observational, experimental, analytical and modelling facilities in ecosystem science in Europe.

By uniting these highly instrumented ecosystem research facilities under the same umbrella and with a common vision, ExpeER intends to contribute to structuring the still fragmented research community on terrestrial ecosystems within the European Research Area. ExpeER is improving quality and performance of these infrastructure components in a sustainable manner and stimulating their international use.

ExpeER contributes to the development of a state-of-the-art research infrastructure by:

> enabling collaboration and integration across experimental, observational and modeling approaches in ecosystem research;

> improving the technology and methodology at play in ExpeER infrastructures through specific research programs;

> hosting research teams within its 30 sites and platforms through a strong and coordinated program for Transnational Access;

> linking these highly instrumented facilities to existing networks of long-term research sites across Europe (*e.g.* LTER-Europe);

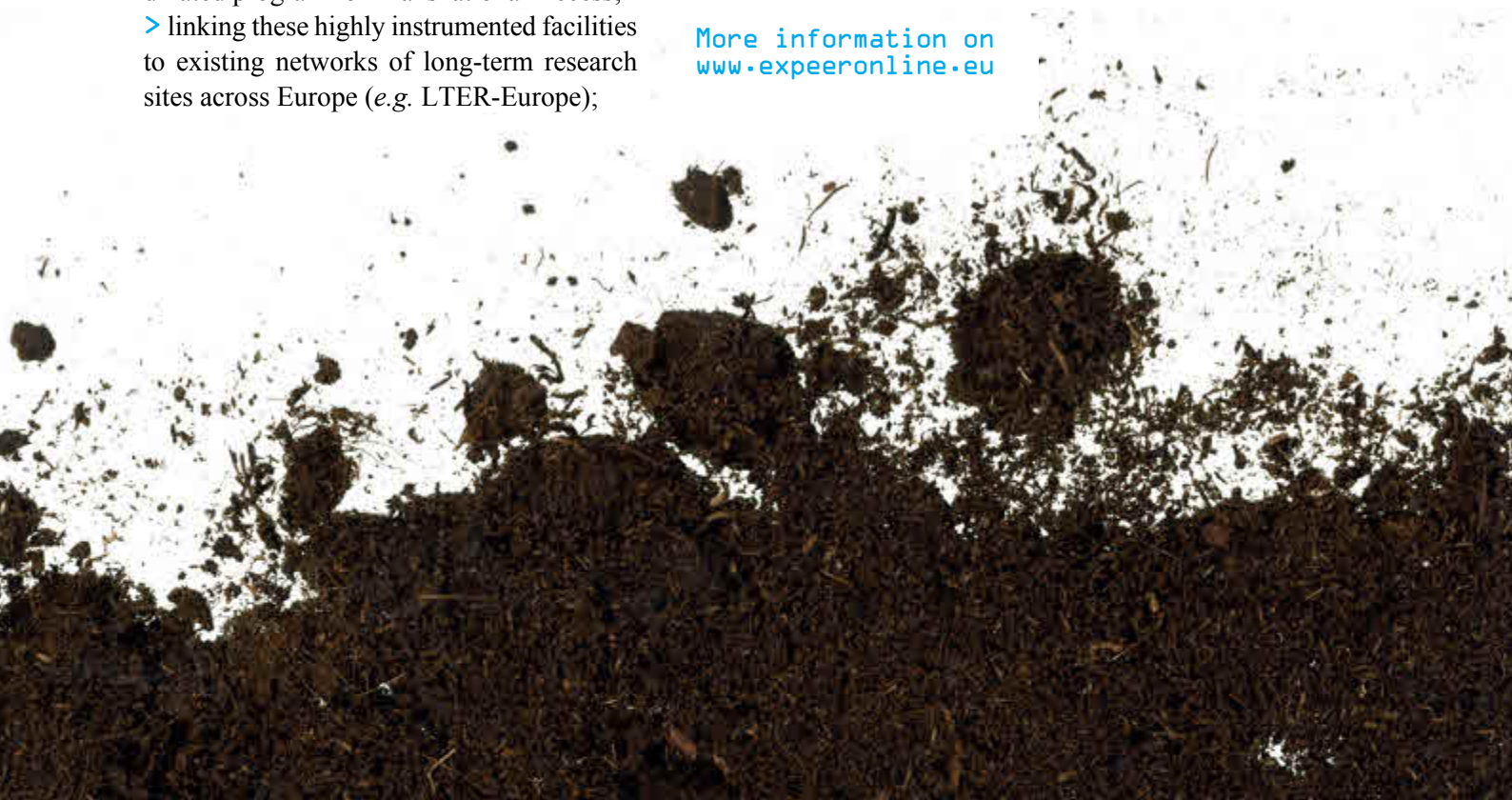
> developing a "model toolbox" allowing the scientific community within and outside the ExpeER network to better use modelling platforms. This will allow easy access to models for experimentalists and improve forecasting of ecosystem function and services under different future climate scenarios.

Scientists involved in the project consortium range from physiologists to environmental scientists, with a large number of participants involved in agronomy, ecology and biochemistry. This range of disciplines is essential to the long-term development of ecosystem science, in that detailed studies of small, rapid processes need to be embedded in longer term, larger scale experiments in order to develop a true systems approach, resulting in models that transfer information across scales. Much progress in environmental research has been the result of disciplinary and reductionist attempts to analyse separate compartments of the environmental system. However, the complexity of problems created by global change, land use changes, ecosystem services, food security issues, *etc.* needs an integrated interdisciplinary approach to solve environmental problems raised by today's society.

More information on www.expeeronline.eu

19 countries across Europe

ExpeER concerns 19 countries across Europe. Refer to map page 66 to know ExpeER participants.



INFRASTRUCTURES INVOLVED IN ExpeER

Interacting ecosystem processes are of different types and take place at different time and space scales. Therefore, ExpeER integrates complementary types of infrastructures in the field of ecosystem research in order to allow investigation of these different processes.

All the infrastructures involved in the project ExpeER are highly instrumented. They are research sites or facilities with sufficient instrumentation and sampling to allow manipulation (in the case of Ecotrons and experimental sites), or monitoring, (in the case of observational sites) of environmental and ecological parameters. They aim to generate comprehensive data sets for model development, validation and mechanistic hypothesis testing.

ECOTRONS

Their principle is to confine ecosystem samples in individual experimental units in order to simultaneously simulate precisely a large range of environmental conditions and to measure accurately ecosystem processes fluxes of carbon dioxide, water and isotopes. Platforms at different scales (intact or reconstructed ecosystems samples from 100g to 10tons) enable us to address a range of questions. A minimum of 12 independent units per platform allows the study of interacting factors under replicated conditions.

HIGHLY INSTRUMENTED EXPERIMENTAL SITES (HIES)

They are designed for *in situ* analyses of the responses of ecosystems structures and processes to experimental treatments.
Each of the ExpeER experimental sites is characterised by one or more experiments. Ten relates to forest, 8 to croplands and 3 to grasslands. Land use (rotations, cutting regimes, *etc.*) is the most common experimental treatment (8 sites) followed by precipitation regime (5 sites) and fertilisation (5 sites). Temperature is manipulated on 5 sites and plant biodiversity in one site.
Processes under study concern the carbon cycle, other greenhouse gases, soil biogeochemistry, soil biology, hydrology and biodiversity.

HIGHLY INSTRUMENTED OBSERVATIONAL SITES (HIOS)

They are designed for long-term observational of ecosystems structures and processes.
Among the ExpeER observational sites, some are characterised by intensive measurements of ecological processes (*e.g.* many fluxes on a single plot) while others also cover entire catchments for integrated ecosystem studies including biodiversity. About 300 of such sites are provided by LTER-Europe. An open question is how to better link HIOS and HIES with the much larger number of monitored plots across climatic gradients, ecosystem types and land use intensity providing many opportunities to analyse impacts of environmental changes and how they change with time.

ANALYTICAL PLATFORMS

They are laboratories equipped with a range of instruments for measuring of a large variety of parameters in samples. They provide a range of chemistry data (*e.g.* for isotopes, volatile organic compounds and trace gases) that enables in-depth analysis of ecosystem processes.

MODELLING PLATFORMS

Developed during the course of ExpeER, they consist of modelling toolkits that will include an integrated parameter library, models of hydrological and biogeochemical dynamics, vegetation dynamics/species interactions as well as evaluation tools for uncertainty estimations.

For an overview of interactions between these elements - also at the interface with other networks and projects - see pages 14/15.

Pictures

1 The Jena biodiversity experimental site (p 40) where plant community diversity is varied from 1 to 64 species and many ecosystem processes are analysed. ©Jena

2 The Macrocosms platform of the Montpellier European Ecotron (p 44). ©H. Raguet, Photothèque CNRS

3 The Tatra observational site (p 58) where consequences of windstorms are studied. ©TANAP

4 A field laboratory for aquatic research and experimentation associated with the TERENO sites (p 47). ©A. Künzelmann, UFZ

5 The analytical platform of BIOEMCO (biogeochemistry and ecology of the earth surface; p 40). ©BIOMECO

ExpeER WORKPACKAGES

ExpeER workpackages span a variety of activities

> It was necessary to thoroughly describe all the 30 sites in 19 countries and to determine gaps in their research capacities (WP1). Since an objective is to integrate the results of all these sites, improving the standardisation of the measurements and providing guidelines for database interoperability is a continuous important task (WP2 and WP3).

> Joint research activities provide a common framework and roadmap for improving the quality and performance of the infrastructures: WP7 is developing new measurement techniques, from DNA sequencing techniques up to remote sensing of primary productivity. WP8 improves environmental control techniques (warming, CO_2 enrichment) and experimental approaches (model ecosystems, biodiversity impacts). WP9 builds a toolbox around 3 models for the analysis of ecosystem processes. Finally, WP10 develops a model-data fusion approach to upscale ecosystem responses to environmental changes.

> ExpeER provides a framework for increased use and exploitation of its facilities through a strong and coordinated programme for Transnational Access (WP6). 65 research visits have been conducted during the first two years and their number is increasing exponentially. This is an efficient tool to stimulate the collaboration between European research groups.

> Networking (WP4) and communication activities (WP5) strengthen collaboration and integration with related networks and projects. Options for the division of tasks between infrastructures of the European ecosystem research are elaborated.

DEVELOPING AN UNDERSTANDING OF EXISTING INFRASTRUCTURES

The workpackage 1 (WP1) aims to:

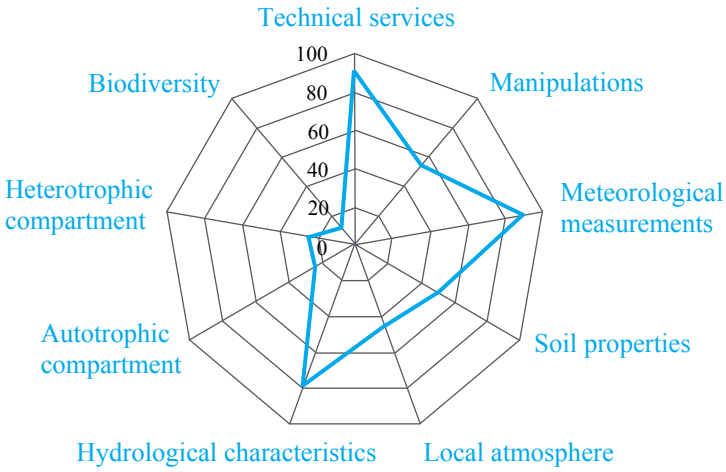
> provide a detailed description of the instrumentation, methods, experimental design, and coverage of ecosystem types and geographic regions of the ExpeER sites;

> provide regularly updated information on the technical and operational capacities (*e.g.* new instrumentation, improved control systems) of the infrastructure and identify synergies (and potential gaps) in terms of instrumentation, methods, models, scientific questions in order to contribute to the development of the other workpackages;

> define a roadmap for the ExpeER infrastructure which reduces current gaps and puts in place synergies and propose a *modus operandi* for the roadmap detailing the manner (procedures, collaborations, *etc.*) in which the roadmap will be carried out (during and post project).

Based on questionnaires and site visits, WP1 conducted an early review of the exemplary set of infrastructures provided by the ExpeER partners. Overviews of these results are provided in radial diagrams (see example in figure), each axis representing different capacities or emphasis of individual sites.

The ExpeER ecosystem research sites cover seven climatic zones, including humid subtropical, oceanic, continental, semiarid, subtropical (dry), subarctic and highland, with annual rainfall and air temperature ranging from 500-2500mm and < 5 - > 15°C, respectively. 50% of the sites demonstrated relatively high levels of capacity with respect to meteorological observations and the monitoring of soil physical parameters, atmospheric analyses and autotrophic organisms. In addition, the majority of sites have the high levels of technical service necessary to facilitate good quality ecosystem research. However, site responses relating to experimental manipulations, biodiversity studies, hydrology and soil characterisation indicated scope for improvement in these areas at many sites. There was also an indication that there may be the need to increase the number of ecosystem studies at some sites. Increasing the ecosystem coverage would enhance the potential for comparative research between similar ecosystems located in different climatic zones. Compared to the ecosystem coverage of Europe, there is currently an over-representation of forest ecosystems among the ExpeER facilities, hence additional sites should be considered for the long term European ecosystem research facility. At a workshop in year two, site managers were able to share information, identify gaps and synergies, and begin to form alliances with common interest.



Figure

Example of a radial chart of research capacities at the Harz Tereno site, which is classified as a highly instrumented experimental site (HIES), hence high scores on meteorological measurements, hydrological characteristics and manipulation axis.

For the final roadmap, three user groups with the following goals have been defined:

(1) Research scientists: access to experimental facilities that can provide sufficient and advanced technology and data needed for model calibration and validation; sufficient coverage of ecosystem/climate zones.

(2) Site managers: sufficient use of facility and participation in research projects; ensure complementary facilities across Europe; consistent and comparable measurement schemes; technological development.

(3) Policy makers and governments: ensure ecosystem research contributes to economic development, innovation, social well-being, environmental sustainability and Europe's prosperity, make sure Europe's funds are well spent, efficient use of facilities, ensure complementarities and synergy effects.

WP2
WP3

IMPLEMENTING A STANDARDISED SET OF CORE VARIABLES AND PROTOCOLS

For ecosystem research to be truly integrated, it is essential that data can be pooled across sites, experiments and years to feed into models. Such data integration is much easier when core variables are measured in comparable ways. The degree of standardisation of protocols varies greatly from one area of ecosystem science to another. Therefore, part of the work of ExpeER involves establishing which core variables would benefit from standardisation, developing standards for these protocols, and training people, both inside and outside the ExpeER project, on how these can be implemented. Such measurements are intended to complement, not replace, environmental monitoring already happening at the individual sites. Moreover, this exercise is not just restricted to ExpeER; it is hoped that this will help integrate the monitoring of ecosystems around the world.

The work has progressed in four stages: first the protocol topics were selected; then protocols were proposed; these were tested at a training course during 2012, and revised before two training courses open to non-ExpeER scientists and technicians in the summer of 2013.

Selection of core variables

Protocol selection drew upon a list of indicators of ecosystem structure and processes, from which a core set of protocols was derived using a combination of questionnaire, workshop discussions and engagement with modellers and other stakeholders. This work built on recent work on standardisation within LTER-Europe and the Life+ project Env-Europe, ensuring integration between different research communities.

The core set of variables (Table) was agreed in the spring of 2012, although this was subject to later revision during protocol development.

Protocol development

The development of protocols followed in an interative fashion. Draft protocols were developed and compiled into a handbook used for a field testing session held in Italy on 27-31 August 2012 near Rome. This week-long course included field visits to forest sites, some grassland work and lectures and discussions indoors and in the labs. Nine protocol developers and fifteen others (including students and post-doctoral staff) discussed and tried particular protocols. This work led to recommendations for protocol development. It dealt with metadata and quality assurance issues as well as data gathering techniques.

Training courses

The final protocols need to be disseminated across the community. As a first step, training sessions were conducted for people involved in ecosystem measurements at sites outside the ExpeER community, in Rome (20-24 May 2013) and Amsterdam (26-30 August 2013).

Picture

Giorgio Matteucci leading one of the training sessions near Rome. ©L. Firbank

Table

Core set of ExpeER variables selected for standardisation in WP2. This may differ from the final published set of protocols, depending on the outcomes of the training courses.

ABOVE-GROUND BIOMASS
ORGANIC MATTER DECOMPOSITION
LAND USE AND MANAGEMENT
LEAF AREA INDEX
SOIL MICROFAUNAL DIVERSITY
SOIL ORGANIC MATTER – CARBON AND NITROGEN STOCKS
TRACE GAS EMISSIONS FROM SOILS
TRANSPIRATION MEASUREMENTS IN WOODY AND HERBACEOUS PLANTS

The second step will be the publication of the protocols on the ExpeER website to allow for their continued development following feedback from the training courses.

Information management and data access

Guidelines will be provided to ensure the use of common vocabularies and metadata discovery systems will allow international interoperability of the ExpeER database. Technical tools for data sharing will be provided and a common data policy established.

> **Metadata Framework:** Work on the metadata standard guidelines has been progressing well with strong cooperation with the LTER-Europe community and EnvEurope project, leading to a metadata profile based on Ecological Markup Language (EML) and a tool suitable for ExpeER HIOS. Work is underway to review this EML profile to make it fit for purpose for Ecotrons and ecosystem experiments.

A metadata portal building on the DEIMS, the Drupal Ecological Information Management System developed by US-LTER, will provide a metadata management service for LTER-Europe.

> **Data architecture (semantics):** ExpeER has established strong links with EnvEurope to develop an Environmental Thesaurus encompassing links to controlled vocabularies such as CAST, ChEBI, GEMET, EARTH, NatureSDI+ as well as the US-LTER Topics list and parameter lists from Nitro-Europe. A hands-on introduction to these tools will be provided in the near future.

> **Data policy:** ExpeER site managers were surveyed about their data management requirements, current practices and expectations. This information has been used to develop a data policy, which will be released in the next few months.

Pictures

1 Tree cut in manageable pieces for the measurement of its biomass. ©L. Firbank

2 Soil sampling at the Amsterdam field course, August 2013. ©E. Krab

WP4

TOWARDS SUSTAINABLE INFRASTRUCTURES

Motivation for WP4 on networking and main lines of actions

Motivation for WP4 on networking and main lines of actions: many infrastructures for ecosystem research target at producing information about ecosystems trajectories beyond the time span of individual research projects. Long-term observations provide valuable information on trends in response to main drivers. Therefore, ExpeER was challenged to anchor its infrastructural elements **in the landscape of related projects and infrastructures**. Besides from developing an **appropriate division of tasks** with these projects and infrastructures, **options for the permanent operation and funding of ExpeER´s elements** needed to be explored. Recognising the fact that ExpeER was limited to sites owned by consortium members, but not based on a quantitative overview of European facilities, efforts were made to attract comparable sites, their primary investigators and institutions to the ExpeER, concepts and products. To this end a **Related Sites Group** was established.

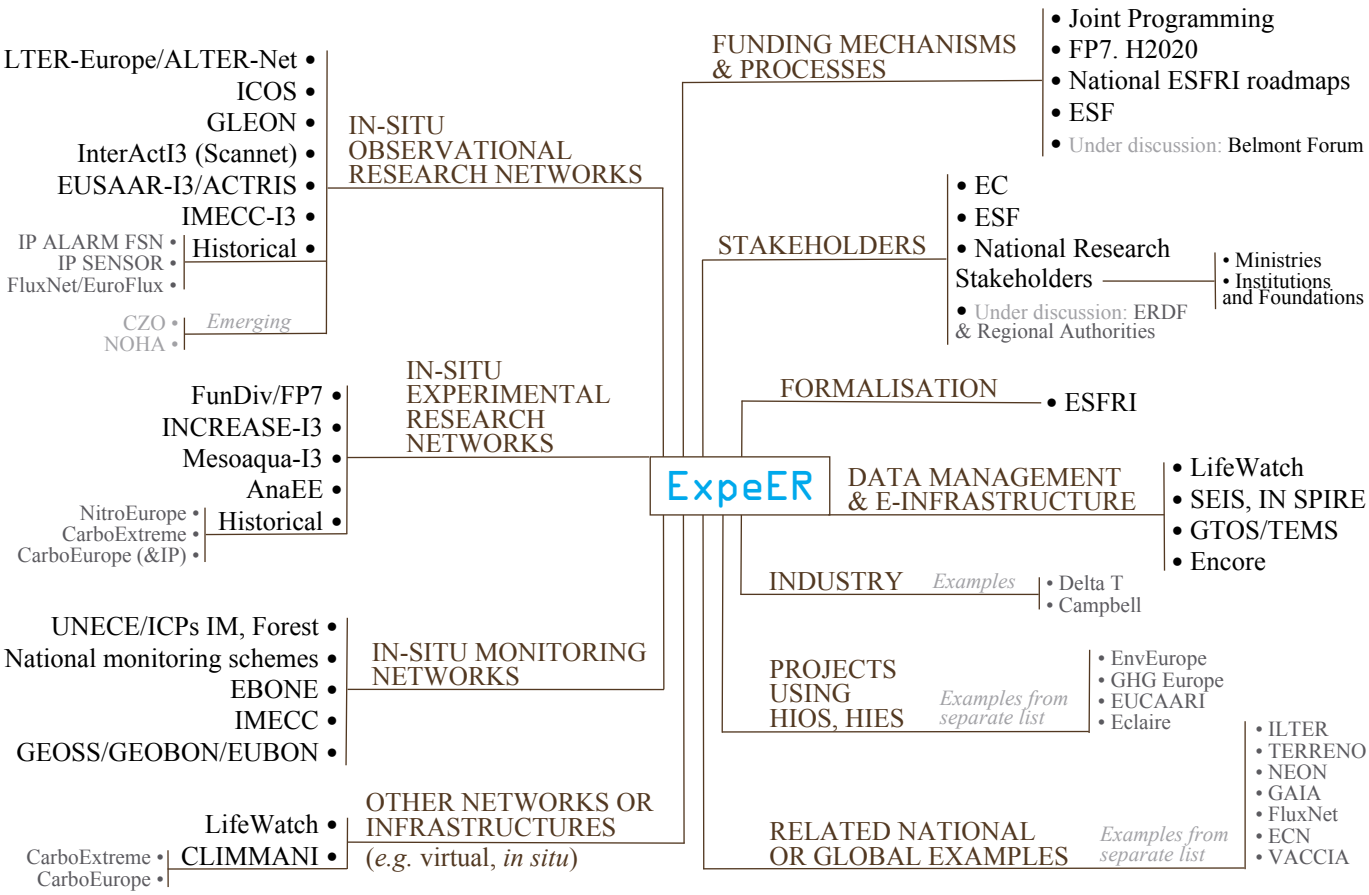
Getting an overview of the strategic environment of ExpeER

A comprehensive inquiry of relevant networks, projects, infrastructures, strategic processes and funding mechanisms was carried out based on input from the ExpeER community, stock takes in the WEB and bilateral interviews with relevant coordinators and stakeholders. The elements of the resulting database were prioritised, grouped into main branches such as "*in-situ* observational research networks" and "*in-situ* experimental research networks" and graphically illustrated in a MindMap of the strategic environment of ExpeER.

The left side of the MindMap represents related research infrastructures, whereas the right side covers the strategic environment, services and users.

Figure

MindMap of the strategic environment of ExpeER.



The Related Sites Group (RSG)

is an outreach- and feedback-body consisting of primary investigators of highly instrumented sites, which are not working with one of the ExpeER partner institutions. It offers an opportunity to informally affiliate with ExpeER. The RSG provided valuable input to the conceptual and strategic work of ExpeER, including criteria for highly instrumented sites.

Networking towards sustainable infrastructures

The MindMap of ExpeER's strategic environment gives evidence, that ExpeER could build on several initiatives (*e.g.* Climmani, AnaEE), networks (*e.g.* LTER) and projects (*e.g.* EnvEurope). It also shows that ExpeER represents a novel combination of peers from the experimental and observational research community, and provides a platform for identifying their common ground, specifically in the field of IT tools, standards and methods. Joint experts groups across projects were fostered and ExpeER introduced at most key events of relevant networks and projects since 2010, including the biodiversity research community and monitoring networks (nationally, in Europe and globally).

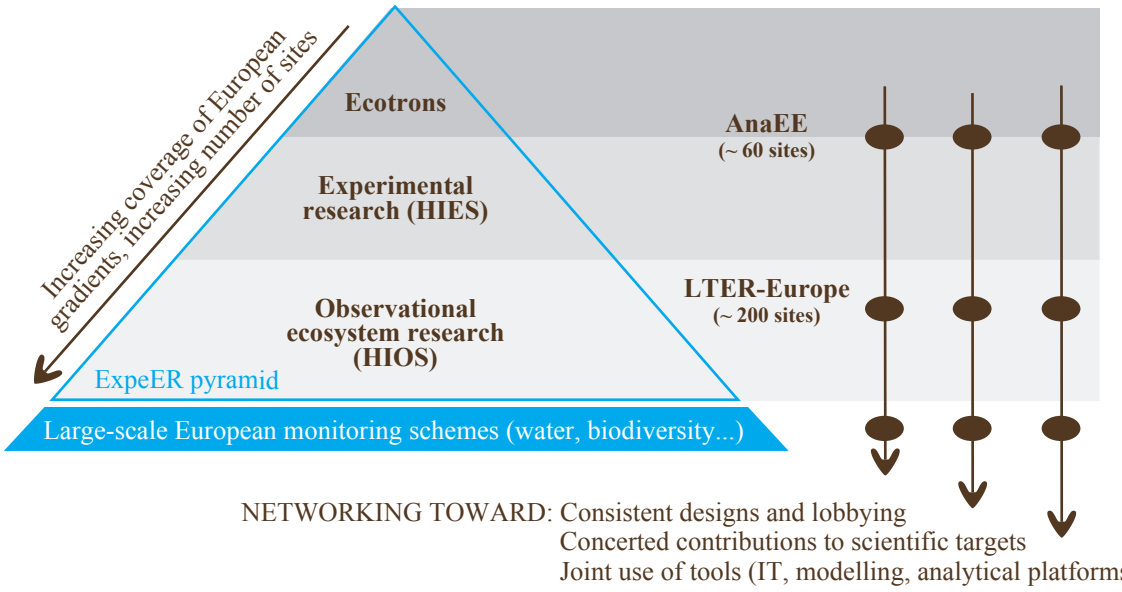
Permanent funding

The ExpeER pyramid represents the conceptual elements of the project, comprising Ecotrons, highly instrumented experimental, highly instrumented observational research sites, modeling and analytical platforms. The hierarchical design of ExpeER also envisages strategic interactions between these actual research infrastructures and larger scale monitoring schemes.

Fostered by ExpeER, there are good chances for the successful implementation of its building blocks (AnaEE, LTER-Europe) in a co-ordinated manner and as part of a European environmental research infrastructures cluster. This will support highly integrated national ecosystem research infrastructure clusters, their efficient multiple use towards scientific targets and the joint development of further services. The AnaEE project was successful and entered its ESFRI preparatory phase (2012-2016). LTER-Europe is based on solid governance structures and national networks in 21 countries and prepares a H2020 I3 project.

ExpeER and the outside world - towards a division of tasks in the European Research Area

Intense discussions are ongoing with ICOS, LifeWatch, InterAct and other infrastructures and networks about the further structuring and design of the European infrastructures in the field of biodiversity and ecosystem research in preparation of the next ESFRI roadmap. The role of ExpeER in the interplay of observation, experimentation, the generation of large scale reference data and modeling need to be continued.



Figure

ExpeER paves the way for the European integration of various complementary ecosystem science infrastructures.

WP7

DEVELOPING AND TESTING NEW METHODS TO OVERCOME CURRENT LIMITATIONS IN UNDERSTANDING ECOSYSTEM PROCESSES

New measurement techniques will be developed and/or tested with regards to soil moisture, structure and metagenomics and canopy activity. With instruments from atomic force microscopy to remote sensing, these methods, where possible, will be tested at a range of scales from laboratory to field and region.

Combined novel DNA re-sequencing approach and field scale experiment techniques to explore soil moisture impacts on soil biodiversity

The main focus of this task is to investigate the potential of next generation sequencing technologies in elucidating the biodiversity of soil, sampled from long-term ecosystem manipulation experiments using a soil metagenomics approach. With this in mind, three long-term manipulated sites have been selected and were sampled for DNA extraction.

Pictures

1 Biochar treated crop site. ©SOTON

2 Geophysical monitoring campaign at the Schaefertal site. ©Steffen Zacharias, UFZ

The sites chosen represent (1) a long-term droughted forest site in central Italy; (2) a crop site where biochar had been added as treatment some years ago; (3) a short rotation coppice (SRC) site in the South-East of England, in which biochar amendment has been recently carried out. The first of these sites was forest scrub and the second had been used for a variety of crops, including maize and soybean. The third site comprises of a 3 year old SRC willow stand. A highly stratified soil sampling approach was taken such that in each plot, five soil samples were taken and for each site, there were three plots in each of two treatments (with and without drought; with and without biochar).

During the summer and autumn 2011, soil DNA and RNA were extracted using well established soil protocols. From November 2011, DNA samples were extracted for sequencing using *Illumina Technologies*. First data were available early 2012 to give some indication of the level of sequencing that will be necessary in this study to provide adequate detail of biological diversity and abundance.

Analysis of the initial biochar data is currently being undertaken using several metagenomic tools, including MetaPhlan, MEGAN and MG-RAST, to ascertain changes in microbial community composition between treatments. Soil samples from the additional biochar treated field site (site (3) associated with the EUROCHAR project) will allow comparison of community composition and gene frequencies once metagenomic analysis is complete. Time series samples (before biochar, one month after amendment and one year from amendment) collected from the third site will allow study of changes in community composition over time as a result of biochar addition. In addition, soil respiration data from the EUROCHAR site will permit comparison of soil respiration rates with hydrocarbon degradation gene frequencies, to determine the rate of biochar decomposition. Sequencing of the samples collected from site (3) is to be undertaken during 2013.

16S rRNA sequencing and analysis is being carried out on samples from sites (1) and (2). This will allow comparison of shotgun metagenomic techniques with more traditional 16S barcode methods. Use of this technique in conjunction with shotgun sequencing should provide an indication of

the accuracy of the use of shotgun metagenomics and bioinformatics pipelines.

Soil moisture as a driver of soil interface architecture and function - developing new approaches for testing at laboratory, experimental and field scale

Soil aggregates provide an extremely large, heterogeneous and structurally-complex three-dimensional surface which harbours a vast biological diversity and chemical variability, highly dependent on the soil moisture status. They are intimately involved in the major soil hydraulic, chemical and biological processes. As such they are a key factor for interaction, transport and turnover of mobile soil constituents and are intimately involved in the major water and biogeochemical cycles. With the advent of advanced spectroscopic and spectromicroscopic imaging and mapping, such as AFM (atomic force microscopy), NanoSIMS (secondary ion mass spectrometry) and XPS, as well as compound-specific analysis techniques in combination with advanced preparation, sectioning and ablation techniques, we will be able to study architecture, three-dimensional build up and processes at the nano-scale and in real time. These techniques will become established within the new soil system research platform coordinated at FSU Jena. This approach makes it possible to characterise the soil structural assemblage with respect to its function as a microbial habitat.

A new sample preparation technique for the micro-scale evaluation of soil interfaces has been developed. Furthermore, lab-scale experiments to test new approaches for the analyses of interfaces while avoiding artefacts from dissolution processes have begun. An improved isotopic technique for studying the turnover of organic molecules in soil under different land management regimes has been tested at the Lusignan ExpeER site. It has been used to follow the impact of grassland conversion on the dynamics of cutin and suberin.

Moreover, suitable samples for the study of the effect of microbial diversity on litter decomposition using the Nanosims technique were identified and will be analysed in the forthcoming project period.

New sensor technologies for integrated observation of soil moisture at the field scale and landscape scale

This task explores new and innovative sensors and novel measurement technologies to better assess of soil moisture. This allows improvements in the analysis of complex feedback mechanisms between the different environmental compartments, and the validation of biogeochemical models. Bridging the gap between field and landscape observation scales is an important issue as well. Emerging technologies within remote sensing and low-cost, on-line sensor technologies allow for near real-time estimates of soil moisture.

In ExpeER, we have assessed the strengths and weaknesses of these techniques to observe soil moisture dynamics at different spatial and temporal scales.

A range of measurement technologies were tested at different ExpeER sites. They included hydrogeophysical methods such as mobile geophysical platforms using electromagnetics and gamma-ray specotroscopy, wireless soil moisture sensor networks (WSN) and Cosmic Ray Probes (CRP). Several CRPs were set up at several TERENO observatories. Eifel/Lower Rhine valley and Harz/Central German Lowland. First results of the cosmic-ray sensor evaluation have already been published. The extensive soil moisture measurements of the WSN installed at the Wüstebach (forest) and Rollesbroich (grassland) sites (FZ Julich), and the Schaefertal site (grassland, UFZ)

Pictures

1 Soil sampling being under-taken. ©SOTON

2 The monitoring design at the Schaefertal site is presented during the 2nd International Conference on Hydropedology. Leipzig, 2012. ©Steffen Zacharias, UFZ

have been already used to calibrate the CRPs. A soil-plant-atmosphere transfer model specifically adapted to grass vineyards at the Roujan site has been developed and successfully tested using the infrastructure installed within the context of the ExpeER project. A WSN was installed at the Roujan site in winter 2013.

Remote sensing platforms to assess plant primary production and phenology

ExpeER has explored a variety of remote sensing systems, mainly involving state-of-the-art hyperspectral approaches. We have assessed their suitability for determining various ecological variables such as plant primary production, phenology, leaf area index, chlorophyll and nitrogen content, and examined ways to overcome current limitations in the use of remotely sensed measurements.

Three levels of measurements scale were employed: laboratory, plot/field and airborne.

Studies included: (i) laboratory measurements of soil samples and leaves, placed in a petridish, using a hyperspectral point spectrometer; (ii) laboratory measurements of plants and vegetation canopy, located in 1x1m test parcels, using a hyperspectral image spectrometer; and (iii) plot/field measurements of vegetation and soil patches in 3x8m test parcels from a 3m above-ground construction, and (iv) plot/field measurements of vegetation canopy in 20x20m test parcels from a lifting platform 2-12m above the vegetation.

Picture

Map of ECa (apparent electrical conductivity) at the Schaefertal site measured in August 2012 using EM38DD (Geonics Ltd.).

Satellite-based technologies for Earth observation provide a wide range of radiometric and spectral information in many different temporal and spatial resolutions. Today, data from space are the best available information source to operate cross-regional or even global model systems. But, there are still several serious obstacles preventing their effective use. A major problem is that the precise relationship between the remotely sensed proxy and the environmental parameter of interest is very often unknown or only poorly known.

One workpackage in WP7 focusses on methods to overcome major limitations using satellite-derived measures for land surface phenology and net primary production. Hyperspectral technologies are tested in order to compare long-term ecological effects of different land use in terms of soil quality. In this context, a new method to assess and compare properties describing soil quality (*e.g.* texture, pH) has been developed and is expected to replace traditional time and man-power consuming methods.

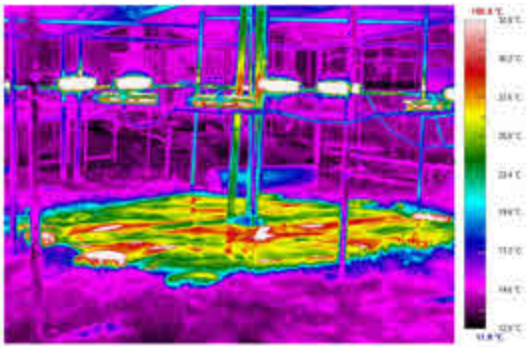
Another workpackage evaluates new technologies for soil moisture observation. A technology which is evaluated here in detail is the Cosmic Ray Moisture Sensing technology. This method measures low-energy cosmic-ray neutrons above the ground over a footprint of about 30ha. The neutron intensity is closely correlated with the soil water content in the upper soil horizon. There are still some methodological obstacles regarding the influence of other moisture sources within the footprint. Water in the biomass and in the litter layer of forest stand may significantly affect the inversion of soil moisture information. Within the workpackage, a calibration function was developed which includes the water content of the litter layer and improves the applicability for forest stands.

Bogena, H. R., J. A. Huisman, R. Baatz, Harrie-Jan Hendriks-Franssen, and H. Vereecken: Application of the cosmic-ray soil water content probe in a humid forested catchment: A worst case scenario? - Submitted to WRR.

DEVELOPING IMPROVED ENVIRONMENTAL CONTROL TECHNIQUES AND NEW EXPERIMENTAL APPROACHES

WP8

Current methods for experimenting with ecosystems are subject to artifacts, distortions and shortcomings. In ExpeER, improved CO_2 and temperature control techniques, and new experimental approaches including ecosystem miniaturisation were designed and tested. The aim was to create a new generation of experiments that were both more realistic and more generalisable, especially towards a better understanding of global change impacts.



Picture

Thermal image of a test-plot warmed by infrared heaters. ©H. De Boeck

Designing realistic climate warming experiments

We analysed and quantified artifacts associated with infrared heating of vegetation patches in free air conditions, both regarding the way of supplying the heating and the possible convolution with drying effects as heating may provoke drought. The analysis demonstrated, among others, that the artifact of excess water loss which is associated with infrared heating turns into a benefit when simulating heatwaves, as water loss during heatwaves is enhanced by naturally occurring lower relative humidity (De Boeck *et al.* 2012a). In 2014, a new infrared irradiation system will be tested. The system has the geometric design developed by Kimball (2005), but is equipped with a novel control system in order to supply the infrared radiation in a way that the natural regulation of leaf temperature by the plant's transpiration, is not distorted or overruled (De Boeck and Nijs 2011).

As many studies use enclosures to increase temperatures either passively or actively, we also studied artifacts associated with such setups and suggested workarounds to solve or minimize them. An important finding here is that passive open-top chambers enhance leaf temperatures more than suggested by air temperature increments (De Boeck, De Grootte & Nijs 2012b), owing to lower wind speeds in such enclosures compared with outside. We therefore recommend that studies using open-top chambers should always record leaf or canopy temperature. A similar analysis for greenhouses, on the other hand, revealed no such leaf temperature artifacts provided that wind speeds inside the greenhouse are high enough. At lower wind speeds than outside, corrective climate-control algorithms would still be required. Yet it seems easier to construct enclosures with realistic wind speeds that remove the need for such corrections.

In the Montpellier Ecotron, problems with simulating other than local climates have been identified and quantified. Decoupling temperatures in Ecotrons from outside conditions can be achieved through corrective climate-control or shading, but the proper regulation of soil temperature remains a challenge and requires further study. In the Imperial College Ecotron, the use of weather station data to emulate changing field conditions in ecotrons was explored. Here the existing control system was succesfully adjusted to realistically mimick microclimate variation in the field.

Finally, we investigated artifacts from excavating, translocating and re-installing large soil cores in lysimeters, a technique frequently used in climate change studies. Differences between soil temperatures in the lysimeters and soil temperatures in the natural environment can arise from the air surrounding the lysimeters. Such artifacts were quantified, and solutions to minimise them tested.

WP8

Using computational fluid dynamics (CFD) to design CO_2 enrichment technologies

Given the limited spatial scale and high running cost of current FACE Systems (Free Air CO_2 Enrichment), we used CFD to simulate improved designs of CO_2 release systems on the computer. These designs were tested in a central facility deployed in Northern Italy. Currently this facility consists of octagonal FACE rings with a newly developed control system (see pictures). Our next generation FACE system was operated for two years for extensive testing and fine-tuning.

Recent CFD simulations demonstrated that relatively stable spatial CO_2 gradients might be created in changing wind conditions by using arrays of CO_2 emission points instead of classical ring-based designs. This opens perspectives for creating a range of CO_2 levels within the same experimental unit.

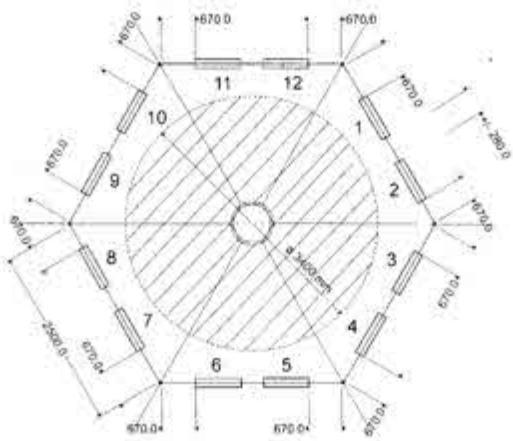
Pictures
Left: FACE system (whole ring/ control unit).
Right: Infrared heating prototype diagram.

Designing new approaches for experimental ecosystems

Physical models of the earth were built to study the global carbon cycle on a minituarised scale. Analyses focused on the disparity between these prototypes and the parameters of earth system models, and problems related to the addition of an artificial ocean were explored.

New generation biodiversity/climate change experiments

This task aimed at an improved understanding of biodiversity dynamics in response to disturbance and climate change and its consequences for ecosystem processes, by designing experimental approaches that are more realistic and more generalisable than past attempts. As a first step we produced a report on weaknesses and limitations of current techniques/approaches to study ecosystems in future, which is now available (see deliverable D8.1 in the ExpeER website). This was followed by two separate research efforts. One addressed abiotic and environmental drivers in manipulation studies, and one the other focused on biotic manipulation. The result was two synthesis/perspectives papers, one of which, "Choices and pitfalls in global change experiments" was submitted for publication.



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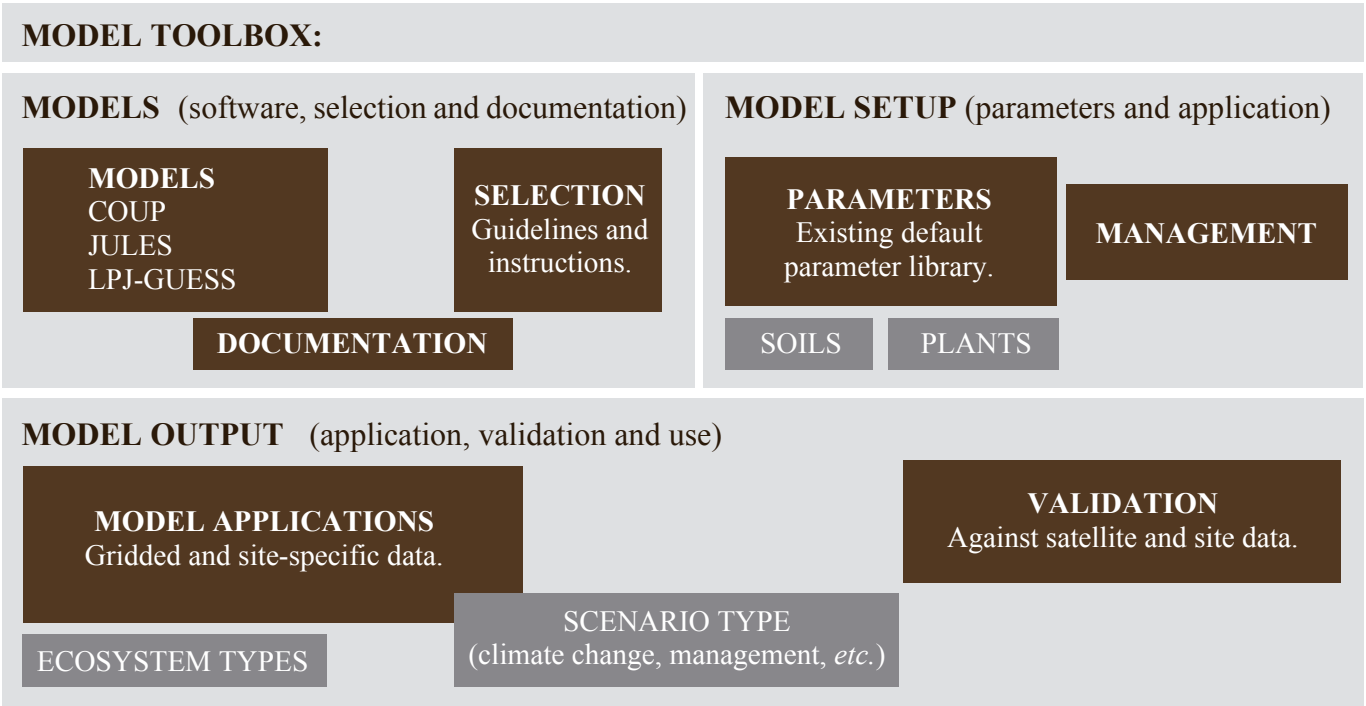
DEVELOPING ECOSYSTEM MODELS AND PROVISIONING A MODEL TOOLKIT

WP9

Model toolbox developement

Three models (COUP, LPJ-GUESS and JULES) were considered in ExpeER. Each can be used to analyse ecosystem processes and functioning and thus are valuable tools for ecosystem experiments. The three models have different strengths (Table). The models were applied to more than 1000 gridcells across a N-S and E-W gradient in Europe, as well as at all ExpeER sites, using globally available datasets for each grid cell. At five sites, models were applied to use site-specific data for specific hypothesis testing. The toolbox includes tutorials as well as example output from model runs (Figure).

	COUP	LPJ-GUESS	JULES
PURPOSE/ FEATURES	Quantification of basic hydrological and biological processes in the soil-plant-atmosphere system. The model simulates soil water and heat processes in many types of soils.	Dynamic global vegetation model for simulation of interactions between climate, atmospheric burdens of trace gases and vegetation, biogeochemical cycles and trace gas exchange.	Process-based model that simulates the fluxes of carbon, water, energy and momentum between the land surface and the atmosphere.
SCALE/ SPATIAL UNIT	Spatial resolution: plot. However model can be run in distributed mode representing any region.	Typically 10 minutes (Europe) or 0.5 degree (globe) but may also be applied at stand or plot scale.	Typically 1km for the UK or 0.5 degree (globe) but may also be applied at stand or plot scale.
STRENGTHS	Soil hydrology and energy. Flexible feedback between components. Integrated methods for calibration of model.	Dynamic vegetation.	Linking energy, water and carbon.



WP10

UPSCALING AND INTERPRETING ECOLOGICAL PROCESSES

Upscaling tools using model-data fusion approaches were developed to assess the potential of the ExpeER infrastructure to upscale ecosystem responses to environmental changes and to develop new monitoring strategies.

Two research groups (from CNRS, France and Forschungszentrum Jülich, Germany) centred their activities on upscaling of biogeochemical fluxes (water, CO_2 and N_2O). Philippe Peylin and co-workers at CNRS used a variational data assimilation approach in combination with ORCHIDEE to upscale the mentioned fluxes from individual flux towers to the continental scale. This allows an improved estimate of water and carbon balances of entire continents. The research group in Jülich developed a sequential data assimilation approach in combination with CLM to upscale the fluxes to the regional scale, making use of different types of information like flux measurements and remote sensing information. The University of Helsinki team deduced relevant information (like fPAR) from remote sensing images, which can be used to improve estimates of large-scale water, CO_2 and N_2O fluxes. Two research groups (from the University of Leeds, UK and Umweltforschungszentrum - UFZ - Leipzig, Germany) dedicated their research in this project to the upscaling of biodiversity, with a focus on detecting relations between biodiversity and ecosystem functioning. This was done by searching for correlations in the scaling of biodiversity and the scaling of properties like soil moisture content, carbon stocks and (probably) water quality. In order to understand the relations between upscaling of biogeochemical fluxes and biodiversity, three of the four research groups (CNRS, Jülich and University of Leeds) also analysed the TERENO-site of Rollesbroich in the region of North-Rhine Westphalia, Germany. The Rollesbroich site was also analysed by different models (LPJ-GUESS, Coup, Jules) which were used by groups in WP9. The application of such a large number of models on a site, allowed a better understanding of errors, which were made when effective parameters and simplified model dynamics were used to represent processes in larger scale models. The last step in this activity consisted of making recommendations for improving the infrastructure to monitor ecosystem processes. Showing that some type of measurements are more useful to constrain predictions, whereas other data types are less useful, has value when designing a monitoring network for ecosystem processes and the variables which are measured there.

Building an operational upscaling framework for biogeochemical fluxes from the plot to the regional and continental scales

WP10 organised three workshops, the first in Jülich (November 2011), a second one close to Stockholm (September 2012) and a third one close to Helsinki (October 2013). The last two workshops were joint workshops with WP9. These workshops focused on the coordination of the work in WP10 to achieve the goals set for WP10. Particular issues addressed were (1) linking the upscaling of biogeochemical fluxes and biodiversity and (2) the intercomparison of land surface models on a common site, where both models developed for benchmarking in WP9 and larger scale models, applied in WP10, are compared.

Both Jülich and CNRS worked on the development of upscaling frameworks of water, energy and carbon using two different global land surface models (CLM and ORCHIDEE). Jülich developed an upscaling framework (Ensemble Kalman Filter including parameter estimation) and worked on the implementation of it in combination with CLM. Measurements of net eco-system exchange and latent heat flux by eddy

covariance towers were assimilated to improve predictions with land surface models. Leaf area index data from MODIS were assimilated to further improve the parameterisation of the land surface model. CNRS finished the implementation of a variational data assimilation framework in combination with the land surface model ORCHIDEE and tested it for various European sites with eddy covariance flux towers. CNRS found that using more than 70 FluxNet sites worldwide to optimise critical model parameters significantly improved the model performances (estimated with independent atmospheric CO_2 data for instance) and led to large changes in the future prediction of land carbon fluxes.

Julich, CNRS and project partners from WP9 compared several land surface models for the TERENO-site Rollesbroich. Julich applied CLM, CNRS made simulations with ORCHIDEE, and the project partners from WP9 made model runs for this site with the Coup model, LPJ-GUESS and Jules. The model performances were analysed using two years of observations: sensible heat fluxes were slightly overestimated and latent heat fluxes slightly underestimated. The interannual variability was stronger in the models than in reality, indicating potential weaknesses in terms of soil moisture /temperature control on photosynthesis and/or respiration. The model comparison was extended further, making use of the unique data collection at this site which includes a dense soil moisture and soil temperature observation network, many measurements in respiration chambers and evaluation of carbon stocks. This allowed for detailed model evaluation and increased insight into the reasons for differences in performance between models.

For upscaling of fluxes with a data assimilation approach, it is important to assess the measurement uncertainty of fluxes accurately. Therefore, Julich developed an improved procedure to estimate random errors of carbon fluxes measured by the eddy covariance method and tested it at the TERENO-site Rollesbroich. This new approach took into account that simultaneous measurements made by two eddy covariance towers do not only differ because of random measurement errors, but also because of systematic differences in conditions between the sites. The systematic differences were found to be scale dependent. We found that more realistic estimates of the random error were obtained with the new, improved procedure.

UHEL tested an approach to estimate gross primary production (GPP) on the basis of the photochemical reflectance index (PRI) derived from MODIS. UHEL found that correlation between PRI and light use efficiency (needed to calculate GPP) was high at the leaf level, but unfortunately not at the level of eddy covariance flux tower.

University of Leeds also investigated the distribution of ecological infrastructure in Europe. The ExpeER sites are concentrated in Western and Central Europe, with fewer sites in Alpine, Boreal, Steppic and Pannonian regions. Forest sites are the most numerous, followed by grassland and agricultural. In biogeographic terms, the best way of adding value to the ExpeER network will be to introduce infrastructures in Eastern Europe, especially in the Boreal and Steppic zones that have a large surface area in Europe, but low representation within ExpeER.

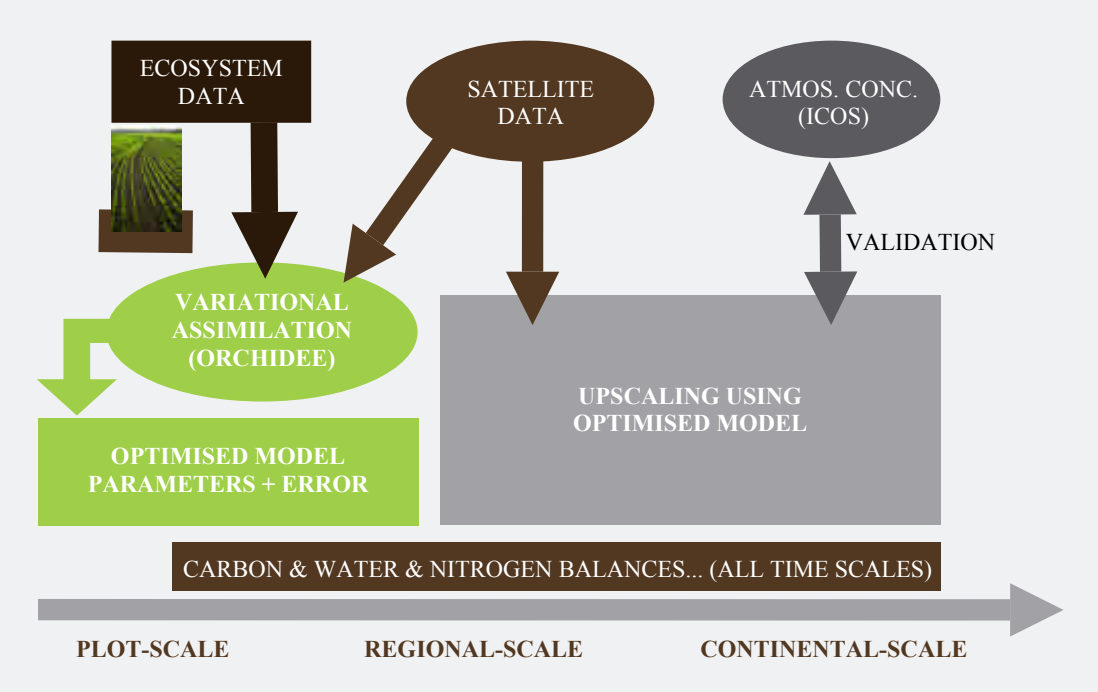
Picture

EC-station of Rollesbroich. ©H. Post

Two frameworks for upscaling of biodiversity were developed and are already implemented: a sampling-based statistical approach (Leeds) and an approach based on wavelet analysis (UFZ). The sampling-based statistical approach for upscaling of biodiversity was tested for experimental TERENO-sites in the Eifel and Harz (including biodiversity sampling campaigns) and related to the upscaling of other hydrological and biogeochemical state variables. First analyses indicate that the upscaling of biodiversity for the Eifel TERENO-site shows little relation with the upscaling of hydrology, and is more strongly governed by difference in land use (*e.g.* different kinds of farming and agricultural intensity).

For the Harz TERENO-site, an extensively used grassland, biodiversity showed a stronger link with the scaling of hydrological variables. We produced species-area curves for the two study sites. They range from $0.01m^2$ to $1000m^2$ in quadrats, and then to the whole catchments. They show the influence of land ownership (Julich) and land management and topography (UFZ) on species-area relationships.

Finally, we linked results for upscaling of biogeochemical fluxes and biodiversity with new monitoring strategies. Uncertainty estimates of the upscaling methods were used directly to estimate data value and the need for additional monitoring stations.



TRANSNATIONAL ACCESS (TA)
ACCESS NEW SITES FOR YOUR RESEARCH!

The ExpeER call for Transnational Access (TA) proposals is continuously open. It offers access to 30 state-of-the-art research infrastructures across Europe. It is possible to join on-going experiments and measurements, to initiate new ones, to use data bases *etc.*

The ExpeER call for Transnational Access (TA) proposals provides a unique opportunity for research teams and individuals to **access some of Europe's major research infrastructures focused on ecosystem research**. The services offered by the TA program go beyond those available at the national scale, thus encouraging greater collaboration amongst Europe's top researchers to fill existing knowledge gaps.

This program was launched in June 2011 and is since continuously open. TA users are offered reimbursement of travel and a contribution for subsistence expenses incurred during TA visits. It is open to researchers and students from EU-member and Associated countries. Proposals are submitted via the ExpeER website (2-6 months before intended visit) via a two-step process: pre-application (short proposal) and application (full proposals following eligibility and feasibility approval). The TA selection process gives priority to collaborative projects promoting science, methodology, and technology transfer and advancement.

WHAT FINANCIAL SUPPORT?

TA users are offered financial support to contribute to subsistence and travel expenses incurred during TA visits. Travel expenses are covered up to a maximum rate of 300€ (500€ for visits to Negev, Israel). Daily subsistence costs (*i.e.* accommodation and meals) are covered by country specific per diem rates: AUSTRIA: 138.8€ - FINLAND: 150.5€ - FRANCE: 151.1€ - GERMANY: 128.3€ - ISRAEL: 180€ - ITALY: 141.9€ - NORWAY: 123.4€ - ROMANIA: 137€ - SERBIA: 135.7€ - SLOVAKIA: 126.5€ - SPAIN: 50€ (free on-site accommodation provided) - SWITZERLAND: 123.4€ - UK: 170.3€. For TA visits longer than 1 month (31 calendar days), the accommodation costs will be covered by real cost under the condition that the rent should be economical and reasonable. The other costs will be covered under daily allowance. In this case, justification such as rent contract is needed.

HOW TO APPLY?

TA is open to researchers, post-docs and PhD students from EU-member and associated countries. Proposals can be submitted via the ExpeER website (www.expeeronline.eu; 2-6 months before the intended visit) in a two-step process: pre-application (short proposal) to check applicant eligibility and project feasibility with the site to be visited, followed by submission of a full application. The TA selection process gives priority to collaborative projects that promote the transfer and advancement of scientific results, methods and technologies.

MULTIPLE VISITS

It is possible, and encouraged, to visit more than one site! So far, only one application for a multiple site visit has been received.

FAST TRACK APPLICATIONS

ExpeER offers "fast track" transnational access applications to researchers interested in visiting one or more TA sites for a brief period (max. 5 days)!

More information on www.expeeronline.eu

TRANSNATIONAL ACCESS STATISTICS

BETWEEN JUNE 2011 AND APRIL 2014, **72 PROJECTS WERE ACCEPTED**.

PROJECTS BY RESEARCH TOPICS:

GLOBAL CHANGE & CLIMATE OBSERVATION	23
ECOSYSTEMS & BIODIVERSITY	18
OTHER - ENVIRONMENT	9
OTHER - EARTH SCIENCES	6
OTHER - LIFE SCIENCES & BIOTECHNOLOGY	10
WATER SCIENCES/HYDROLOGY	6

AVERAGE GRANT AWARDED: 2167€
(Min: 464.74€ - Max: 6480€)

AVERAGE DURATION: 19 days
(Min: 2 days - Max: 90 days)

TA VISITORS' AGE:
< 30: 22%
31-50: 58%
> 50: 20%

TYPE OF VISITORS' INSTITUTION:
University: 73%
Public research organisation: 26%
Industrial and/or profit private organisation: 1%

TA VISITORS' STATUS:
Technician: 1%
Post-graduate: 27%
Post-doctoral: 26%
Experimented researcher: 45%

TA VISITORS' ORIGIN

GERMANY	18%
NETHERLANDS	14%
SPAIN	8%
DENMARK	7%
ISRAEL	7%
UK	7%
PORTUGAL	4%
AUSTRIA	4%
CZECH REPUBLIC	4%
ESTONIA	4%
ITALY	3%
FINLAND	3%
BELGIUM	3%
POLAND	3%
GREECE	3%
TURKEY	1%
ROMANIA	1%
NORWAY	1%
FRANCE	1%
NEW ZEALAND	1%
SWITZERLAND	1%

TA VISITORS' SATISFACTION

TRANSNATIONAL ACCESS PROJECTS > EXAMPLES

TA Ex1

NITROUS OXIDE (N_2O) AND METHANE (CH_4) EMISSIONS FROM *PINUS SYLVESTRIS* (NOME).

ExpeER site

HYYTIALA OBSERVATIONAL SITE, FINLAND.

When?

May, 2013
Duration: 76 days.

TA User

KATERINA MACHACOVA
CzechGlobe - Global Change Research Centre, Czech Republic.

Picture

Example of a chamber used for measurement of CH_4 and N_2O emissions from shoots of *Pinus sylvestris*.

Nitrous oxide (N_2O) and methane (CH_4) are important greenhouse gases contributing to global climate change. N_2O and CH_4 are emitted from surfaces of riparian plants. However, data on the emissions of these greenhouse gases by trees, especially by upland tree species, are scarce. To our knowledge, no data are available for coniferous tree species. Therefore, the main objective of the proposed project was the characterisation and quantification of N_2O and CH_4 emissions from tree surfaces (stem and shoots) of *Pinus sylvestris*, representative of coniferous tree species. The gas fluxes were investigated on mature trees under natural field conditions using chamber systems (stem and shoot chambers) and gas chromatographic analyses. Moreover, determined soil emissions of N_2O and CH_4 were used for comparison with emissions of both trace gases from tree surfaces. Finally, the influence of soil and air characteristics (*e.g.* soil and air humidity and temperature, radiation) on trace gas emissions was analysed.

Interview

Please describe briefly the work carried out?
The main objective of the TA visit was to determine whether, and to what extent, mature Scots pine (*Pinus sylvestris*) trees emit N_2O and CH_4 from aboveground tree surfaces under field conditions. Emissions of these gases from this tree species has not been previously studied. Therefore, the main task was the characterisation and quantification of CH_4 and N_2O emissions from stems and shoots of *P. sylvestris*. Soil emissions of both trace gases were determined parallel to stem and shoot emissions. The effect of soil humidity on stem and soil emission rates were studied by comparison of emission rates of both gases from stems of trees growing on experimental plots with higher and lower mean soil humidity. The emission fluxes of N_2O and CH_4 from shoots were measured parallel to stem and soil emissions thus enabling their comparison.

Please highlight the key outcomes of your visit?
To my knowledge, this is the first study focusing on the determination of N_2O and CH_4 emissions from coniferous tree species. Moreover, the presented work was performed on adult trees under natural forest conditions, which enables an estimation of contribution of Scots pine trees to the trace gas exchange between pedosphere/ecosystem and the atmosphere. Such studies of mature trees are rather uncommon; the majority focus on experiments on seedlings under greenhouse conditions. My study complements the CH_4 and N_2O flux measurements at the experimental site and will contribute to analyses of the processes influencing trace gas fluxes at the footprint.

Do you have any personal comments or anecdotes regarding your visit?
I would like to thank research and technical staff from the University of Helsinki for their help with the measurement campaign. Special thanks belong to Mari Pihlatie, Anni Vanhatalo, Elisa Halmeenmäki, Jaana Bäck, Hermanni Aaltonen, Pasi Kolari, Juho Aalto, Jukka Pumpanen, Reijo Pilkottu, Heikki Laakso, Matti Loponen, Sirkka Lietsala and Janne Levula. I wish to thank the ExpeER project for the financial support of the measurement campaign and Cristina Martinez for the help with formalities.

In general, what do you think about this kind of research opportunity?
I find this kind of research opportunity great, especially for young researchers (PhD and PostDoc students), who are at the beginning of their research career. Such funding enables them to work at international top-class experimental sites, to broaden their scientific experiences and knowledge, and to establish new international contacts and cooperation!

TA
Ex2

ECOPHYSIOLOGICAL RESPONSES OF URBAN TREES TO DROUGHT CONDITION (ECOTREE)

Green infrastructure is a very important element of urban landscapes, influencing the quality of inhabitants' lives. Unfortunately, the environment in which we live undergoes continuous and often adverse changes as a result also of human activities. It has been predicted by IPCC models (IPCC, 2007) that, because of climatic changes, drought periods will be more frequent and severe in the future, and these conditions will be even more exacerbated in urban areas. Data on factors affecting plant mitigation capacity often originate from experiments with seedlings grown in non-stressed conditions. Such data are not directly applicable to vegetation in urban areas.

Thus, this project aimed to study the involvement of the antioxidant system and of photoprotective mechanisms in drought resistance and adaptation of common species used for urban greening infrastructures in Italy (Bologna) and Poland (Warsaw). Although most research on plant antioxidants has focused on non-volatile compounds, certain volatiles belonging to the isoprenoid family have also been implicated in protection against oxidative and other abiotic stresses.

Furthermore, these volatile isoprenoids, once emitted into the atmosphere, play a crucial role in the formation of tropospheric ozone. Thus, the emission of Volatile Organic Compounds (VOC) released by plants was investigated for their protective role against oxidative stress and for the effect on air quality. The studies were carried out on urban ornamental species differing in level of VOC emission potential and site requirements: *Robinia pseudoacacia* and *Liquidambar styraciflua* as high VOC emitters and *Fraxinus excelsior* and *Malus domestica* as low VOC emitters. *R. pseudoacacia* and *M. domestica* are found on dry sites, but *L. styraciflua* and *F. excelsior* prefer moister sites. The experiments were performed on potted plants of these species exposed to controlled drought conditions. Measurements of the efficiency of photosynthetic apparatus (*i.e.* gas exchange, chlorophyll fluorescence and photosynthetic pigments) were performed together with the analysis of isoprenoid emission potential to gain information on how plants coped with applied stress conditions. Photosynthesis and transpiration was measured in situ using a portable gas exchange system set up also for VOC sampling. The chemical-physical analysis of volatile isoprenoids was performed by using a gas chromatograph-mass spectrometer (GC-MS) and Proton Transfer Reaction-Mass Spectrometer (PTR-MS).

ExpeER site

BOLOGNA ANALYTICAL PLATFORM, ITALY

When?

May, 2013
Duration: 12 days.

TA User

ARKADIUSZ PRZYBYSZ
Warsaw University of Life Sciences, Poland.

Interview

What motivated you to request access to this site?

I was motivated by the possibility to work with a very experienced team in an excellent laboratory. I found it a great opportunity to improve my skills and knowledge. Scientists working in the Institute of Biometeorology in Bologna are recognized specialists in the field of identification and quantification of volatile isoprenoids compounds. My stay in IBIMET was also a chance to establish scientific and personal contacts, which in the near future should lead to new projects.

Please highlight the key outcomes (scientific and other) of your visit?

Preliminary results showed that limited water availability in pots had a negative effect on some plant species. The first symptoms of drought stress were recorded from the 5th day of the experiment, and included wilting of plants and decreased values of relative water content and leaf water potential. Simultaneously rates of photosynthesis and transpiration, as well as values of chlorophyll a fluorescence decreased. A decreased rate of photosynthesis can be explained, at least partially, by reduced stomatal conductance. Another important outcome of the project was to learn about the method of VOC sampling, which will be implemented in my laboratory in Poland.

In general, what do you think about this kind of research opportunity?

I am very positive about this kind of research opportunity. In Bologna, I found everything I was looking for, such as an excellent team and infrastructure, enabling me to perform an experiment with good publication potential and leading to future scientific cooperation. It is also important to clarify that without the support of ExpeER, I would not have been able to carry out my work at this research infrastructure.

TA
Ex3

INFLUENCE OF BIODIVERSITY ON SOIL WATER FLOW.

Besides comprising an essential resource for plants, soil water acts as a transport medium for dissolved matter and mediates microbial activity. Thus soil water fluxes and resulting redistribution of soil water provide important information for understanding, not only resource use strategies, but also other biological and abiotic processes. Up to now, it has not been possible to measure soil water flow directly (Vereecken *et al.*, 2008), and our knowledge about changes of ecosystem root water uptake profiles with plant diversity is rudimentary. Soil water fluxes can only be estimated either (1) through inverse modelling or (2) directly for a large soil column with lysimeters like in the ECOTRON, where, with the drainage flux, a closed water balance can be recorded.

The aims of this research were to investigate: (1) whether root water uptake profiles differ significantly between ecosystems of different diversity; (2) how plant diversity influences vertical soil water fluxes and redistribution of soil water over the growing season; (3) how plant diversity contributes to groundwater recharge or to what extent they use groundwater for transpiration. Furthermore, we aimed to prepare data for validation of an inverse model, and apply it to the original plots in the Jena Experiment.
This task could only be achieved with data from a lysimeter, such as the Ecotron. In order to investigate the questions, we analysed time series of soil matric potential, soil moisture, groundwater table, drainage, evapotranspiration as well as irrigation recorded in a measurement campaign on 12 lysimeters in the Ecotron facility from April to August 2012. These lysimeters from the Jena Experiment field site cover two diversity levels (4 and 16 species).
We closed the water balance of each of the macrocosms, and applied data-driven methods on lysimeters with different diversities to estimate root water uptake profiles and soil water fluxes based on the short term fluctuations of soil moisture.
The visit to Montpellier was needed to work with the Ecotron personnel and to use the Ecotron database related to the Ecotron-Jena experiment which was run from March to August 2012.

ExpeER site

MONTPELLIER ECOTRON, FRANCE.

When?

February, 2013
Duration: 59 days.

TA User

MARCUS GUDERLE
Max Planck Institute Biogeochemistry Jena, Germany.

Picture

Lysimeter with acess holes for the TDR sensors, the tensiometers and the suction cups in different soil layers.

Interview

What motivated you to request access to this site?
We are members of the Jena Biodiversity Experiment research community, which conducted a measurement campaign on 12 lysimeters (4 and 16 species mixtures) in the Ecotron facility 2012. In this measurement campaign, a variety of components of the water balance were measured (*e.g.* infiltration, drainage and evapotranspiration as well as soil matric potential and soil moisture). The visit to Montpellier enabled us to collaborate with Ecotron staff on data analysis. This was a necessary step as all measurement devices where managed by the Ecotron personnel.

Please describe briefly the work carried out?
In order to address our objectives, I analysed time series of soil matric potential, soil moisture, groundwater table, drainage, evapotranspiration as well as irrigation and climate data recorded in 2012 to close the water balance. In addition, I applied a data-driven method for interpreting short term fluctuations of soil moisture, especially comparing changes in dynamics between day and night. This method allows a first order distinction between root water uptake and vertical flux and thus the estimation of evapotranspiration and root water uptake patterns over depth and time; without solving soil water flow equations. The results of the evapotranspiration estimated with these two methods were compared with the evapotranspiration measured with the weight change of the lysimeter.

Please highlight the key outcomes of your visit?
Preliminary results show that more diverse species mixtures transpire more water than less diverse species mixtures. To answer our key questions, I have to conduct further data analyses, which are in progress.

Do you have any personal comments or anecdotes regarding your visit?
Thanks to the team of the CNRS Ecotron for the great time and their hospitality. Especially, I would like to thank Alex Milcu, Jacques Roy, Damien Landais and Gilbert Jacquier for the fruitful discussions and conversations.

TA
Ex4

TILLAGE OPERATIONS & SOIL MOVEMENT: IMPLICATIONS FOR LONG-TERM EXPERIMENTS (MOVE).

Modelling and monitoring changes of phosphorus and soil organic carbon in long-term field experiments.

The objectives of this study were:
(1) to develop a flexible and robust model for describing and predicting tillage-induced soil and soil constituent (P, SOC -Soil Organic Carbon-) redistribution over time in long-term experiments.
(2) to test a spectroscopic method for quantifying gradients in SOC across experimental plots using a low-cost un-manned aerial vehicle (UAV).

Tillage has been shown to cause considerable dispersion of soil and its constituents. This can have important implications for the integrity of long-term field experiments and the interpretation of treatment effects on the temporal change of soil properties, such as total P or SOC, in the plough layer. Depending on plot width and tillage intensity, substantial amounts of the original soil will have left the plot area after 50 years. Researchers have developed a distributed model for predicting soil and soil constituent redistribution on sloping terrain.
In our study we tested this model for the well-documented management conditions of long-term experiments. With SOC contents dynamically changing in arable landscapes as a function of management, climate and topography, there is a need for developing low-cost methods for monitoring SOC contents in plough layers. Remote sensing methods based on multi-spectral images can map SOC variation. Recently, the costs for UAVs and multi-spectral cameras have dropped dramatically, opening an interesting perspective for flexible, local SOC mapping. With their pattern of distinct SOC contents in adjacent plots, long-term field experiments provide a very efficient experimental design/layout for systematically testing such a remote sensing approach for SOC.

The Broadbalk experiment at Rothamsted is uniquely suited for this work. In 1990, total P in the plough layer was measured along a transect at high spatial resolution, traversing several plots with contrasting soil P contents. Resampling this transect after a period of 23 years (1) provided support for plot-to-plot movement in Rothamsted and (2) provided unprecedented data to constrain and test a spatial-ly explicit soil movement model. The advantage of this approach was that the initial conditions were well defined and there were detailed records on fertilizer inputs, crop yields, P offtake and soil management. Additionally, Broadbalk provided the necessarily wide range of SOC for testing SOC sensing. In this project we collected soil samples for TP and SOC analyses in selected parts of the Broadbalk long-term experiment. The soil data were used for model calibration and validation. We conducted aerial surveys of these areas with an UAV (low altitude c. 30-50m) and a multi-spectral camera testing an inexpensive spectroscopic method for mapping SOC. This work was a collaboration between institutes from three countries and required several field campaigns on Broadbalk starting spring 2013. Some of this research was part of a PhD project.

ExpeER site

ROTHAMSTED EXPERIMENTAL & OBSERVATIONAL SITE, UK

When?

April, 2013
Duration: 10 days.

TA User

KRISTOF VAN OOST Earth & Life Institute/Earth & Climate Research Centre (TECLIM), Belgium.

Picture

Mobile stand with multi-spectral camera and controller. The person in front is operating the portable spectrometer. The white targets are used for geo-referencing the images.

Interview

Please highlight the key outcomes of your visit?
One of the key outcomes of this project is that the ExpeER funding allowed us to start collaboration between the University of Aarhus, Rothamsted Research and the *Université catholique de Louvain*. We are currently analysing the samples in the laboratory and we started with the interpretation of the spectral images. Preliminary results indicate that our spectroscopic method gives good results (RMSE c. 0.2%) and we are able to obtain high-resolution (10cm) maps of SOC. However, an in-depth analysis and scenario analysis with the improved model will require the quantification of SOC and P content of all the samples.

INTERVIEW

Dr Eeva Furman, Director of Centre for Environmental Policy, Finnish Environment Institute (SYKE) and chair of the ALTER-Net Council at the time of the interview.

In your role as the chair of the ALTER-Net Network Council...:

How important is like that provided by ExpeER for the kinds of ecosystem and biodiversity research carried out by ALTER-Net members?

> ALTER-Net strives to provide understanding on processes, their underlying societal drivers as well as alternative solutions for biodiversity, ecosystems and ecosystem services. To be able to gain solid scientific knowledge which takes into account the various contexts of Europe and the long term evolution of issues, proper infrastructures like ExpeER ones are needed. Working in close collaboration with LTER-Europe and carrying out multisite experiments ALTER-Net, has proved that it can use these kind of facilities, it wants to use them and it needs them.

Do you welcome a project like ExpeER which aims to improve these research infrastructures? If so, what aspects of ExpeER particularly interest/excite you?

> The kind of research infrastructure that ExpeER is developing would serve its partners and their joint deliverables as a network. ExpeER is an important project which builds on the existing infrastructure and develops an adaptive mechanism for the evolving needs of research and the society.

How do you think ALTER-Net (or its partners) may benefit from ExpeER's work in developing this infrastructure, if at all?

> ALTER-Net is a network of 27 partners which share certain qualities but differ in others. ExpeER could provide ways to link the institutes better together and open possibilities for those partners which may not be part of LTER-Europe to get access to European research infrastructures.

Are there any aspects of ecosystem research infrastructures you would particularly like to see developed (*e.g.* better databases, better experimental facilities, more sites in certain parts of Europe, *etc.*)?

> ExpeER provides a strong component of infrastructure to deliver high quality ecological research. As ALTER-Net is focusing on delivering research which aims to support society in decision making around sustainability and ecosystems, it is absolutely crucial that the research infrastructures foster interdisciplinary dialogue, with sites and platforms being the core focus areas. In addition, ExpeER could provide databases consisting not only of numeric data but also visual and verbal data. There is a great need for these kinds of facilities, capacity building and building of metadata.

Do you think ALTER-Net can help ExpeER in any way?

> Many ALTER-Net members are already now active in ExpeER, thus helping the project. ALTER-Net as a network is keen on engaging in the development of frameworks for European research infrastructures through dialogue. For example, we encourage ExpeER to become accustomed with the outcomes of the ALTER-Net Ghent conference, which highlight many important research topics for the future.

Any other comments about ExpeER?

> ALTER-Net is not a closed and stagnant institution but rather a strong, transparent "process" which moves forward along with other actors in the field. Presently, ExpeER is one of these key actors.

ALTER-Net

ALTER-Net is a network of 27 partner institutes from 18 European countries. It integrates research capacities across Europe: assessing changes in biodiversity, analysing the effect of those changes on ecosystem services and informing policymakers and the public about this at a European scale. Originally funded by the European Union's Framework VI program to stimulate a collaborative approach, ALTER-Net is now operating independently.

More information on www.alter-net.info

DESCRIPTIONS OF ExpeER TA SITES

HIES

ACHENKIRCH (AUSTRIA)

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OPERATING INSTITUTE: Bundesforschungs und Ausbildungszentrum für Wald, Naturgefahren und Landschaft. Federal Research and Training Centre for Forests, Natural Hazards and Landscape (BFW).

MAIN PURPOSE: Biogeochemistry.

ECOSYSTEM TYPE: Spruce forest.

EXPERIMENTAL TREATMENTS: Soil temperature, drought.

FACILITIES: The mature mountain forest in the western limestone Alps serves as a long-term monitoring site for biogeochemical pools and fluxes. It was upgraded to a climate manipulation site in 2004. Soil is warmed by 4°C compared to ambient during the growing season. Soil gas exchange is measured manually as well as fully automatically at high temporal resolution.

In 2008, three temporary roofs (100m2 each) were installed to simulate summer drought. New plots were established (warmed and control beneath roofs). The basic roof construction remains on site; plastic roofs can be assembled any time except winter. Trenched plots (roots cut) allow permanent estimation of autotrophic and heterotrophic soil respiration. Site access is possible year round. Winter measurements of gas transport through snow are made.

Since the start of ExpeER, warming effects on root and mycorrhizal dynamics have become a major focus at the Achenkirch field site. These often understudied processes were intensively investigated within two TA-projects in cooperation with Werner Borken from the University of Bayreuth and Ivika Ostonen from the University of Tartu. Root biomass and turnover were assessed as well as root morphology and fungal colonisation. Additionally, a newly established cooperation with Douglas Godbold from the University of Life Sciences (BOKU) will provide deeper insights into warming effects on micorrhizal turnover.

Picture

Site overview.
©A. Schindlbacher

RECENT PUBLICATIONS

● Schindlbacher, A., Jandl, R., Schindlbacher S. (2014) Natural variations in snow cover do not affect the annual soil CO_2 efflux from a mid-elevation temperate forest, **Global Change Biology**, 20: 622–632.

● Schindlbacher, A., Wunderlich, S., Borken, W., Kitzler, B., Zechmeister-Boltenstern, B., Jandl, R. (2012) Soil respiration under climate change: prolonged summer drought offsets soil warming effects, **Global Change Biology**, 18: 2270–2279.

● Kuffner, M., Hai, B., Rattei, T., Melodelima, C., Schloter, M., Zechmeister-Boltenstern, S., Jandl, R., Schindlbacher, A., Sessitsch, A. (2012) Effects of season and experimental warming on the bacterial community in a temperate mountain forest soil assessed by 16S rRNA gene pyrosequencing, **FEMS Microbial Ecology**, 82: 551–562.

KLAUSENLEOPOLDSDORF (AUSTRIA)

OPERATING INSTITUTE: Bundesforschungs und Ausbildungszentrum für Wald, Naturgefahren und Landschaft. Federal Research and Training Centre for Forests, Natural Hazards and Landscape (BFW).

MAIN PURPOSE: Biodiversity, pollution, soil science, GHG.

ECOSYSTEM TYPE: Beech forest.

EXPERIMENTAL TREATMENTS:
N-fertilization (6 plots at 5x5m) and tree girdling (3 plots girdled in 2006; 3 plots girdled in 2008 at 20x20m).

FACILITIES: Klausenleopoldsdorf site offers meteorological data measured with standard meteorological devices (PAR, wind direction, wind speed, air humidity, air temperature, precipitation, rainfall chemical analysis -NO_2-, NO_3-, NH_4+, DOC- and global radiation). It also provides soil temperature and soil moisture sensors at various soil depths; and allows measurements such as litterfall, throughfall, stemflow, wet deposition, soil solution at 3 soil depths, site and soil characteristics, forest growth and condition, plant and soil biodiversity, DNA and PLFA analysis of mineral soil, enzyme activity, extensive soil fauna inventory, sapflow, GHG fluxes (N_2O, CH_4, CO_2) plus ozone and NOx, 15N mineralization, 15N nitrification, soil chemistry, litterfall involving metagenomics and proteomics and litter decomposition, stochiometry effects and carbon turnover.
The available laboratory devices are N_2 measurement system, soil GHG parameterization (Schaufler *et al.*, 2010, EJSS), and PLFA (microbial community composition) analysis. The site was part of several EU funded projects (NOFRETETE and NITROEUROPE) and various national projects.
Recent developments at the site include: (1) Replacement of the meteorological station. The data logger was changed (CR10X → CR1000) and new sensors installed (the precipitation sensor was replaced by an automatic precipitation gauge : PLUVIO); (2) Replacement of all old soil moisture sensors and additional installation of new soil moisture sensors at different soil depths (new soil water sampling pumps were installed and connected to a data logger); (3) Replacement of dendrometers at 10 beech trees.

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Pictures
1 AGPS. ©BFW
2 Girdled plots, 2008. ©BFW

RECENT PUBLICATIONS

● Kaiser, C., Koranda, M., Kitzler, B., Fuchslueger, L., Schnecker, J., Schweiger, P., Rasche, F., Richter, A. 2010. Belowground carbon allocation by trees drives seasonal patterns of extracellular enzyme activities by altering microbial community composition in a beech forest soil. **New Phytologist** 187 (3): 843–858.
● Koranda, M., Schnecker, J., Kaiser, C., Fuchslueger, L., Kitzler, B., Stange, C.F., Sessitsch, A., (...), Richter, A. 2011: Microbial processes and community composition in the rhizosphere of European beech - The influence of plant C exudates. **Soil Biology and Biochemistry** 43 (3): 551–558.

HIOS

ZÖBELBODEN (AUSTRIA)

OPERATING INSTITUTE: Umweltbundesamt GmbH.

MAIN PURPOSE: Air pollution, organic matter dynamics, biodiversity, N dynamics, C sequestration.

ECOSYSTEM TYPE: Spruce and spruce-beech forests in karst catchment.

EXPERIMENTAL TREATMENTS: Managed and unmanaged forest, N and C enrichments.

FACILITIES: The Zöbelboden was established in 1992 as the only Integrated Monitoring station in Austria under the UN Convention on long-range transboundary air pollution (CLRTAP).
In 2006, it became part of LTER Austria. It covers a small forested catchment (90ha) of a karstic mountain range (500 to 950m above sea level) in the Kalkalpen national park. The Zöbelboden represents one of the best known karst catchments in Europe with long-term data series of the major components of its ecosystems. Sampling of chemical specimens is done by local staff. Chemical analyses are carried out by the laboratory of the Umweltbundesamt in Vienna. All data and metadata from monitoring and research projects are stored in a semantically structured database.
Recent developments at the site include: (1) Establishment of a carbon budget for an intact and a disturbed forest stand including all major pools and fluxes; (2) Measurement of N_2O in an intact and a disturbed forest stand; (3) Equipping the intensive plots and the runoff weirs for high resolution water sampling (a few hours) of heavy rain events (this includes the precipitation, the humus and soil lysimeters and the runoff weirs); (4) Measurement of soil and catchment scale dynamics of dissolved carbon and nitrogen during heavy rain events using high resolution sampling (three hours) and analysis.

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More information on the moovie "Monitoring & Forschung - 20 Jahre Zöbelboden" available on youtube.

Pictures

1 Messstation of Zöbelboden. ©H. Rokop

2 Messhütte auf Intensiplot. ©M. Mirtl

RECENT PUBLICATIONS

● Hartmann, A., M. Kralik, F. Humer, J. Lange & M. Weiler, W. (2012). Identification of a karst system's intrinsic hydrodynamic parameters: upscaling from single springs to the whole aquifer. **Environmental Earth Sciences** 65: 2377–2389.
● Holmberg, M., Vuorenmaaa, J., Posch, M., Forsius, M., Lundin, L., Kleemola, S., Augustaitis, A., Beudert, B., de Wit, H.A., Dirnböck, T., Evans, C.D., Frey, C.D., Grandin, U., Indriksone, I., Krám, P., Pompei, E., Schulte-Bisping, H., Srybny, A., Vána, M. 2012. Relationship between critical load exceedances and empirical impact indicators at Integrated Monitoring sites across Europe. **Ecological Indicators** 24: 256–265.
● Jost, G., Dirnböck, T., Grabner, M.-T. & Mirtl, M. 2011. Nitrogen leaching of two forest ecosystems in a Karst watershed. **Water Air and Soil Pollution** 218: 633–649.

HYYTIÄLÄ (FINLAND)

HIOS

OPERATING INSTITUTE: University of Helsinki, Helsinki.

MAIN PURPOSE: Biosphere/atmosphere interaction and climate change.

ECOSYSTEM TYPE: Pine forest.

EXPERIMENTAL TREATMENTS: Prescribed burning.

FACILITIES: The SMEAR site (Station for Measuring Ecosystem-Atmosphere Relations) is situated at the Hyytiälä Forestry Field Station of the University of Helsinki. The site consists of a managed, 50 years old Scots pine forest stand, two open oligotrophic fen sites and a humic lake with forested catchment. The main idea of SMEAR-type infrastructures is continuous, comprehensive measurements of fluxes, storages and concentrations in the land ecosystem–atmosphere continuum. The forest measurements have been operated continuously since 1996, and include leaf, stand and ecosystem scale measurements of green-house gases, volatile organic compounds, pollutants (*e.g.* O_3, SO_2, NO_x) and aerosols, in addition to a full suite of meteorological measurements. The biogeochemical cycles and vegetation-soil-atmosphere interactions are studied both experimentally and with long-term observations. The site has full carbon, water and nitrogen budgets made over 10 years, and it is a full ICOS ecosystem station.

In summer 2012, 18 trenching plots were established in the pine stand, in order to analyse how plant input of recently assimilated carbohydrates to soil is linked to the decomposition of soil organic matter and utilisation of soil organic nitrogen sources.

In summer 2013, measurements of carbonyl sulfide (COS) fluxes started in the forest, in order to obtain improved estimates of the magnitude and variability of ecosystem-scale photosynthesis, respiration and transpiration. The lake eddy covariance measurements have been complemented with campaign wise turbulence, VOC and CH_4 measurements. The nearby spruce swamp forest was drained in order to analyse the effect of water level on GHG fluxes and ecosystem carbon balance.

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Pictures

1 Overview. ©UH

2 Forest floor and soil measurements at SMEAR II station, *e.g.* automatic chamber for gas exchange, litter collectors and soil moisture content measuring setup. ©J. Aalto

RECENT PUBLICATIONS

● Korhonen, J. F. J. , Pihlatie, M., Pumpanen, J., Aaltonen, H., Hari, P., Levula, J., Kieloaho, A. J. , Nikinmaa, E., Vesala, T., and Ilvesniemi, H. (2013) Nitrogen balance of a boreal Scots pine forest. - **Biogeosciences** 10: 1083–1095.

● Aaltonen, H., Aalto, J., Kolari, P., Pihlatie, M., Pumpanen, J., Kulmala, M., Nikinmaa, E., Vesala, T. & Bäck, J. (2012) Continuous VOC flux measurements on boreal forest floor. **Plant and Soil** DOI 10.1007/s11104-012-1553-4.

● Bäck, J., Aalto, J., Henriksson, M., Hakola, H., HE, Q. & Boy, M. (2012) Chemodiversity of a Scots pine stand and implications for terpene air concentrations. - **Biogeosciences** 9: 689–702.

AP

GRIGNON (FRANCE)

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OPERATING INSTITUTE: BIOEMCO (biogeochemistry and ecology of the earth surface).

MAIN PURPOSE: Soil organic matter turnover, hydrological processes.

FACILITIES: The laboratory of Biogeochemistry and Ecology of the Earth Surface (BIOEMCO) has an international reputation for the use of isotopic techniques to study soil organic matter turnover as well as hydrological processes. The laboratory is equipped with 8 isotopic ratio mass spectrometers, (IRMS) which can be used to determine the stable isotope signature of C, N (OM and CO_2), O and H (H_2O and CO_2). For soil organic matter studies, these spectrometers are coupled either to an elemental analyser for bulk analysis or to gas chromatographs, which allow the determination of the isotopic signature of single molecules. This isotopic facility with different applications in the field of environmental research is unique in Europe, because the isotopic signature of the different components of the ecosystem (gas, water, plants and soil) may be studied in the same laboratory, where users will be supported by combined expertise of researchers and technicians thereby optimising the application of the isotopic techniques within the framework of the ExpeER project.
Since the beginning of ExpeER, the development of the use of cutin and suberin as tracers for shoot and root derived carbon in different environments has been pursued. Moreover, a stable isotope measurement technique for sugars isolated from soil has been developed and an additional kinetic isotope effect during the analyses of labelled sugars has been evidenced.
In collaboration with the NanoSIMS facility in Paris and the experimental ExpeER site at Lusignan, the possibility to combine long-term field experiments with labelled material and nanoscale analyses in order to enhance process understanding of organic matter stabilisation in subsoil horizons has been tested.
A correction factor for organic compounds in environmental water samples affecting oxygen and hydrogen isotope measurements by wavelength-scanned cavity ring-down spectroscopy has also been developed.

Pictures

1 Soil incubation with gas emission monitoring. @T. Lerch

2 Isotope ratio mass spectrometer for molecular analyses. @A.Chabbi

RECENT PUBLICATIONS

● Mendez-Millan, M., Dignac, M. F., Rumpel, C., Derenne, S., 2011 : Can cutin and suberin biomarkers be used to trace shoot and root derived organic matter? A molecular and isotopic approach. **Biogeochemistry**, 106:23–38.
● Baumann, K., Dignac, M.F., Bardoux, G., Rumpel, C., 2012: Effect of 13C enrichment and sugar type on analysis of sugars by gas chromatography/combustion/isotope-ratio mass spectrometry. **Rapid Communications in Mass Spectrometry**, 26: 1934–1940.
● Hamer, U., Rumpel, C., Dignac, M.F., 2012. Cutin and suberin biomarkers as tracer for the turnover of shoot and root derived organic matter along a chronosequence of Ecuadorian pasture soils. **European Journal of Soil Science**, 63: 808–819.

PIERROTON (FRANCE)

OPERATING INSTITUTE: National Institute for Agricultural Research (INRA).

MAIN PURPOSE: Atmospheric exchanges, energy, water and C balances, nutrient cycles.

ECOSYSTEM TYPE: Maritime pine, Molinia, *Ulex nanus*.

EXPERIMENTAL TREATMENTS: Irrigation, fertilisation, forest management.

FACILITIES: The infrastructure is an experiment aimed at determining the carbon, water, energy and nutrient balances of short rotation forests dedicated to biomass and wood production. The infrastructure comprises two sites located in Cestas and Salles. The Salles site (60ha plot of pine forest), has been fully operational since 2000 with an eddy flux tower (CO_2, H_2O, heat, radiation), wet and dry nitrogen deposition, soil moisture, micrometeorological and ancillary measurements. The site benefits from mains power and satellite data transmission. The Cestas site installed in 2013 is composed of: (1) a set of 32 plots organised into complete randomised blocks where forest management alternatives are compared; (2) a set of four large plots (8-10ha) designed for carbon, nitrogen and water fluxes monitoring. Quite recently, the Salles (ex "Bilos") site (10 years old maritime pine plantation) has been monitored for dendrological and biomass growth, and for CO_2 and water fluxes since 2001. New equipments has been installed to complete the measurement of GHG fluxes and micrometeorological measurements between terrestrial ecosystems and the atmosphere, according to ICOS standards.

In the INRA Bordeaux-Pierroton domain, 50ha of experimental plots were installed during the winter 2012-2013: (1) Eight different options for dendrobiomass production including maritime pine, eucalyptus, nitrogen fixing species, and a mix of 6 tree species selected in the perspective of climate change, are tested at stand level in a randomised block trial (plots of 0.25ha, 4 replications); (2) Four plots of 8-10ha, representing 4 sylvicultural options (maritime pine for biomass production, mixed plantation of eucalyptus and maritime pine, maritime pine plantation intercropped with nitrogen fixing species, comparative plantation of pure eucalyptus and maritime pine stand crossed with irrigation and fertilisation treatments) were planted and equipped with a set of automated measurement systems concerning the biophysical and biogeochemical functioning.
A biomass technical platform for manipulation of whole trees and root systems, 3D measurement of architecture and biomass for models calibration, wind stability studies, nutrient balance, and preparation of biomass and wood samples was set up at the INRA Pierroton in January 2014.

Picture

The comparative plantation of eucalyptus and maritime pine crossed with irrigation and fertilisation treatments.

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RECENT PUBLICATIONS

● Moreaux, V., A. P. O'Grady, N. Nguyen-The and D. Loustau (2013). Water use of young maritime pine and Eucalyptus stands in response to climatic drying in south-western France. **Plant Ecology & Diversity** 6 (1): 57–71.
● Dannoura, M., P. Maillard, C. Fresneau, C. Plain, D. Berveiller, D. Gerant, C. Chipeaux, A. Bosc, J. Ngao, C. Damesin, D. Loustau and D. Epron (2011). In situ assessment of the velocity of carbon transfer by tracing 13C in trunk CO(2) efflux after pulse labelling: variations among tree species and seasons. **New Phytologist** 190 (1): 181–192.

HESSE (FRANCE)

HIES

OPERATING INSTITUTE: National Institute for Agricultural Research (INRA).

MAIN PURPOSE: Forest C sequestration, water budget.

ECOSYSTEM TYPE: Beech forest.

EXPERIMENTAL TREATMENT: Precipitation exclusion with a 20 m² roof.

FACILITIES: The Hesse site is a beech forest plot equipped since 1996 with an eddy covariance system to measure continuously (half-hourly) the net fluxes of CO_2, H_2O and energy exchanged between ecosystem and atmosphere. Supplementary sensors provide the main meteorological data (temperature, humidity, radiation) and edaphic status (soil water content, soil temp.). Additional field campaigns give information about ecosystem characteristics evolution (Leaf Area Index, tree growth, fine roots biomass), carbon allocation to ecosystem compartments (soil and stem CO_2 efflux, heterotrophic respiration) and their isotopic signature ($_{13}C$).
The scientific infrastructure of the Hesse site was renewed during the winter 2012-2013 in order to join the ICOS network (Integrated Carbon Observa-tory System) and obtain the upper level label (ICOS level 1). This site improvement includes first the construction of a new 35m height tower overhanging the forest canopy on which a new set of eddy covariance and meteorological sensors have been installed; secondly a new set of pedo-climatic sensors with more instruments to better represent of the spatial variability of the soil characteristics. The complete system will provide measurements with a higher accuracy and reliability. Regular leaf, wood, soil and soil water sampling will be performed (several times per year) to measure carbon, nitrogen and mean nutriment concentrations and to archive organic matter for future studies.

Contact

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Picture

Hesse infrastructure.
©B. Longdoz

RECENT PUBLICATIONS

● Zapater, M., Breda, N., Bonal, D., Pardonnet, S., Granier, A. (2013) Differential response to soil drought among co-occurring broad-leaved tree species growing in a 15-to-25-year-old mixed stand. **Annals of Forest Science**, 70: 31–39.
● Ngao, J., Epron, D., Delpierre, N., Bréda, N., Granier, A., Longdoz, B. (2012) Spatial variability of soil CO_2 efflux linked to soil parameters and ecosystem characteristics in a temperate beech forest. **Agricultural and Forest Meteorology**, 154–155, 136–146.
● Marron, N., Plain, C ., Longdoz, B., Epron, D. (2009) Seasonal and daily time course of the carbon isotope composition of soil CO_2 efflux measured with a tunable diode laser spectrophotometer. **Plant and Soil**, 318 (1-2): 137–151.

LUSIGNAN (FRANCE)

OPERATING INSTITUTE: SOERE ACBB, National Institute for Agricultural Research (INRA).

MAIN PURPOSE: Land use change, C and N biogeochemical cycles, biodiversity.

ECOSYSTEM TYPE: Agricultural site, grassland, arable crops.

EXPERIMENTAL TREATMENTS: Rotation, fertilisation, grazing, mowing.

FACILITIES: The Lusignan experiments are a temporary grassland (leys arable crop rotations system) dedicated to study the long-term anthropogenic disturbance on biogeochemical cycles and biodiversity.
The practical scientific questions that need to be answered are: (1) Would introduction of leys within arable crop rotations have an effect on C and N and soil quality for the long term? (2) Would this effect influence the quality of drainage water and reduce greenhouse gas emission? (3) What are the effects of grassland duration and grassland management on soil organic matter dynamics (quantity and composition); on GHG emissions, on nitrate leaching and on functional biodiversity?
Measurements recorded systematically include soil chemistry (CEC, C, N, ^{13}C, ^{15}N...); soil solution parameters (DOC, total dissolved nitrogen, cations, anions); microbial and soil fauna diversity; aboveground and belowground biomass; functional traits; nitrogen oxide emission; dry and wet nitrogen deposition. The site also includes 2 eddy-flux towers that continuously monitor atmosphere-vegetation exchange of CO_2, water and energy since 2005.
Recently, the whole CO_2 eddy covariance system was renewed according to ICOS standards. In addition, a supplementary new experiment on grass-legume mixtures *vs.* pure stands was set up to assess the role of grasses and legumes on N and C storage and the fate of N grass and legume N in the soil.

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Pictures
1 SOERE ACBB overview. ©A. Chabbi
2 Measurments of soil biodiversity. ©X. Charrier

RECENT PUBLICATIONS

● Baumann, K., Sanaullah, M., Chabbi, A., Dignac, M.F., Bardoux, G., Steffens, M., kogel-knabner, I. & Rumpel, C., (2013) Changes of litter chemistry and soil lignin signature during decomposition and stabilisation of 13C labelled wheat roots in three soil horizons. **Soil Biology & Biochemistry** 67: 55–61.
● Sanaullah, M., Chabbi, A., Girardin, C., Durand, J.L., Poirier, M., Rumpel, C., (2014) Effects of drought and elevated temperature on biochemical composition of forage plants and their impact on carbon storage in grassland soil. **Plant and Soil**, 374: 767–778.
● Senapati, N., Chabbi, A., Gastal1, F., Smith, P., Mascher, N., Loubet, B., Cellier, P. and Christophe, N. (2014). Net carbon storage measured in a mowed and grazed temperate sown grassland shows potential for carbon sequestration under grazed system. **Carbon Management**, in press.

E

MONTPELLIER ECOTRON (FRANCE)

OPERATING INSTITUTE: CNRS UPS 3248 Ecotron Européen de Montpellier.

MAIN PURPOSE: Submit ecosystem samples to environmental changes and measure processes.

ECOSYSTEM TYPE: Ecosystem to organism scale, natural or cultivated, sampled *in situ* or reconstructed.

EXPERIMENTAL TREATMENTS: Various simulated environmental conditions (CO_2, temperature, precipitation, light, biodiversity…).

FACILITIES: The Montpellier Ecotron is devoted to the analysis of responses to environmental change by ecosystems, organisms and biodiversity. It is open to the international community through calls for proposals. Its principle is to confine samples of ecosystems or organisms in order to better simulate various environmental conditions and to accurately measure ecosystem and organism function. Three platforms allow studies at different scales (ecosystem to organism) on different types of ecosystem ("natural" or cultivated, sampled *in situ* or reconstructed). The Ecotron has the flexibility to simulate a wide range of climatic conditions (including sub-zero degree Celsius temperatures) and CO_2 concentrations. At Montpellier, ecosystem processes are measured at high temporal resolution, in particular the automated on-line flux measurements of H_2O, CO_2, CH_4 and N_2O. A specific emphasis is put on isotopic techniques (^{13}C labeling of the organic matter and carbon dioxide ^{13}C on line measurements). Real time access to the environmental conditions of each unit and to the on-line measurements *via* the internet allows authorised researchers to follow the experiment from any location. A staff of 8 research engineers and technicians runs the infrastructure and secures the online measurements.

Recently, a more powerful cooling system has been added to the macrocosms platform in order to allow the simulation of a larger range of climatic conditions with, in particular negative temperatures. It is now also possible to work in totally controlled conditions in 6 of the macrocosms by blocking the sun's radiation and using plasma lamps instead. A platform of 12 growth chambers with flexible light conditions (sun-like radiation spectrum with plasma lamps, of variable spectrum with LED lamps) has been installed.

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Pictures

1 Loading intact grassland ecosystems into the Macrocosms platform. ©H. Languet, photothèque CNRS

2 Measuring infiltration at the end of a biodiversity experiment. ©J. Roy

RECENT PUBLICATION

● Milcu, A., Roscher, C., Gessler, A., Bachmann, D., Gockele, A., Guderle, M., Landais, D., Piel, C., Escape, C., Devidal, S., Ravel, O., Buchmann, N., Gleixner, G., Hildebrandt, A., Roy, J. (2014) Functional diversity of leaf nitrogen concentrations drives grassland carbon fluxes. **Ecology Letters**, early view doi:10.1111/ele.12243.

PUECHABON (FRANCE)

OPERATING INSTITUTE: CNRS CEFE UMR 5175.

MAIN PURPOSE: Ecophysiological research, biogeochemistry, hydrology.

ECOSYSTEM TYPE: Evergreen oak, *Buxus sempervirens*, *Juniperus oxycedrus*.

EXPERIMENTAL TREATMENTS: Throughfall exclusion, rainfall exclusion, thinning.

FACILITIES: The site is located on a flat area 35 km North-West of Montpellier. The forest is dominated by the overstorey evergreen tree *Quercus ilex* (80% cover) managed as a coppice for centuries with the last clear-cut performed in 1942. Mean annual precipitation is 883mm with 75% rainfall between September and April. However, because of the large fraction of rocks and stones in the soil profile, available water averages only 150mm.
Long-term 30% throughfall exclusion and thinning experiments started in 2003. A two layer footbridge (40m long) allows an easy access to the canopy. In 2007, a new and unique manipulative experiment was designed to simulate the effect of extreme droughts on the functioning and the vulnerability of this ecosystem. A mobile rainfall shelter was installed above the canopy in order to simulate 100% rain exclusion during different seasons. This last experiment is now on standby. Measurements recorded include soil and organ-level gas exchange; tree transpiration; aboveground and belowground biomass; phenology; functional traits; litterfall; regeneration; organs, soil and litter biochemistry; VOC emission; dry and wet nitrogen deposition; ectomycorhizal communities. The site also includes an eddy-flux tower that continuously monitors atmosphere-vegetation exchange of CO_2, water and energy since 1998. In 2003, the eddy flux tower was upgraded to be part of the ICOS project. A large number of papers have already been published from research at the site and an important database is already available for the users. In 2013, the site was electrified.

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Picture
Long-term 30% throughfall exclusion experiment.
©CEFE CNRS

RECENT PUBLICATIONS

● Martin-StPaul, N. K., Limousin, J.-M., Vogt-Schilb, H., Rodríguez-Calcerrada, J., Rambal, S., Longepierre, D. and Misson, L. (2013) The temporal response to drought in a Mediterranean evergreen tree: comparing a regional precipitation gradient and a throughfall exclusion experiment. **Global Change Biology**. doi: 10.1111/gcb.12215.
● Perez-Ramos, I. M., J. Rodriguez-Calcerrada, J. M. Ourcival and S. Rambal (2013). *Quercus ilex* recruitment in a drier world: A multi-stage demographic approach. **Perspectives in Plant Ecology Evolution and Systematics** 15(2): 106–117.

HIES
HIOS

EIFEL (GERMANY)

OPERATING INSTITUTE: Forschungszentrum Jülich GmbH, Institute for Bio- and Geo- sciences, Agrosphere Institute (IBG-3).

MAIN PURPOSE: Ecosystem observation, water cycle, eddy covariance, climate, soil respiration.

ECOSYSTEM TYPE: Forest, grassland, arable land.

EXPERIMENTAL TREATMENTS: Soil management, deforestation.

FACILITIES: The infrastructure consists of three intensive test sites (ITS): Wüstebach (ITS1), Rollesbroich (ITS2) and Selhausen (ITS3).
The infrastructures are operated by IBG-3 permanently since 2007. The sites are equipped with wireless soil moisture networks, groundwater monitoring, runoff and solute monitoring stations, eddy covariance tower (CO_2, NO_2, CH_4), soil respiration monitoring, climate stations with rainscanner (only Wüstebach) and lysimeter/deposition stations. A deforestation experiment (approx. 12ha) was done in Wüstebach in 2013. The Selhausen ITS is also equipped with geophysical and remote sensing monitoring systems. Within the observatory, a climate feedback experiment (SoilCan) using a lysimeter network was finished in 2012.
Recent developments of the site includes: (1) Two rhizotron facilities to investigate root growth and soil water dynamics under cropped fields (at the Selhausen site); (2) A biodiversity scaling experiment (at the Rollesbroich experimental grassland site); (3) A controlled deforestation experiment (in the Wüstebach site, by Forschungszentrum Jülich together with National Park Eifel Authority); (4) Creation of long-term data sets regarding changes in terrestrial systems as a function of climate change (SOILCan project).

Picture

Radiometer test site Selhausen. ©H. Bogena

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RECENT PUBLICATIONS

● Qu, W., Bogena, H.R., Huisman, J.A. and H. Vereecken 2013. Calibration of a Novel Low-Cost Soil Water Content Sensor Based on a Ring Oscillator. **DOI** 10.2136/vzj2012.0139.
● Montzka, C., Bogena, H.R. , Weihermüller, L., Jonard, F., Bouzinac, C., Kainulainen, J., Balling, J., Loew, A., DallAmico, J., Rouhe, E., Vanderborght, J. and H. Vereecken 2013. Brightness temperature validation at different scales during the SMOS validation campaign in the Rur and Erft catchments, Germany. IEEE Transactions on Geosciences Remote Sensing, 51(3): 1728–1743, DOI 10.1109/TGRS.2012.2206031.
● Herbst, M., L. Bornemann, A. Graf, G. Welp, G., H. Vereecken and W. Amelung 2012. A geostatistical approach to the field-scale pattern of heterotrophic soil CO_2 emission using covariates. **Biogeochemistry** 111: 377–392, DOI 10.1007/s10533-011-9661-4.

HARZ/CENTRAL GERMAN LOWLAND (GERMANY)

HIES
HIOS

OPERATING INSTITUTE: UFZ Helmholtz Centre for Environmental Research Leipzig.

MAIN PURPOSE: Global and climate change effects on terrestrial environmental systems.

ECOSYSTEM TYPE: Grassland, forest, arable land, floodplains, urban areas.

EXPERIMENTAL TREATMENTS: Climate change, land use change.

FACILITIES: Based on UFZ priority areas in environmental research, water research, soil research, biodiversity research and different social scientific aspects form the central focus of the research programme at the observatory. The effects of changes in climate and land use on biodiversity are being explored at a network of biodiversity observation sites.
A hydrological observatory covering the catchment of the river Bode (3300km²) is devoted to research on the relationship between climate, land use and water balance. Within the observatory main intensive test sites are in place in order to investigate specific hydrological issues and matter fluxes in detail. The infrastructure consists of wireless soil moisture networks, groundwater monitoring, runoff and water quality monitoring stations, eddy covariance towers (ICOS sites), cosmic ray moisture probes, geophysical monitoring (ERT, GPR, EM), airborne monitoring and lysimeters. In addition, rain radar and additional weather stations were installed in regions that are relevant for modeling studies.
A Critical Zone Observatory, the CZO "Selke", is an integral part of the observatory and serves research on the interplay between catchment structure and dynamic external forcing and the effects on hydrological dynamics and matter transformation.
A set of MOBICOS (Mobile Aquatic Mesocosms) - laboratory containers are set up close to water bodies and fed with the "on-site water", creating a "natural" testing environment to explore feedbacks between water quality and aquatic ecosystems.
At the GCEF (Global Change Experimental Facility) in Bad Lauchstädt, a large-scale outdoor infrastructure that uses a well-replicated design with large field plots (400m²) allows the simulation of changing climatic and land use conditions and the assessment of ecological systems response.

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More information on www.tereno.net. Look at the promotion video about the GCEF available at the UFZ YouTube channel.

Note

In the framework of **TERENO,** "terrestrial observatories" are set up in selected German regions for climate and land use change studies. The Harz/Central German Lowland Observatory is one of these observatories that are equipped with a combination of *in situ* measuring instruments and ground-based, airborne and satellite-borne remote sensing techniques.

Picture

MOBICOS Container within the Harz/Central German Lowland Observatory.
© A. Künzelmann, UFZ

RECENT PUBLICATIONS

● Kamjunke, N., Büttner, O., Jäger, C.G., Marcus, H., von Tümpling, W., Halbedel, S., Norf, H., Brauns, M., Baborowski, M., Wild, R., Borchardt, D., Weitere, M. 2013. Biogeochemical patterns in a river network along a land use gradient. **Environ Monit Assess** 2013, doi:10.1007/s10661-013-3247-7.
● Brosinsky, A., Lausch, A., Doktor, D., Salbach, C., Merbach, I., Gwillym-Margianto, S., Pause, M., (2013): Analysis of spectral vegetation signal characteristics as a function of soil moisture conditions using hyperspectral remote sensing. **J. Indian Soc. Remote Sens.**

HIES

HÖGLWALD FOREST (GERMANY)

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OPERATING INSTITUTE: Karlsruhe Institute of Technology, Institute for Meteorology and Climate Research, Atmospheric Environmental Research (IMK-IFU) - Garmisch - Partenkirchen.

MAIN PURPOSE: Biosphere-atmosphere-hydrosphere exchange processes.

ECOSYSTEM TYPE: Forest.

EXPERIMENTAL TREATMENTS: Forest management.

FACILITIES: The Höglwald is a Norway spruce-dominated forest of about 370ha surrounded by farmland in the hilly landscape of Southern Bavaria, approx. 70km north of the Alps and 40km west of Munich at 11° 5' E and 48°18' N. The Höglwald site (560m asl) has been operated by IMK-IFU perma-nently since 1993.

With more than a decade of data, Höglwald forest holds the world record for the longest detailed dataset on biosphere-atmosphere exchange of greenhouse gases.

The site is equipped with 2 fully automated, remotely controlled measuring and data acquisition systems in standard containers for continuous quantification of net exchange of trace gases (CO_2, N_2O, CH_4, NO_x) at the soil-atmosphere interface in high temporal resolution using static and dynamic chamber techniques. These use a tower (50m height) for quantification of net ecosystem exchange of CO_2, H_2O and sensible heat.

Within the ExpeER TA scheme, new chambers for measuring GHG emissions from tree stems have been developed, mainly N_2O. They have been used in a field study and stem fluxes were compared to soil fluxes measured by the automatic measuring system.

Pictures

1 Eddy-Covariance system at 50 m tall tower. ©KIT IMK-IFU

2 Chamber measurements of trace gas exchange. ©KIT IMK-IFU

RECENT PUBLICATIONS

● Luo, G.J., Bruggemann, N., Wolf, B., Gasche, R., Grote, R., Butterbach-Bahl K. (2012) Decadal variability of soil CO_2, NO, N_2O, and CH_4 fluxes at the Hoglwald Forest, Germany. **Biogeosciences**: 9, 1741-1763. DOI: 10.5194/bg-9-1741-2012.

● Gundersen, P., Christiansen, J. R., Alberti, G., Bruggemann, N., Castaldi, S., Gasche R., Kitzler, B., Klemedtsson, L., Lobo-do-Vale, R. Moldan, F., Rutting, T., Schleppi, P., Weslien, P., Zechmeister-Boltenstern, S. (2012) The response of methane and nitrous oxide fluxes to forest change in Europe. **Biogeosciences**: 9: 3999–4012. DOI: 10.5194/bg-9-3999-2012.

● Van Oijen, M., Cameron, D. R., Butterbach-Bahl, K., Farahbakhshazad, N., Jansson, P. E., Kiese R., Rahn, K. H., Werner, C., Yeluripati, J. B. (2011) A Bayesian framework for model calibration, comparison and analysis: Application to four models for the biogeochemistry of a Norway spruce forest. **Agricultural and forest meteorology**: 151: 1609–1621. DOI: 10.1016/j.agrformet.2011.06.017.

JENA (GERMANY)

OPERATING INSTITUTE: Friedrich-Schiller-University Jena.

MAIN PURPOSE: Biodiversity, ecosystem functions, element cycling, ecology, multi-trophic interactions.

ECOSYSTEM TYPE: Grassland with different levels of plant diversity.

EXPERIMENTAL TREATMENTS: Plant species richness and functional groups, drought.

FACILITIES: The Jena experiment is one of the world's largest terrestrial biodiversity experiments. It investigates the relationship between plant diversity and ecosystem processes. Plant communities where plant species richness ranges from 1-60 species are established from a species pool of 60 species from Central European Arrhenatherum grasslands, divided into four functional groups. In total, research can be carried out on more than 600 plots. The experimental communities serve as the basis to study ecosystem fluxes of carbon and nutrients. There are continuous measurements of meteorological variables on all large plots as well as monitoring of important components of the C, N and P-cycle.

In addition to the long-term experiments, a set of new experimental plots (138 plots) was established in late 2010/2011, the so called Trait-Based Biodiversity Experiment (TBE). The aim of the TBE is to establish communities with different plant diversity and representing different levels of functional complementarity. In contrast to previous biodiversity experiments, the TBE combines a non-random species loss scenario with an almost orthogonal manipulation of complementarity. The design aims to advance functional diversity research by directly manipulating functional diversity, thereby considering and separating different types of functional traits (spatial resource acquisition traits and temporal resource acquisition traits). This makes it possible to test whether conse-quences of species loss for a certain function or ecosystem multifunctionality can be predicted from the distribution of species' traits in the community.

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Pictures

1 Overview. ©Jena

2 Field work. ©A. Gockele

RECENT PUBLICATIONS

● Ebeling, A., Pompe, S., Baade, J., Eisenhauer, N., Hillebrand, H., Proulx, R., Roscher, C., Schmid, B., Wirth, C., & Weisser, W. (2014). A trait-based experimental approach to understand the mechanisms underlying biodiversity-ecosystem functioning relationships. **Basic and Applied Ecology**, http://dx.doi.org/10.1016/j.baae.2014.02.003.

● Abbas, M., Klein, A. M., Ebeling, A. Oelmann, Y., Ptacnik, R., Weisser, W.W. & Hillebrand, H. (2014). Plant diversity effects on pollinating and herbivorous insects can be linked to plant stoichiometry. **Basic and Applied Ecology**, http://dx.doi.org/10.1016/j.baae.2014.02.001.

HIES

BEANO (ITALY)

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OPERATING INSTITUTE: Department of Agricultural and Environmental Sciences, University of Udine.

MAIN PURPOSE: Agricultural management and climate change effects on soil C cycle.

ECOSYSTEM TYPE: Agricultural site, maize.

EXPERIMENTAL TREATMENTS: Tillage, fertilisation, rotation, renaturalisation.

FACILITIES: Long term greenhouse gases flux measurement experiment with multiple eddy covariance towers, replicated soil flux automated systems on several agricultural treatments within large (eddy covariance) and small replicated plots (soil and vegetation measurements).
Long term treatments are based on land use changes with reduction of agricultural impacts (low inputs, reduce tillage, rotations and re-naturalisation). Soil carbon dynamics following land use changes (C3 plants) are also assessed with isotopic methods as soil has a strong C4 signal.
Partitioning between fluxes is assessed on air, liquid and solid samples with automatic samplers and mass spectroscopy. Soil N_2O and CH_4 fluxes are also measured continuously using automatic samplers.
New experiments have been carried out at the site in the last three years (*i.e.* warming /cooling experiment; biochar experiment). Several visits within the ExpeER project have been carried out on the biochar plots, aiming to understand biochar impacts on soil biodiversity and biochar stability after application to the soil.

Pictures

1 Automated soil respiration chambers. ©G. Alberti

2 Experimental site after alafalfa harvest. In the background the eddy covariance system is visible. ©G. Alberti

RECENT PUBLICATIONS

● De Simon, G., Alberti G., Delle Vedove, G., Peressotti, A., Zaldei, A., Miglietta, F. (2014) Cropland responses to late winter temperature extreme events: results from a field manipulation experiment in north-eastern Italy. **Biogeoscience**.
● Rees, R. M., Agustin, J., Alberti, G., Ball, B. C., Boeckx, P., Canterel, A., Castaldi, S., Chirinda, N., Chojnicki, B., Giebels, M., Gordon, H., Horvath, L., Juszczak, R., Kasimir Klemedtsson, Å., Klemedtsson, L., Medinets, S., Machon, A., Mapanda, F., Olesen, J., Reay, D., Sanchez, L., Smith, K.A., Sowerby, A., Sommer, M., Soussana, J. F., Stenberg, M., Topp, C. F. E., van Cleemput, O., Vallejo, A., Watson C. A., Wuta, M. (2013) Nitrous oxide emissions from European agriculture, an analysis of variability and drivers of emissions from field experiments. **Biogeosciences**, 10: 2671–2682.
● Poeplau C., Don A. (2013) Sensitivity of soil organic carbon stocks and fractions to different land-use changes across Europe. **Geoderma**, 192: 189–201.

BOLOGNA (ITALY)

OPERATING INSTITUTE: Consiglio Nazionale delle Ricerche (CNR).

MAIN PURPOSE: Biogeochemistry, genomics, ecophysiology, atmospheric chemistry.

FACILITIES: At CNR-IBIMET (Bologna), facilities are available for gas exchange analysis on site and, at the same time, a VOC collection using a portable infrared gas analyser (Li-Cor 6400) equipped with a leaf chamber fluorometer. For VOC analytical analysis different instruments are present: (1) A Gas Chromatography Mass Spectrometry (GC-MS) equipped with a Thermal Desorber; (2) A Proton-Transfer-Reaction Mass Spectrometry (PTR-MS) for outline and online measurements, respectively.
At CNR-IBAF (Porano), a recent upgrade of the IRMS lab makes available three isotope ratio mass spectrometers, holding different prep-systems for solid, liquid and gaseous samples. Isotope ratio measurements involve C, H, N, O and S. Isotope ratio mass spectrometers and prep-systems consist of: (1) GV, Isoprime, in continuous flow with pyroliser EUROVECTOR PyrOH and GILSON Multiprep.; (2) VG Isotech, ISOCHROME II, in continuous flow with elemental analyser Carlo Erba NA1500 and diluter GV, especially dedicated to N, C and S isotope ratio determinations on solid samples; (3) VG Isotech, SIRA 10, dual inlet and continuous flow configurations, coupled with GV Liquiface HPLC interface, especially dedicated to gaseous analyses and chromatographic separations of metabolites for C isotope ratio determinations.
At CNR-IPP (Firenze), a large number of instruments are present in our laboratories: (1) Fluorescence measurements are performed using an inverted epifluorescence microscope equipped with a high-pressure mercury lamp as light source. A high-performance liquid chromatograph combined with a diode array detector (HPLC-DAD), with a refractive index detector and a triple quadrupole mass spectrometer are used to detect and quantify several plant secondary metabolites. (2) A GC-MS and a Thermal Desorber are used to identify and quantify volatile organic compounds (VOCs) and a GC-FI system combined with a flame ionisation detector is used to analyse several compounds that can be vaporised without decomposition. (3) Gas exchange analysis on site coupled with VOC collection using a portable infrared gas analyser (Li-Cor 6400) equipped with a leaf chamber fluorometer. (4) Two portable systems for measuring gas exchange & fluorescence are also available for collecting VOCs. There is also an imaging fluorimeter system (Walz IMAGING-PAM).

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Pictures
1 GC-MS for VOC measurements.
2 Licor 6400 for gas exchange measurements.

RECENT PUBLICATION

● Sæbø, A, Hanslin, H. M., Baraldi, R., Rapparini, F., Gawronska, H., and Gawronski, S. W. Urban Greening Contribute to Better Air Quality; Plant Choices Matter. 2014. **ISHS 2nd Symposium on Woody Ornamentals of the Temperate Zone**.

HIOS

ROMA-LECCETO (ITALY)

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OPERATING INSTITUTE: Consiglio Nazionale delle Ricerche (CNR).

MAIN PURPOSE: Ecosystem response, C and water biogeochemical cycles, ozone and aerosols, productivity.

ECOSYSTEM TYPE: Mediterranean evergreen forest.

EXPERIMENTAL TREATMENTS: Two stations with the same ecosystems under different water availability.

FACILITIES: The Estate of Castelporziano covers 6000ha close to Rome and has macchia and forest ecosystems (holm oak, mixed oaks, stone pine) distributed along the typical sea-inland belt with access to the ground water table.
Work at Castelporziano has focused on biodiversity and conservation as well as carbon, water and biogenic trace gas fluxes. Lecceto is a very typical holm oak coppice located in Tuscany with intense and prolonged droughts, where the impact of climate on ecosystem processes can be studied, with special emphasis on actual and potential carbon-sink capacity. Towers equipped for flux measurements are run all year round at both installations, with stations for meteorological and plant physiological parameters. Manipulation experiments are possible, particularly at Lecceto. Installations are closely connected with local research infrastructures with well equipped laboratories (mass spectrometry, chemistry, gas-exchange) and lodging possibilities close to- or on-site.

Since the beginning of ExpeER, the Castelporziano site of the Rome-Lecceto infrastructure has been improved with the installation of new equipment, in cooperation with Dr. Silvano Fares of the Research Centre for Soil-Plant System studies (RPS) of the Agricultural Research Council (CRA). In particular, the flux tower at the *Quercus ilex* dominated evergreen mixed forest has been impemented with continuous measurements of ozone concentration and fluxes, and below-canopy methane/CO_2 fluxes. Additional meteorological sensors have been installed at the tower, complementing the two long-term meteorological stations installed at the Castelporziano estate.

Pictures
1 Overview. ©CNR
2 Towers for flux measurements. ©CNR

RECENT PUBLICATIONS

● Fares, S., Matteucci, G., Scarascia Mugnozza, G., Morani, A., Calfapietra, C., Salvatori, E., Fusaro, L., Manes, F., Loreto, F. 2013. Testing of models of stomatal ozone fluxes with field measurements in a mixed Mediterranean forest. **Atmospheric Environment**, 67: 242–251.
● Fares, S., Vargas, R., Detto, M., Goldstein, A. H., Karlik, J., Paoletti, E., Vitale, M. 2013; Tropospheric ozone reduces carbon assimilation in trees: Estimates from analysis of continuous flux measurements. **Global Change Biology**, 19 (8): 2427–2443.
● P. C. Stoy, M. Mauder, T. Foken, (...) F. Vaccari, A. Varlagin. (2013) A data-driven analysis of energy balance closure across FLUXNET research sites: The role of landscape scale heterogeneity. **Agricultural and Forest Meteorology** 171–172, 137–152.

TETTO FRATI (ITALY)

OPERATING INSTITUTE: Unito.

MAIN PURPOSE: Agricultural site, organic matter dynamics, N leaching.

ECOSYSTEM TYPE: Arable land, maize-based cropping systems.

EXPERIMENTAL TREATMENTS: Fertilisation, manure, rotation.

FACILITIES: Ecosystem manipulation platform aimed at studying: (1) Soil C and N turnover (balance and effects on plant growth and yield); (2) Mineral & organic (farmyard manure, bovine slurry) fertiliser efficiency; (3) Water and mineral N dynamics through soil; (4) GHGs emissions from soil and microbial diversity in agroecosystems.
A wide range of treatments are compared, as a combination of 6 cropping systems x 9 fertilisation managements of maize-based forage systems. Treatments differ for C and N additions, and replicate real farm operations in 75m² plots, 3 randomised blocks design. It was established in 1992, therefore it is suitable for studying systems at equilibrium. The site has a unique combination of climate and soil in Europe. With its sandy loam and deep calcareous soils, it is representative of the Po Plain.
Facilities are: (1) All standard field equipment for monitoring crop growth and nutritional status; (2) Portable photo-acoustic infrared gas analyser; (3) Equipped chemical lab (LC, HPLC, TOC, CHNS, GC for monitoring gaseous emission, growth chambers for incubation studies and other standard facilities).
Recently, the fertilisation amounts have been updated to adapt to current regulations (amount of N from manures = 170 and 250 kg.ha^{1}). An intensive monitoring of the soil mineral N content at various depths in 22 treatments differing for C and N additions has been started. New and larger closed chambers for GHG measurements are now available.

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Pictures

1 Soil samples waiting to be sieved. ©E. Remogna

2 GHG measurements after maize sowing. ©E. Remogna

RECENT PUBLICATIONS

● Zavattaro, L., Monaco, S., Sacco, D., Grignani, C., 2012. Options to reduce N loss from maize in intensive cropping systems in Northern Italy. **Agriculture, Ecosystems & Environment** 147, 24–35.
● Borda T., Celi L., Zavattaro L., Sacco D., Barberis E., 2011. Effect of agronomic management on risk of suspended solids and phosphorus losses from soil to waters. **J Soils Sediments** 11:440–45.
● Bertora, C., Zavattaro, L., Sacco, D., Monaco, S., Grignani, C., 2009. Soil organic matter dynamics and losses in manured maize-based forage systems. Europ. **J. Agronomy** 30, 177–186.

HIES
HIOS

NEGEV (ISRAEL)

OPERATING INSTITUTE: BGU.

MAIN PURPOSE: Hydro-geo-ecology, ecosystem services, biodiversity, remote sensing, afforestation.

ECOSYSTEM TYPE: Semiarid forest, shrubland, arable land.

EXPERIMENTAL TREATMENTS: Soil management, irrigation, fertilisation, grazing.

FACILITIES: The Northern Negev LTER network in addition to 4 field sites is composed of the following facilities: (1) A hydrological laboratory that provides permanent and portable rain simulators, laser particle size analysers and hydrological instrumentation that monitor *in situ* rainfall, runoff, soil moisture, and sedimentation; (2) A field laboratory that enables investigation of the tradeoffs among water use, carbon sequestration, energy fluxes, and radiation budgets. It also includes a sonic anemometer, as well as instruments for measuring meteorological and soil conditions. The field lab is connected with a stable isotope lab that includes a Gas Source – Isotope Ratio Mass Spectrometer; (3) A remote sensing lab that provides image processing facilities and hyperspectral spectrometers.

Currrently, there are two prevailing methods of afforestation in the semi-arid areas of the northern Negev Desert: (1) Rain Fed Afforestation (RFA) where direct rainfall is the main water resource and planted trees replace the natural growing shrubs; (2) Runoff Harvesting Afforestation (RHA) that spatially integrates natural and human-made systems in order to harvest runoff water from the natural system and concentrate it into water-enriched patches where trees are planted. The study aims to compare the two afforestation systems and also between them and the adjacent natural areas.

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1 Planted forest along the desert fringe. ©BGU

2 Characterising soil surface properties by spectral measurements. ©BGU

RECENT PUBLICATIONS

● Cierniewski, J., Karnieli, A., Kuśnierek, K., Goldberg, A., and Herrmann, I. 2013. Approximating the average daily surface albedo with respect to soil roughness and latitude. **International Journal of Remote Sensing**.

● Maestre T. F., Quero, L. J., Gotelli, J. N., (...) Wang, D., Zaady, E. 2012. Plant Species Richness and Ecosystem Multifunctionality in Global Drylands. **Science** 335: 214–218.

● Sher, Y., Zaady, E., Ronen, Z., Nejidat, A. 2012. Nitrate accumulation in soils of a semi-arid ecosystem following a drought-induced shrub death. **European Journal of Soil Biology** 53: 86–93.

APELSVOLL (NORWAY)

HIES

OPERATING INSTITUTE: Norwegian Institute for Agricultural and Environmental Research, Arable Crops Division.

MAIN PURPOSE: Production, soil properties, soil ecology, water pollution.

ECOSYSTEM TYPE: Agricultural site, cereals, grassland.

EXPERIMENTAL TREATMENTS: Soil management, organic and inorganic fertilisation, crop rotation.

FACILITIES: The ExpeER site is a tile-drained 3.2ha experimental site on loam soil representing the Scandinavian inland climate zone. Six cropping systems, each with 2 replicates, are practiced on twelve 0.18ha blocks, each equipped for volume proportional sampling of drainage discharge and surface runoff. There are three systems with cash-cropping and three systems with both arable and fodder crops (both conventional and organic management).

Studies focus on yields and yield quality; nutrient leaching and runoff losses; food productivity versus environmental impact; pesticide drainage and runoff; economic aspects; nitrogen; phosphorus and potassium balances; soil microbial biomass; insect predators; environmental indices; economic risk assessment; soil structure and earthworm populations; exploring long-term effects of a range of cropping systems on production related properties (*e.g.* yields, yield quality, food productivity, soil physics and chemistry) and on the environment (soil biology, losses of nutrients and pesticides).

The tools for analysing the experimental data are now expanded to include life cycle assessments (LCA), and a first paper using this method has been written.

During 2013, the water measurement facilties were comprehensively changed. The system of measuring the total drainage discharge from each farm (block) as a total, was altered so that discharge and related volume proportional sampling is performed at rotation plot level. There are four rotation plots per farm. This infrastructural change enables higher resolution analyses of water and nutrient dynamics to be made, as each crop in the rotations may be assessed separately.

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Picture

Overview.
©A. Korsaeth

RECENT PUBLICATIONS

● Korsaeth, A. 2012. N, P, and K budgets and changes in selected topsoil nutrients over 10 years in a long-term experiment with conventional and organic crop rotations. **Applied and Environmental Soil Science**:17 pages. doi:10.1155/2012/539582.

● Korsaeth, A. 2008. Relations between nitrogen leaching and food productivity in organic and conventional cropping systems in a long-term field study. **Agriculture, Ecosystems and Environment** 127: 177–188.

HIES
HIOS

BRAILA ISLANDS (ROMANIA)

OPERATING INSTITUTE: : Universitatea din Bucuresti - Centrul de Cercetare in Ecologie Sistemica si Sustenabilitate/ University of Bucharest - Research Centre in Systems Ecology and Sustainability.

MAIN PURPOSE: Biodiversity, biogeochemistry, land use change, ecosystem services, and climate change, management and sustainability.

ECOSYSTEM TYPE: Riparian vegetation, rice fields, agricultural lands and crops, poplar forest, marshland, large rivers.

EXPERIMENTAL TREATMENTS: N and C fertilisation, grassland and forest, random block design. Five blocks are randomly distributed among all suitable substrates within an area of about 20x20m, with at least 2m between blocks. Blocks are repeated 5 times.

FACILITIES: The Braila Islands long term socio-ecological research (LTSER) platform offers a unique combination of ongoing long-term measurements of regional climate, hydrology, nutrients in sediments and water, benthic community structure, aquatic, terrestrial and wetland vegetation structure and productivity, and aquatic birds community structure, coupled with more recent developments in monitoring sensors and research infrastructure. The platform is composed of: (1) One research facility located in the city of Braila equipped with the necessary communication and transport facilities for the field work; (2) A series of field and research monitoring stations (sampling points) covering the spatial heterogeneity of the LTSER platform in terms of habitat types (terrestrial, *i.e.* farms, grasslands and forests, aquatic, *i.e.* shallow lakes and the Danube river, and marshes); (3) One complex intensive monitoring and research station (equipped with meteo and hydrological sensors for real time measurements and other equipment for research activities as well as with portable equipment for long term CO_2 soil measurement (LICOR); (4) One complete automated real time measurements hydrological station (for ground water analysis - including depth wells); (5) A research vessel hosting up to 6 researchers and equipped with the necessary instruments for both sample collection as well as primary analysis of different samples, field equipment including automatic analyser for algae classes, YSI for real time water analysis (for pH, conductivity, dissolved oxygen, nutrients); (6) A laboratory located in Bucharest and used for complex analysis such as DOC (Dissolved organic Carbon), CHNS analyser, automatic analyser for nutrients, heavy metals using atomic spectrophotometers. The Bucharest facility also includes a complete GIS and modelling laboratory equipped with software for integrated analysis of the results.

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Picture

Field activities.
©M. Bujor

RECENT PUBLICATIONS

● Vadineanu, A., 2009, Deterioration and Rehabilitation of the Lower Danube Wetlands System, in Maltby et al. (Eds.) **The Wetlands Handbook**, Maltby, E. (Ed.) Blackwell Publishing Ltd, 876–907.

● Vaidianu, M. N., Adamescu, M. C., M. Wildenberg, C. Tetelea, 2014. Understanding Public Participation and Perceptions of Stakeholders for a Better Management in Danube Delta Biosphere Reserve (Romania), Fuzzy Cognitive Maps for Applied Sciences and Engineering Intelligent Systems Reference Library Springer Volume 54, 2014, 355–374. http://dx.doi.org/10.1007/978-3-642-39739-4_19

FRUŠKA GORA (SERBIA)

OPERATING INSTITUTE: University of Novi Sad (UNS).

MAIN PURPOSE: Changes in ecosystem structure, biodiversity and function.

ECOSYSTEM TYPE: Forest, grassland, shrubland.

EXPERIMENTAL TREATMENTS: air pollution, climate change, land use changes.

FACILITIES: Fruška gora (34771ha) is a National park. Its geological substrate is loess, marl, clay, sands, serpentine, limestone and flysch. This site was founded to explore climate change and air pollution impacts on forests, land use changes (primarily in forest ecosystems), the structure and function of forest ecosystems and its biodiversity and the structure and function of steppe habitats. It includes three research localities within the National Park. Multidisciplinary research will be strenghtened by the application of ICT (Information and communication technologies) concepts, methods and tools in ecology, forestry and agriculture. Infrastructure for monitoring of forest ecosystems on Mt. Fruška gora follows the best European practices currently incorporated inside the framework of the International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forest operating under the UNECE Convention on Long-range Transboundary Air Pollution.

The infrastructure is composed of: (1) Environmental wireless sensor network offering on-line internet access to data, based on state-of-the-art communications technology. Apart from real-time access to data, the system provides easy 2D and 3D visualisation of data of interest across multiple years; (2) Laboratory for pedoecology and molecular laboratory; (3) Laboratory for ecosystem monitoring.

The infrastructure is a part of a network of 7 sites for monitoring forest ecosystems in Serbia focused on climate change and air pollution impacts on forests, as well as a part of the Fruška gora LTER site.

Since joining ExpeER, Fruška gora has been included in the national interdisciplinary project "Biosensing Technologies and Global System for Long-Term Research and Integrated Management of Ecosystems" funded by the Ministry of Education, Science and Technological Development, encompassing quantification of main ExpeER parameters.

Due to national project involvement, Fruška gora site has been additionally equipped with a Spectral Camera (HS-CL-30-V10E Cased Version with shutter), ElvaX- X ray (EDXRF) fluorescence spectrometer, Alpha-GUARD for continuous radon monitoring, Infrared CO_2/H_2O analyser, D-T neutron generator, and a portable germanium detector with lead shielding for *in situ* measurement.

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Picture

Collecting adult hoverflies, Beočin. ©A. Ricarte

RECENT PUBLICATIONS

● Trifunov, S., Krašić, D., Markov, Z., Mudri-Stojnić, S., Butorac, B., and A. Vujić (2013). Forest changes due to human activities in National park "Fruška gora" (Serbia) – Ecological and Economic Signals. **Archives of Biological Sciences**, vol 65 (2).

● Štajner, D., Orlović, S., Popović, B. M., Kebert, M., Stojnić, S. and B. Klašnja (2013). Chemical Parameters of Oxidative Stress Adaptability in Beech. **Journal of Chemistry**, Volume 2013, Article ID 592695, 8 pages.

HIOS

TATRA WINDSTORM (SLOVAKIA)

OPERATING INSTITUTE: Research Station and Museum of Tatra National Park.

MAIN PURPOSE: Long term ecological changes, biodiversity.

ECOSYSTEM TYPE: Spruce forest.

EXPERIMENTAL TREATMENTS: Ecological status under changing environmental conditions, natural *versus* traditional forestry.

FACILITIES: After a heavy windstorm in 2004, more than 12 000ha of mostly natural and seminatural Norway spruce forest was blown down in the Tatra National Park. In 2005, the international scientific community began joint research on ecological consequences and erected 3 eddy covariance towers for carbon balance studies. Despite the fact that eddy towers were dismantled in 2007, research activities still continue. Global and net radiation, vertical profile of air tempe-rature and humidity, wind, rain amount and chemistry, soil moisture and temperature, heat and CO_2 fluxes are still measured on former eddy sites. Physical and chemical parameters support biodiversity monitoring (flora, insect, small mammals) based on terrestrial and aerial methods. A unique feature is parallel comparable observation of mountain forest ecosystem parameters and behaviour on large scale windfall sites with contrasting management (traditional forestry *vs.* natural devices only). Participation in the ExpeER consortium led to development of the site: new sensors (soil heat flux, soil moistue, temperature, soil) and instruments (soil CO_2 efflux, ground vegetation NEE) were installed. The original four research and monitoring sites (1. disturbed by wind and managed, 2. disturbed by fire and managed, 3. disturbed by wind and unmanaged, 4. undisturbed, reference) were enlarged by the fifth site – forest killed by insects, which have killed almost 7000ha of mostly natural spruce forest in National Park. The new site is located in the core zone of the National Park, so it remains unmanaged. As welle as continuous micrometeorology, soil respiration is intensively monitored using manual chamber method. An automatic soil CO_2 chamber has been tested at the site. Weather data are used for online calculation of fire index (Angstrom), available for visitors and Park staff *via* internet.

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Pictures

1 Larch spruce forest suffered from widthrow and bark beetle outbreak. ©P. Fleischer

2 Soil fluxes in reference forest. ©P. Fleischer

RECENT PUBLICATIONS

● Lóšková, J., Ľuptáčik, P., Miklisová, D., Kováč, Ľ., 2013: The effect of clear-cutting and wildfire on soil Oribatida (Acari) in windthrown stands of the High Tatra Mountains (Slovakia). **European Journal of Soil Biology** 55 (2013) 131–138.
● Don, A., Bärwolf, M., Kalbitz, K., Andruschkewitsch, R., Jungkunst, H.F., Schulze, E.D., 2012: No rapid soil carbon loss after a winthrow event in the High Tatra. **Forest Ecology and Management** 276 (2012) 239–246.

DOÑANA (SPAIN)

OPERATING INSTITUTE: ICTS-Doñana.

MAIN PURPOSE: Climate and land use change, biodiversity, water quality, ecology.

ECOSYSTEM TYPE: Shrubland, woodland, riparian zones, rice fields, marshland, lagoons, rivers, shoreline, dunes.

EXPERIMENTAL TREATMENTS: Ecological restoration of wetlands under different physical conditions.

FACILITIES: The setup and implementation of the infrastructure was driven by 2 major goals: (1) To supply communication infrastructure and technological equipment to the Doñana Natural Space in order to improve and standardize the existing long term ecological monitoring programme granting data quality and access; (2) Offer to the European scientific community open access to the Doñana infrastructure in order to increase the knowledge on Doñana ecosystems and species, as a reference for global change processes.

The integrated monitoring program includes more than 80 standardised and scientifically supervised methodological protocols (for many of these, data have been collected since the early seventies) producing up-to-date results on biodiversity status and trends in natural processes. Doñana's many major ecosystems, including, shoreline, dunar system, marshlands, river estuary, aquifer lagoons and Mediterranean shrublands and wood-lands are fully covered by both traditional manual, automatic monitoring protocols and devices.

During the period 2011-2013, the Doñana HIOS enlarged its infrastructure by incorporating 2 new eddy covariance towers in 2 different ecosystems, on marshlands and on *Erica scoparia* shrublands. Additional instruments on the *Erica shrublands* tower measure environmental parameters such as radiation and soil moisture. Also, 2 new airborne hyperspectral campaigns were carried out, funded by the HYDRA Research Project (MICINN CGL2009-09801). Such campaigns collect aerial images of the whole Doñana Natural Space (100 000ha) with CASI and AHS hyperspectral sensors covering the full optical and thermal spectral range. The Instituto Nacional de Técnica Aeroespacial (INTA) performed the airborne campaigns and the geometric correction of the images. Hyperspectral images like these allow us to map the distribution of alien species such as the aquatic fern *Azolla filiculoides*, or to map the distribution of plant communities, including aquatic plants. In the last one, an experiment was carried out on artificial targets to test radiometric performance of both sensors over the different Doñana land covers.

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Picture

The eddy covariance tower set up in the Doñana marshlands. ©ICTS-Doñana

RECENT PUBLICATIONS

● Pugnetti, A., Mirtl, M. and Díaz-Delgado, R. 2012. Harmonious methods. **International Innovation** 13:12–14.

● Díaz-Delgado, R., Ameztoy, I., Cristobal, J. & Bustamante, J. (2010a) Long time series of Landsat images to reconstruct river surface temperature and turbidity regimes of Guadalquivir estuary. Proceedings of the 2010 IEEE International Geoscience & Remote Sensing Symposium on Remote Sensing (IGARSS2010) **Geosciences and Remote Sensing Society**.

HIOS

DAVOS SEEHORNWALD (SWITZERLAND)

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Note
In 2006, the Davos Seehorn-wald research site was incorporated into the Swiss LWF Long-Term Forest Ecology Research program of WSL and equipped according to the guide lines for intensive monitoring sites of the UN/ECE ICP Forests network.

Pictures
1 Eddy covariance tower within a sub-alpine spruce forest.
2 Maintenance of lysimeter for chemical analyses of soil water.

OPERATING INSTITUTE: Swiss Federal Research Institute WSL Birmensdorf & Institute of Agricultural Sciences, ETH Zurich.

MAIN PURPOSE: Water cycle, carbon cycle, climate.

ECOSYSTEM TYPE: Subalpine spruce forest.

EXPERIMENTAL TREATMENTS: System- and process- oriented observations of biogeochmical cycles and forest growth.

FACILITIES: This site offers a unique combination of ongoing long-term measurements of regional climate (since 1876), CO_2 and H_2O fluxes as well as microclimate profiles through the forest including soil climate and water status (since 1996), tree physiological records such as sap flow and continuous stem radius changes (since 1997), turbulent fluxes of CO_2 and H_2O by eddy covariance (since 1996), continuous atmospheric NO, NO_2 and O_3 concentrations (since 1991), and multiple properties of the vegetation (*e.g.* crown transparency, litterfall) and soil structure (since 2004). Additionally, continuous gas-exchange of twigs was measured under ambient and increased CO_2 concentrations from 1997 to 2005. The very long continuous track record of most measurements makes this research site to an ideal location for investigations about (missing) links between climate change and tree physiological adaptations. It is also well suited to addressing questions about the ecosystem carbon balance in relation to soil related components and tree physiological processes (under changing environmental conditions). Davos is an ecosystem-level research site in the ICOS Research Infrastructure project, with funding for at least two years. Continuous soil respiration measurements are being conducted during the plant growing season and complement the above-ground measurements. A snow height sensor was added in winter 2012/2013. It is moved along a horizontal track to cover the spatial variability in below-canopy snow cover. A StarDot Net-Cam was added to take a picture of the singular forest in the northeast of the eddy flux tower.

RECENT PUBLICATIONS

● Etzold, S., Zweifel, R., Rühr, N., Eugster, W., Buchmann, N. (2013) Long-term stem CO2 concentration measurements in Norway spruce in relation to biotic and abiotic factors. **New Phytologist** 197:1171-1184. DOI: 10.1111/nph.12115.
● Sidorova, O.V., Eugster, W., Etzold, S., Cherubini, P., Zielis, S., Saurer, M., Siegwolf, R., Buchmann, N (2013) Increasing relevance of spring temperatures for Norway spruce trees in Davos, Switzerland, after the 1950s. **Trees**.
● Churakova, O.V. (Sidorova), Eugster, W., Etzold, S., Cherubini, P., Zielis, S., Saurer, M., Siegwolf, R., Buchmann, N (2014) Increasing relevance of spring temperatures for Norway spruce trees in Davos, Switzerland, after the 1950s. **Trees** 28: 183–191.

THERWIL (SWITZERLAND)

OPERATING INSTITUTE: Forschungsinstitut für biologischen Landbau, FiBL and Eidgenössisches Volkswirtschaftsdepartement (Agroscope Reckenholz-Tänikon Research Station) (EDV-ART).

MAIN PURPOSE: Sustainable food production and ecosystem services.

ECOSYSTEM TYPE: Agricultural site, rotation.

EXPERIMENTAL TREATMENTS: Fertilisation and crop protection in conventional and organic agricultural systems.

FACILITIES: The DOK experiment compares two organic and two conventional farming systems in a seven-year ley rotation on a loess soil. It was established in 1978 in 1978 in Therwil (Basel-Land) in the vicinity of Basel (Switzerland). Systems differ in terms of fertilisation and plant protection. The experiment is designed as a split plot with 4 replicates and a plot size of 5x20m, and comprises 96 plots in total. Data on yields, soil and plant assessments are stored in a data base. Plant and soil archive samples over 35 years are also available. Biogeochemical processes of N, C, and P are studied as well as plant-microbe interactions. The site has been equipped with chambers to study trace gases (CO_2, N_2O, CH_4) in the next three years.

Quite recently, the DOK trial was upgraded by a GC system to measure greenhouse gases (GHG), which were sampled by the closed chamber technique. Since August 2012, soil-derived greenhouse gases (GHG) have been measured regularly for a time span of three years in conventional and organic farming systems in the DOK long-term field trial. For this, the closed chamber technique is applied to collect gas samples which are further measured for their concentrations using a GC system (Agilent Technologies, Santa Clara, California/USA) equipped with a CTC-Gerstel multi-purpose auto-sampler (Gerstel, Mühlheim/Ruhr, Germany). This device enables high-through-put analyses of the greenhouse gases CO_2, N_2O and CH_4 within four minutes in a broad array of vials differing in size. Furthermore, the freely programmable CTC-Gerstel auto-sampler device eases the generation of sample aliquots for stable isotope analyses of the above-named gases through the implementation of so-called prep sequences. The CTC-Gerstel auto-sampler also facili-tates the continuous measurement of GHG in the head space of laboratory incubations and therefore enables in-depth studies of phenomena observed in the field. Until now, the GHG fluxes were determined in a grass-clover/maize sequence and during the cropping of winter wheat in organic and conventional farming systems of the DOK trial.

The field research is accompanied by the conduction of global meta-analyses on soil carbon development and GHG fluxes in soils under organic and non-organic management (Gattinger *et al*., 2012; Skinner *et al*., 2014).

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Picture

Greenhouse gas sampling from closed chambers. ©FiBL

RECENT PUBLICATIONS

● Gattinger, A., Muller, A., Haeni, M., Skinner, C., Fliessbach, A., Buchmann, N., Mäder, P., Stolze, M., Smith, P., Scialabba, N., Niggli, U. (2012): Enhanced top soil carbon stocks under organic farming. **Proceedings of the National Academy of Science**, 109: 18226–18231.

● Skinner, C., Gattinger, A., Muller, A., Mäder, P., Fließbach, A., Stolze, M., Ruser, R., Niggli, U., 2014: Greenhouse gas fluxes from agricultural soils under organic and non-organic management - A global meta-analysis. **Science of the Total Environment**, 553–563.

HIOS

MOOR HOUSE (UK)

OPERATING INSTITUTE: NERC-Centre for Ecology & Hydrology.

MAIN PURPOSE: Ecological research, climate, air pollution, land use, biodiversity.

ECOSYSTEM TYPE: Grazed moorland.

EXPERIMENTAL TREATMENTS: Sheep grazing, moorland burning.

FACILITIES: Moor House is an upland moorland site on an extensive area of blanket peat bog. It has a long history of research and is currently a focal point for research concerning carbon fluxes in peat soils, water and vegetation. It is also a long-term monitoring and research (LTER) site, part of the UK Environmental Change Network. A wide range of long-term measurements are made at the site. Facilities include a fully automated meteorological station (and a back-up manual weather station). The infrastructure provides a platform for a range of experiments (currently primarily concerning carbon fluxes) that are supported by continuous monitoring of climate (hourly), atmospheric deposition chemistry (weekly), soil solution chemistry (2 weekly), soil bulk chemistry (5 yearly) river chemistry (weekly) and associated flow (hourly), in addition to the annual monitoring of vegetation and more frequent measurement of a range of other biological variables. Measurements follow clear protocols, also carried out at 11 other UK Environmental Change Network sites situated in a range of habitats across the UK that could also provide supporting data.

In addition to the continuing long-term monitoring and research, recent developments include an experimental investigation into the suitability of plastic matting as a surface for moorland tracks (lead by Natural England & Leeds University). The restoration of 20ha of eroded peatland began in 2013 (lead by the North Pennines AONB Partnership).

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Picture

Overview.
©Environmental Change Network

RECENT PUBLICATIONS

● Lee, H., Alday, J. G., Rose, R. J., O'Reilly, J. & Marrs R. H. 2013. Long-term effects of rotational prescribed burning and low-intensity sheep grazing on blanket-bog plant communities. **Journal of Applied Ecology** doi: 10.1111/1365-2664.12078.

● Van Winden, J. F., Reichart, G., McNamara, N. P., Benthien, A. & Sinninghe Damste, J. S. 2012. Temperature-Induced Increase in Methane Release from Peat Bogs: A Mesocosm Experiment. **PLoS ONE** 7(6): e39614. doi:10.1371/journal.pone.0039614.

● Ward, S. E., Ostle, N. J., Oakley, S., Quirk, H., Stott, A., Henrys, P. A., Scott, W. A. & Bardgett, R. D. 2012. Fire Accelerates Assimilation and Transfer of Photosynthetic Carbon from Plants to Soil Microbes in a Northern Peatland. **Ecosystems**, DOI: 10.1007/s10021-012-9581-8.

*no longer available for Transnational Access

HIOS

PLYNLIMON (UK)

OPERATING INSTITUTE: NERC Centre for Ecology & Hydrology.

MAIN PURPOSE: Hydrology and hydrochemistry.

ECOSYSTEM TYPE: Grassland, spruce forest.

EXPERIMENTAL TREATMENTS: Paired catchment experiment investigating effects of plantation forestry on hydrology and hydrochemistry.

FACILITIES: This infrastructure consists of 10 instrumented research catchments representing different land use options on the same geological parent material. The infrastructure records high temporal resolution river flow and meteorological data (40 years data record) and fortnightly stream water and precipitation chemistry for cations, anions, trace metals, nutrients, pH and alkalinity (30 year data record) and some data for suspended sediment. The site has an extensive spatial data library including topography, DTM, soils, geology and vegetation/land-use available open access through the Environmental Information Data Centre.
Recent developments at the site include the ingestion of data into the Environmental Information Data Centre, one of NERC's designated data centres and the issuing of Dols for two major datasets from the Plynlimon work: (1) Plynlimon research catchment hydrochemistry (this dataset includes rainfall, cloud, river and stream hydro-chemistry of the Plynlimon research catchments); (2) Plynlimon research catchment high-frequency hydrochemistry data (this dataset includes rainfall, river and stream hydro-chemistry data from the River Hafren, Severn). It represents high-frequency (7 hourly) monitoring of stream hydrochemistry at both the Lower and Upper Hafren site from 2007-2009.

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Note

Plynlimon is part of DURESS (Diversity of Upland Rivers for Ecosystem Service Sustainability) and EU-SOIL TREC (Soil Transformations in European Catchments) in acting as a satellite "Critical Zone" observatory site.

Pictures

1 Overview of the grassland catchment.

2 Automated weather station with forest catchment in background.

RECENT PUBLICATIONS

● Neal, C., Reynolds, B., Rowland, P., Norris, D., Kirchner, J. W., Neal, M., Sleep, D., Lawlor, A., Woods, C., Thacker, S., Guyatt, H., Vincent, C., Hockenhull, K., Wickham, H., Harman, S., Armstrong, L. 2012 High-frequency water quality time series in precipitation and streamflow: from fragmentary signals to scientific challenge. **Science of the Total Environment**, 434. 3–12. 10.1016/j.scitotenv.2011.10.072.
● Rowland, A. P., Neal, C., Reynolds, B., Neal, M., Lawlor, A. J., Sleep, D.. 2012 Manganese in the upper Severn mid-Wales. **Journal of Environmental Monitoring**, 14 (1). 155-164. 10.1039/c1em10651a.
● Kirchner, J. W., Feng, X., Neal, C., 2000. Fractal stream chemistry and its implications for contaminant transport in catchments. **Nature** 403, 524–527.

HIES
HIOS

ROTHAMSTED (UK)

OPERATING INSTITUTE: Rothamsted Research, Harpenden, Herts.

MAIN PURPOSE: Sustainable food production and ecosystem services.

ECOSYSTEM TYPE: Arable land, grassland, wild woodland.

EXPERIMENTAL TREATMENTS: Manures and fertiliSer use, land management.

FACILITIES: The Rothamsted Long-term Experiments (LTEs) include sixteen field experiments. The Broadbalk Wheat Experiment and the Park Grass Continuous Hay Experiment are two of the most widely known. They were established in 1843 and 1856 respectively. Many of the Rothamsted LTEs were established to examine the effects of different manures and fertilisers on crop production, but have since become of increasing value for environmental and ecological research. In addition, the Rothamsted Sample Archive houses about 250 000 plant and soil samples and long-term data sets are kept in the Electronic Rothamsted Archive (eRA).
Recently, the Park Grass experiment has been identified as a Genomics Observatory because it is a site with a rich history of environmental/ecological data collection and a long-term commitment to future studies. Genomic observatories are being established to take the planet's "biological pulse". DNA sequences are becoming core components of Earth-monitoring systems, and data output is soaring from genomics and other observing technologies, but sequence data alone are of limited value without the context of time and location. The Park Grass soil metagenome from the untreated control plot 3d is now publically available.

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More information on Rothamsted sample archive website:
www.rothamsted.ac.uk
Metagenome website:
www.genomenviron.org

Pictures

1 The Broadbalk Wheat Experiment. ©Rothamsted Research.
2 Rothamsted biodiversity. ©Rothamsted Research.

RECENT PUBLICATIONS

● Clark, I. M., Buchkina, N., Jhurreea, D., Goulding, K. W. T. and Hirsch, P. R. (2012) "Impacts of nitrogen application rates on the activity and diversity of denitrifying bacteria in the Broadbalk Wheat Experiment", **Philosophical Transactions of the Royal Society B-Biological Sciences**, 367, (1593), 1235–1244.
● Delmont, T. O., Prestat, E., Keegan, K. P., Faubladier, M., Robe, P., Clark, I. M., Pelletier, E., Hirsch, P. R., Meyer, F., Gilbert, J. A., Paslier, D. L., Simonet, P. and Vogel, T. M. (2012) "Structure, fluctuation and magnitude of a natural grassland soil metagenome", **ISME Journal**, 6, (9): 1677–1687.
● Freeland, J. R., Biss, P. and Silvertown, J. (2012) "Contrasting Patterns of Pollen and Seed Flow Influence the Spatial Genetic Structure of Sweet Vernal Grass (Anthoxanthum odoratum) Populations", **Journal of Heredity**, 103, (1): 28–35.

WHIM (UK)

OPERATING INSTITUTE: NERC Centre for Ecology & Hydrology.

MAIN PURPOSE: Peatland flora, chemistry and processes.

ECOSYSTEM TYPE: Ombrotrophic bog.

EXPERIMENTAL TREATMENTS: Wet and dry N deposition.

FACILITIES: Whim bog offers a globally unique comparison of how the main N forms affect semi-natural vegetation, with meteorological data and treatment history since 2002. A quantified ammonia concentration/deposition gradient, is provided, plus a wet deposition system, comparing oxidised ($NaNO_3$) and reduced N (NH_4Cl), where treatments are meteorology dependent. *ie.* wind direction and rainfall frequency define the treatment exposure (~120 events y-1). There are four large (13m²) wet plots (4). Opportunities exist to evaluate a whole range of ecosystem services from conservation to carbon sequestration, GHG emissions and water chemistry in addition to understanding how changes in vegetation affect the delivery of these services.

In 2012, a LICOR system was installed for continuous methane and CO_2 monitoring. This system has also been used for real time C flux monitoring on the plots. Flux data from the low N deposition plots have been collected, as well as CN data for soil and various species. Burial of t bags has allowed us to assess conditions for decomposition and see how N form and dose affects water soluble phenol in these materials. Measurement of DOC and DON in soil water collected in dipwells have also been resumed.

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Picture

Overview. ©NERC

RECENT PUBLICATIONS

● Sheppard, L. J., Leith, I. D., Mizunuma, T., Cape J. N., Crossley, A., Leeson, S., Sutton, M. A., Van Dijk, N., Fowler, D. (2011). Dry deposition of ammonia gas drives species change faster than wet deposition of ammonium ions: evidence from a long-term field manipulation. **Global Change Biology** 17, 3589-3607.

● Sheppard, L. J., Leith I. D., Mizunuma, T., Van Dijk, N., Cape, J. N., Sutton, M. A., (2011). All forms of reactive nitrogen deposition to Natura 2000 sites should not be treated equally: effects of wet versus dry and reduced versus oxidised nitrogen deposition. In Nitrogen Deposition and Natura 2000: Science & practice in determining environmental impacts Eds Hicks WK, Whitfield CP, Bealey WJ, Sutton MA. **COST office** 2011, 181-189.

● Currey, P. M., Johnson, D., Dawson, L., Van der Wal, R., Thornton, B., Sheppard, L., Leith, I., Artz RRE (2011). Five years of simulated atmospheric nitrogen deposition have only subtle effects on the fate of newly synthesized carbon in *Calluna vulgaris* and *Eriophorum vaginatum*. **Soil Biology and Biochemistry** 43, 495-502.

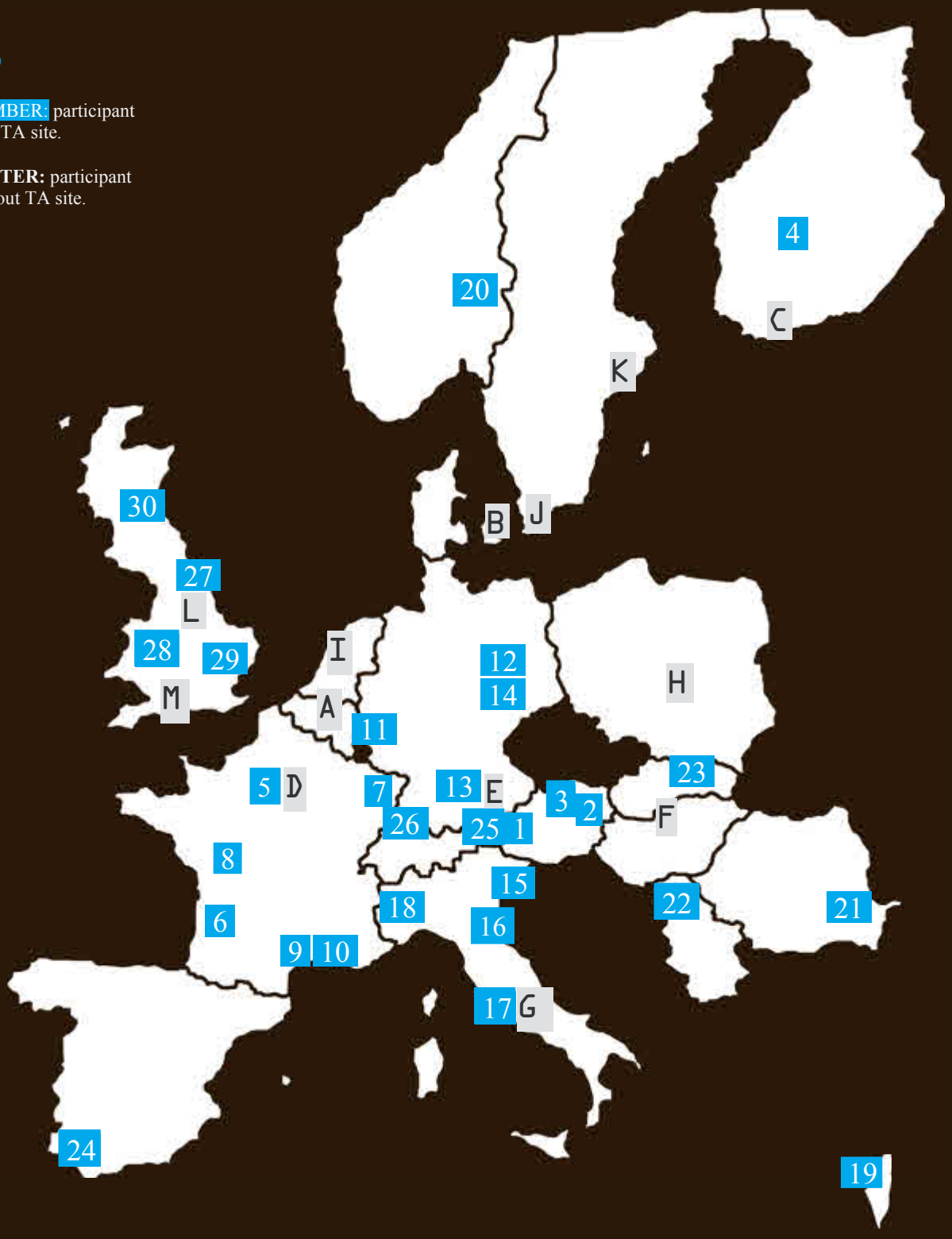
ExpeER PARTICIPANTS

ExpeER COMPRISES 35 RESEARCH INSTITUTES AND UNIVERSITIES FROM 19 COUNTRIES ACROSS EUROPE.

Map

NUMBER: participant with TA site.

LETTER: participant without TA site.



More information on www.expeeronline.eu

Note

HIES: Highly Instrumented Experimental Site.

HIOS: Highly Instrumented Obsevational Site.

ExpeER (Experimentation in Ecosytem Research) brings together existing highly instrumented European infrastructures in the field of ecosystem research to improve their research capacity and to encourage their wider use, in particular through transnational access to various types of facilities.

Experimentation in Ecosystem Research

For more information: www.expeeronline.eu

ExpeER
Ecosystem Research

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

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