BOOK OF ABSTRACTS

ILTER 2nd OSM 2019 –
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Keynotes
Drivers of change in tropical protected areas: long-term monitoring of a Brazilian biodiversity hotspot

Mercedes Bustamante
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Protected areas are the most common and most important strategy for biodiversity conservation. The majority of protected areas are designed to represent and protect specific natural ecosystems and, communities. However, global climate change is leading to a changing relationship between the shifting ranges of plant and animal species, and the fixed boundaries of protected areas. Additionally, recent studies indicated that a significant number of protected areas are under intense pressure from human encroachment. Protected areas may be some of the most sensitive regions as they are often small isolated fragments surrounded by degraded or developed landscapes, and contain rare or unique species and communities with narrow environmental tolerances.

Brazil, a megadiverse country, has two biomes - Cerrado and Atlantic Forest - characterized as hotspots for the conservation of biodiversity due to the high species richness and the high degree of endemism with a marked loss of habitats. The efficiency of protected areas for biodiversity protection and, good conservation planning depend not only on management and protection actions but also on the long-term monitoring of different drivers of change. The expansion of protected areas in Brazil is a great challenge, but currently, the maintenance and correct management of existing areas is a huge task. We will present the Brazilian Long-term Ecological Research Program and then focus on an initiative to monitor long-term changes in a Cerrado protected area. The monitoring involves terrestrial and aquatic ecosystems and is intended to provide early signs of unforeseen changes and to contribute to understanding the effects of potential impacts (defaunation, noise and luminous pollution, eutrophication and biological invasions, extreme events) on biodiversity.
Global Dryland Ecosystem Programme

BOJIE FU
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Drylands occupy about 41% of Earth’s land area and are home to more than 2 billion people. They are also among the most sensitive and fragile ecosystems on the Earth’s surface. Impacts caused by climate change and human interventions simultaneously are felt well on ecosystems and people in and even beyond drylands. Through an integrative approach of biogeochemistry, ecology and sociology, future efforts should explore the links between these impacts and the provisioning of services for human livelihoods in drylands. Such efforts will enhance the monitoring, assessment and management of global dryland ecosystems and be significant for promoting the delivery of Sustainable Development Goals in dryland regions, especially in those developing countries.

The Global Dryland Ecosystem Programme (Global-DEP) is an international cooperation initiative. It aims to provide a platform for global research collaboration on dryland ecosystem with its Science Plan that defines key scientific issues and priority areas for future research. It is also highly expected to engage global researchers, practitioners, and policy makers in developing an Action Plan that secures funding for programme implementation.

To define research priorities in the Science Plan, information and knowledge will be integrated under four major themes in accordance with the ecosystem service cascade model, which are: i) dynamics of global dryland ecosystems and their driving mechanisms, ii) changes in the structure and functions of global dryland ecosystems and their effects, iii) changes in the services of global dryland ecosystems and their linkages with human well-being, and iv) dryland ecosystem management and sustainable livelihoods. Finally, research on global dryland ecosystems will be synthesized through conducting meta-analysis of case studies in typical dryland regions around the world to identify their common features and regional differences.
The significance of continuous comprehensive observations:
From atmospheric clustering via feedback loops to global climate and air quality

Markku Kulmala, Jaana Bäck, Tuukka Petäjä, Joni Kujansuu, Timo Vesala, and Hanna K. Lappalainen

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Currently the observations are typically fragmented into 1) greenhouse gases; 2) aerosols; 3) air quality; 4) trace gases; 5) ecosystems; 6) climate; 7) ... And the different scientific communities typically do not collaborate or even communicate with each other - although these kind of barriers do not exist in nature. However, in order to produce reliable data and in-depth understanding we need integrated approach to be able to answer global grand challenges like climate change, air quality, water and food supply. The integrated approach is also effective in impact and economy point of view. Therefore, we have developed a SMEAR (Stations for Measuring Earth surface Atmosphere relations) concept.

During the past ten years, the SMEAR II station (in Hyytiälä, Finland) has contributed to several Pan-European research infrastructure that are currently in the ESFRI Roadmap, such as ICOS (Integrated Carbon Observation System), ACTRIS (Aerosols, Clouds, and Trace gases Research Infrastructure), AnaEE (Infrastructure for Analysis and Experimentation on Ecosystems), and eLTER (Integrated European Long-term Ecosystem, critical zone and socio-ecological system Research Infrastructure). SMEAR has provided high-quality data, trans-national access, and contributed to the development of advanced technologies in many research fields. Due to its comprehensive concept, SMEAR is capable for providing data also to several global Earth Observation systems and networks, such as to WMO GAW, GEO-GEOSS, FluxNet, AERONET and SolRad-Net.

There are several benefits that can be gained (and has been already obtained) by the integration of scientific domains and co-location of diversity of methodologies and measurements (comprehensiveness). The most important impact of the integration and co-location is on the scientific results like quantification of feedback loops, understanding biogeochemical cycles (including water and carbon cycles) in details, understanding gas-to-particle conversion in quantified way and understanding interlinks of several processes. Actually it seems that the key in very many feedback loops and in biogeochemical cycles is what happened in molecular and cluster level (size range < 1nm – 3nm).

The information from different environments all around the globe is crucial besides scientists and scientific communities also for policymakers and other stakeholders. There are also side benefits like the same staff can be utilized with several infrastructures simultaneously due to co-location. On the other hand also the scale and opportunities for training new generation of scientists to use big data provided by SMEAR stations is important.

Using SMEAR concept globally enables us to perform global feedback loop analysis, find out new interactions, feedbacks and processes and collect new big data for future use to answer questions, which we even cannot foresee yet.
Fostering sustainability transformations through place-based social-ecological research

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Leuphana University of Lüneburg, Faculty of Sustainability

Sustainability science seeks to advance the understanding of social-ecological (or human-environment) to facilitate the design and implementation of interventions that foster sustainability transformations. One of the main challenges of social-ecological systems research is to unravel which interventions in the system can bring substantial transformative change towards sustainability. Previous research has specifically identified those interventions that have exceptional potential to yield truly transformative change towards sustainability: (1) influence of value systems on human-nature relations, (2) co-production of knowledge, including indigenous and local knowledge systems, and (3) re-structuring institutional systems. Based on empirical evidence, I will shed light on how transdisciplinary socio-ecological research can contribute to unravel which interventions in the value systems, knowledge and institutions are able to foster sustainability.
Changes in plant-pollinator interactions and consequences for plants using distributed networks

Tiffany Knight
Helmholtz Centre for Enmental Research - UFZ / German Centre for Integrative Biodiversity Research (iDiv)

Nearly 90% of flowering plants rely on animal pollinators for reproduction, and as a consequence, angiosperm biodiversity relies on stable mutualisms between plants and pollinator. As the world’s human population has grown, native vegetation has been converted to intensively human-managed and urbanized landscapes that, along with increased use of pesticides, have demonstrably reduced pollinator abundance and diversity across various taxonomic groups even in natural areas. Through global meta-analysis, we address how the structure of plant-pollinator interactions has changed across natural and anthropogenic gradients and the consequences for plant reproduction. While this yields many interesting patterns, some questions are difficult to address due to data gaps (e.g., poor sampling in key geographic locations), and differences across studies in spatial grain and sampling methodology. I discuss the need and utility for distributed observations and experiments to address these knowledge gaps.
Long term ecological research is by definition slow, and necessarily so. But the answers it promises to provide are needed right away, as we witness the accelerating degradation of ecosystems worldwide. How can the scientific community respond to this paradox? The response which effectively says “don’t bother me, I am busy doing important work in my lab” simply does not meet the needs of the time. Here are some thoughts about how we can do better.

Data archaeology and historical ecology can both extend the time window of observations to the point where we have more confidence in our science. This includes the possibility of recovering proxies from ‘deep time’, in other words paleoecology, but more typically may need to extend the record only a few decades, using the techniques of environmental historians or cold-case forensic scientists. Sometimes it just depends on the digitisation of paper records, before they get lost.

Space-for-time substitutions have long been a staple technique for ecological researchers. If you don’t have an experiment running for the prerequisite period at your location, maybe there is a comparable set of locations where you can build a chronosequence? A willingness to make provisional findings would help. Researchers are famous for their reluctance to say anything until they are absolutely sure. This is a worthy attribute, when the consequences of getting things wrong are high, and where there is no reason to rush. But there is moral hazard in refusing to give an answer too. Decisions will be made, regardless, and if we have a ‘on balance of likelyhood’ input, that is better than a random uninformed guess. The scientific standard of confidence may be inappropriate, taking into account the consequences of type II error as well. For the category of problems which concern ecologists and society in the 21st century – characterised by complexity, subjectivity and ‘least bad’ solutions, the notion of a ‘right answer’ may be a chimera. The appropriate response may always be conditional and provisional. As scientists we should be comfortable with the idea that all our theories are at some level hypotheses, open for testing.

It is said that the key difference between science and policymaking is that in science, accuracy trumps urgency, while in policy, urgency trumps accuracy. Surely we can find a workable space in between?
Lectures
**Findings from SEACRIFOG Stakeholders Consultation Workshops**

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The SEACRIFOG project promotes the EU-Africa cooperation dialogue at different levels (policy, science, society) on the following themes: land use, land use change, climate-smart agriculture, food security, carbon cycle and greenhouse gases (GHG) observations, in order to support climate mitigation and adaptation. The project aims to develop a road map towards an African network of research infrastructures for long-term observation of GHGs, climate change and environmental dynamics. In the frame of SEACRIFOG three Stakeholders Consultation Workshops were organized. 73 participants from 33 organizations attended the events (held in Kenya in May 2017, Ghana in June 2017, and Zambia in April 2018). At three workshops the world café method was applied in order to gather and share participants’ knowledge about: 1) Land use change implications on food security, 2) GHG observations, carbon stocks and climate change mitigation, 3) Climate-smart agriculture in Africa. This work reports the main outcomes of these participatory workshops.

The most prominent and common issues raised, were about data and metadata availability, accessibility, usability, interoperability, resolution, format and, in summary, their quality. Additionally, it was underlined the importance of sharing data and knowledge and the need to develop not only technologies and research infrastructures but also strong and collaborative networking. Decision-makers as well as stakeholders at various levels need an improved access to current know-how and capabilities on new technologies and best practices, and research activities have to respond also to corresponding needs. Beside scientific and technical aspects, the solution to part of constraints must be a comprehensive approach able to consider also socio-economic dynamics, which may influence the success and the long-term sustainability of a research infrastructure network. Science alone is not enough, thus; mediation among scientists and stakeholders along the entire chain of end users could help in facing some of the crucial aspects. A coherent and thorough analysis and prioritization of all these issues will help in developing a basket of options suitable for specific “on field” conditions, with relevant impacts at national or regional level.
Climate change impact on lake metabolism: Trends, thresholds and predictions in the context of metabolic theory of ecology

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Lake metabolism can be viewed as an overall proxy of ecosystem functionality - because it is through metabolism that organisms interact with their environment. Based on the metabolic theory of ecology, a shift towards heterotrophy is predicted with rising lake water temperature - given that photosynthetic gains from increasing temperatures are smaller than those for respiration. Yet, the temperature at which an autotrophic system switches from net autotrophy to net heterotrophy depends also on the absolute amount of NEP- or in other words trophic state. The larger the NEP at a given reference temperature, the longer it takes ER to overtake GPP if the system gets warmer. At the same time, based on the fundamentals of metabolic theory of ecology, warming increases phytoplankton demands for resources to support higher metabolic rates at higher temperatures. Thus, in the context of global warming algal mass should decline as basal metabolic costs increase.

We will provide results from several case studies based on long-term empirical in situ data (high frequency in situ measurements from lakes around the world within the GLE-ON network; Global Lakes Ecological Observatory Network), remote sensing data and results from large scale mesocosm experiments across a north-south European geographical gradient to elucidate the interaction between global warming, trophic state of lakes and their metabolic balance. We elaborate on the question as to how critical switch point temperatures (switch from net autotrophy to net heterotrophy) depend on trophic state. Our study documents the strength of combining ecological theory with empirical long-term data and experiments for a better understanding of trends, thresholds, and variability in lake’s metabolic balance.
Interactive effects of ozone, nitrogen deposition and climate in terrestrial ecosystems of Spanish mountain areas

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The Mediterranean Basin is one of the Biodiversity Hotspots for conservation priorities. Particularly, the Mediterranean mountains concentrate some of the most valuable areas, due to the high biodiversity and to the provision of many environmental, cultural and economic services. Many of these areas have been recognized and protected under different conservation plans. While conservation plans can implement management strategies to reduce the impact of human activities, those ecosystems will still be affected by air quality and climate change. Tropospheric ozone (O₃) and atmospheric nitrogen (N) deposition are two of the main air pollutants affecting natural and semi-natural ecosystems of the Mediterranean Basin. Unfortunately, most of the air quality networks do not include monitoring stations at high elevation areas. Ozone, atmospheric N deposition and meteorology have been monitored at different elevations in the Guadarrama mountain range (Madrid, central Spain) from 500 up to 2200 m.a.s.l. for several years. At some plots, soil water content data are also available. Air pollutants, meteorological variables and plant physiological activity data of different plant communities along the elevation gradient will be presented. Methodologies to estimate atmospheric N deposition and fluxes of O₃ uptake have been adapted for water-limited environments. The interactions between O₃, N deposition and soil water availability on plant physiology, growth, reproduction capacity and stomatal uptake of air pollutants reported under experimental conditions will be discussed in order to progress in risk assessment of effects of air pollution in Mediterranean mountain areas.
T1: DRIVERS OF LONG-TERM CHANGES IN BIODIVERSITY, ECOSYSTEM INTEGRITY AND ECOSYSTEM FUNCTIONS

Saving Biodiversity of Terrestrial and Riverine Ecosystems: Assessment and Monitoring in Selected Long-Term Ecological Research (LTER) Sites in Southern Philippines

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The Philippines is one of the mega-diverse countries but is also one of the biodiversity hot spots. Thus, this research was conducted to determine and assess the flora, fauna and water quality, as well as monitor the primary productivity and phenology of important tree and fern species, to record climate data, and conduct in situ conservation of the selected threatened and endemic species in three Mindanao Long-Term Ecological Research (LTER) sites namely: Mt. Apo (North Cotabato), Mt. Hamiguitan (Davao Oriental) and Mt. Musuan (Bukidnon). Inventory and assessment were carried out in 2-ha permanent plot in each LTER site using standardized procedures with participatory approach where local people were trained and taught on how to inventory and conserve the biological resources. A total of 834 species of vascular flora, 643 terrestrial fauna, 41 ichyofauna, 71 phytoplankton and 16 zooplankton species were documented in the three LTER sites. This total number of vascular flora and fauna represents 10% and 3% respectively of the country’s record. Of these, 35 are threatened which comprised 22 plant species and 13 faunal species. Endemicity was higher among fauna with 73 species while lower in flora with only 17 species. Meanwhile, there are 12 rare species and 668 economically important species of vascular flora noted. Among the sites, Mt Hamiguitan had the highest species richness with 679 species, followed by Mt. Mt. Musuan (673 species) and Mt. Apo (504 species). Species diversity revealed that for flora, Mt.Musuan had the highest diversity value with $H' = 1.4$ followed by Mt. Apo ($H' = 1.06$) and Mt. Hamiguitan ($H' = 1.04$). Moreover, for fauna, Mt. Hamiguitan had the highest diversity index ($H' = 1.92$); followed by Mt. Apo ($H' = 1.536$), and Mt. Musuan ($H' = 1.436$). The high faunal species diversity in Mt. Hamiguitan was attributed to habitat complexity and heterogeneity; the tolerable temperature in the area also contributed for the increase on the species richness. Further, forest productivity as measured through litterfall showed that Mt. Musuan had the highest litterfall with a value of 1160.25 g oven dry weight (ODW)/m2/yr), followed by Mt. Apo (764.84 g ODW/m2/yr) and least by Mt. Hamiguitan (537.85 g ODW/m2/yr). Water quality was tested and revealed that most parameters that were measured still fall within the ranges of acceptable standard set by the Department of Environment and Natural Resources Administrative Order (DAO) No. 34 for Class AA (watershed water), A (potable water) and B River (irrigation water). Lumbo creek at Mt. Musuan consistently had the highest sedimentation rate (49.12 g/m2/hr). Results revealed that the three LTER sites are habitats for various threatened and endemic flora and fauna and habitats of an array of resources that support the wildlife in the area.
An analysis of agrobiodiversity in México through a causal framework

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It is estimated that of the over 7000 species of food crops under cultivation, only 103 species are used to secure over 90 % of the global food production (Tomich et al. 2011). The agrobiodiversity is the biological diversity present in agroecosystems, in the wild relatives of the cultivated species, and in the plants collected and managed, which together constitute the genetic resources for food and agriculture. This biological diversity is present in ecosystem, species and genes; and it depends on the various biocultural processes that affect its generation and long-term maintenance, and that includes the set of management practices carried out by human beings (CONABIO, 2018). Agrobiodiversity also considers other living components present in these environments and that play an important role. Mexico is the center of origin and diversification of 15.4% of the species that are used as food sustenance worldwide, there are also 62 languages spoken within the territory and it is the most culturally diverse country in America. In this sense, the domestication of species is a biocultural event and therefore the conservation of agroecosystems is of great importance (Barrera-Bassol et al., 2011).

The objective of this article is, on the one hand, to know the main socio-ecological factors that intervene in the perpetuation of agrobiodiversity food in Mexico. On the other hand, an analysis of the Drivers-Pressures-State-Impact-Responses DPSIR model. The methods used are an archival research and empirical analysis.

This article exposes the relevance of considering agrobiodiversity as a fundamental element in the food system. In addition, agrobiodiversity systems are associated with elements such as evolution, culture, social organization among others. We consider the DPSIR framework a useful tool to know the state of the agrobiodiversity in Mexico, knowing and analyzing the main factors that threaten it.
Decadal trends of fog and rainwater inputs to declining relict cloud forests in semiarid Chile

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A dense cloud field is a nearly permanent feature (80% persistence) of the Pacific Ocean along the dry, western coastal margin of South America. The clouds are most prominent as a source of humidity in the arid and hyper-arid climatic region, where fog influx maintains a chain of diversely vegetated hotspots on coastal hills from southern Peru to north-central Chile. The southernmost member of the chain is the fog-inundated relict forest of Fray Jorge National Park (30 S), composed of hundreds of rainforest patches on coastal mountaintops (> 500 m) receiving only sporadic rainfall (mean annual precipitation=140 mm). Because fog water influx is critical for the persistence of forest patches and their rich plant assemblage, which includes taxa that are found in austral temperate rainforests, 1000 km to the south, we initiated a quantitative study of decadal trends in fog and rainwater inputs. We assessed the constancy of fog inputs and their temporal synchrony with rainfall, especially considering recent trends of declining rainfall in the area. For a period of 12 years, we kept monthly records of water inputs originated from passive cloud interception, stemflow, throughfall, and direct precipitation outside and inside six patches varying in size and location on the coastal hills.

Rainfall varied greatly in the period of study. Extreme fluctuations were closely associated with El Niño Southern Oscillation (ENSO) events, with dry extremes of < 10 mm, and an unusually wet year (2002) reaching > 200 mm. Overall, rainfall declined by 12% in the decade of study. Peak rainfall is concentrated in the austral winter months (June-August), usually followed by eight or more rainless months. Fog is a source of moisture to the forest during the rainless period. We estimate that both fog interception and stemflow contributed together an additional ~300 mm of water. Persistent clouds and low air temperatures on hilltops (10 - 15 degrees lower than the air in the semiarid scrubland nearby) severely reduce evapotranspiration water losses, thus enhancing the water economy at the tree and forest patch scale. Only small differences in cloud interception were recorded between small (< 1 ha) and large (20-30 ha) patches, suggesting that all fragments have the same potential for fog water capture. However, small forest patches have lower water retention due to evaporation caused by pronounced edge effects. Smaller patches are then increasingly sensitive to drying trends expected from climate change. Although cloud interception showed no significant trends for the decadal period, smaller patches may become more susceptible to declines in rainfall because larger edge effects. That is critical, because small forest patches outnumber large patches.
Developing a tool for monitoring Sense of Place over the long-term at LTER sites and LTSER platforms

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Sense of Place (SOP) refers to the place attachment and meaning that people and communities create in relation to a geographical location and thus make it a ‘place’. Individuals feel that they are rooted in a place to the extent that it becomes part of their identity (i.e. place-identity) and develop a perception that in this place they can express their full potential (a.k.a. self-dependency), or the opposite phenomenon; they feel alienated by this place.

Although individuals’ attitudes to a place may be negative or positive, SOP generally refers to a positive meaning and the feeling that the place is a home. Recent studies have indicated a relationship between SOP, environmental values and the willingness to protect the local nature, culture, and society. A relationship was also found between residents’ SOP and their willingness to adopt responsible behavior in relation to ecosystems that provide them with ecosystem services. For this reason, SOP may be a useful long-term social indicator toward producing knowledge to inform sustainable approaches in the International Long-Term Ecological Research (ILTER) network. The main obstacle to the standardization, implementation, and scaling-up of such an indicator is that SOP is anchored in the unique nature of the local society and environment. In light of this, it is reasonable to ask whether and how an SOP evaluation tool might be developed that would enable long-term local monitoring as well as the possibility of comparing LTER sites and Long-Term Socio-Ecological Research (LTSER) platforms at an international level.

A joint study of two LTSER Platforms, the arid LTSER in the Negev Highlands of Israel and the Sub-Arctic LTSER at Cape Horn in southern Chile, was designed to provide a preliminary answer to this question. Following a comprehensive literature review, a relatively simple theoretical framework was constructed which allowed the use of a single questionnaire at both platforms, requiring only minor adjustments to adapt it to each local system despite great differences in the two sites’ geographical and social conditions. Thirty residents at each platform answered the questionnaire.

An analysis of the results shows that SOP is a place-based indicator that depends significantly on local conditions. However, making generalizations at a high level of abstraction makes it possible to compare different platforms. We conclude that it is indeed feasible to create a standard indicator with which to monitoring SOP over the long-term at diverse, international sites. To further develop such a tool and implement and scale-up its use...
in the ILTER network, we call upon our colleagues at other LTER sites/LTSER platform to join a new study to survey SOP around the world using a common methodology for the first time.

T6: GLOBAL RESEARCH INFRASTRUCTURES

The vision of a research infrastructure enabling holistic, long-term observations on critical ecosystem processes in Europe

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The global Grand Challenges like climate change, land-use changes, soil degradation, pollution and biodiversity loss are affecting the ecosystems’ functioning and wellbeing, and the sustainability of ecosystem services human societies depend on. At a global level, nearly two thirds of crucial ecosystem services have been degraded in just 50 years. The additional stress imposed by climate change requires novel integrated approaches and the capacity of extraordinary adaptation to preserve the values of nature. While in the short-term such effects are well studied, progress in understanding, managing and securing ecosystem functions and services and their adaptation to Global Changes is hampered by still fragmented and dispersed platforms operated by single disciplines and communities.

The distributed site network of LTER-Europe comprises about 400 formally acknowledged ecosystem research sites and 35 LTSER Platforms for socioecological research, operated by about 150 institutions. This consolidated network is the result of 20 years of defragmentation and integration, resulting in formal LTER networks in 26 countries with well-established national and European governance structures embedded within the global ILTER network. However, such a loose network cannot provide the higher level of governance and services required for the integrated and long-term nature of ecosystem research, since adherence to protocols is by non-binding agreements. Further, the heterogeneous, ad hoc design of current sites does not allow analysis of the state of socio-ecosystems at a continental scale, nor forecasting the future trends in an appropriate manner.

To answer this challenge, the community has desired to pursue a conceptual approach to develop a continental-scale research infrastructure, eLTER (Integrated European Long-Term Ecosystem & Socio-Ecological Research Infrastructure). It is based on a unique “whole system approach” from plot to landscape scale integrated in a nested, hierarchical site design, which supports interdisciplinary natural science research as well as investigations of the social systems impacting environment. eLTER is currently being developed as part of the European Strategy Forum for Research Infrastructures (ESFRI) Roadmap, to consolidate the legal, governance and funding frameworks for sustainab-
The operations in long run. eLTER RI enables integration of European ecosystem, critical zone and socio-ecological research striving for a sound, mechanistic understanding of the impacts of multiple stressors on natural resources, ecosystems and biodiversity through cross-scale and cross-disciplinary analysis. 161 research institutions in 27 European countries have signed the Memorandum of Understanding on the eLTER Science Case. The main impacts of eLTER will be the harmonized and standardized observation methods and their utilisation in upscaling from highly instrumented sites to global Earth Observing systems; providing access to sites and integrated multi-scale data products covering the entire continent; and addressing the societal and policy relevant questions at regional and continental scale.

T6: GLOBAL RESEARCH INFRASTRUCTURES

**Swedish Infrastructure for Ecosystem Science - A national initiative for coordination and harmonization of field-based ecosystem research**

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Swedish University of Agricultural Sciences

The Swedish Infrastructure for Ecosystem Science (SITES) provides the international scientific community opportunities for coordinated large scale and long-term field surveys and experiments at nine research stations spanning the full latitudinal range of Sweden. All stations are members in LTER Sweden, and are taking part in the international LTER cooperation.

The study areas of the stations represent a variety of terrestrial and limnic ecosystems; alpine, forests, wetlands, agricultural land, lakes and streams. With its integrative approach and broad coverage of climate and ecosystem types, SITES constitutes an attractive platform for research projects and contribute to harmonization and standardization of measurements and data handling.

Since its initiation in 2013, SITES has established three research-driven thematic programs, each setting up its procedures and protocols in line with the international processes towards standardization:

- **SITES Water** forms a unique coherent and long-term measurement program where hydrological, physical, chemical, and biological parameters within lakes and streams are collected.
- **SITES Spectral** collects spectral data at fixed and mobile multispectral sensors and cameras. Seasonal and inter-annual variations in vegetation conditions are captured over small and intermediate areas.
- **SITES AquaNet** offers a standardized and flexible platform for mesocosm experiments in lakes adjacent to the research stations.
The strength of SITES is based on its professional monitoring systems that use current state-of-the-art methodology, sensors and instruments in combination with the well-trained support staff at the stations and the highly qualified scientists coordinating the activities.

All data generated within SITES is to be publicly available from the SITES data portal. This advanced and versatile data archiving and dissemination systems makes SITES well positioned to interact on a machine-to-machine basis with other similar initiatives that provide access to scientific data.

Many of the individual stations in SITES have been active for several decades and are operated by five different organisations. Thus, SITES also span across administrative boundaries and this facilitates combined and coordinated access to the stations. By joining SITES, the stations are included in a research infrastructure of national priority, which both in terms of finance and governance strengthens the sustainability of the stations and their activities.

The national coordinating efforts already undertaken positions SITES as a well-prepared international partner in long-term and large scale surveys and experiments in ecosystem science as well as in the establishment of formal international infrastructures such as ERIC eLTER RI.

T2: CLIMATE CHANGE IMPACT ON ECOSYSTEM PROCESSES

Importance of multidisciplinary long-term data to assess groundwater quality and its socio-ecological impact in the Postojna-Planina Cave System

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Due to the specific groundwater hydrogeology, karst areas are particularly vulnerable to environmental impacts. Karst systems are easily contaminated, but difficult to remediate. Karst aquifers contribute substantially to world’s population drinking water supplies (about 75% of EU inhabitants depend on groundwater for their water supply). In addition, groundwater related ecosystems are important habitats for subterranean fauna where biological monitoring should be done concurrent with water quality monitoring. The assessment and efficient protection of drinking water resources within the Dinaric Karst range, and the groundwater related ecosystems need to be addressed through...
constant and long-term multi-parameter monitoring of groundwater, which includes quality indicators, frequency of extreme hydrological events (as direct effect of climate changes), and species assessment (e.g. habitat loss). Due to its complexity and high vulnerability, as well as through its social importance as groundwater resources, karst requires a multidisciplinary research approach.

In this study we develop an interdisciplinary observation system recording time series of various parameters (biological, chemical, hydrogeological, hydro-meteorological) at LTER Slovenia site: Postojna-Planina Cave System. The aim of the system is to assess long-term changes and pressures at the site. This site consists of two large hydraulically connected caves (Postojnska jama and Planinska jama). Caves are active part of hydrologically complex system of underground streams, springs and poljes. Part of the water is captured for the water supply of about 21,000 inhabitants. Complementarily, the site hosts the inaccessible habitats for the European endemic and endangered cave fauna (e.g. the European cave salamander Proteus anguinus).

Specifically, since 1998 onward, the multidisciplinary datasets have been recorded both surface and underground i) historical pollution events through the measurement of chemical parameters (e.g. nitrates, phosphates, chlorides, pH), ii) anthropogenic effects on underground microclimate and karst springs water quality through physical parameters (electric conductivity, CO2, water temperature, and water level), iii) daily measurements of meteorological and hydrological data, iv) artificial tracer tests to find the pollution sources and simulate potential contamination, and v) richness of underground fauna.

Long-term, multidisciplinary data records are crucial indicators of degradation and remediation of karst systems in time. Furthermore, such data can help us understand the functioning of karst as an ecosystem, and to better fill the gaps when analyzing overall changes of the European ecosystems and critical zones.
It is well-known that climate is a major driving force for all ecosystems; wetlands included. What has been seldom demonstrated, though, is the influence of biological features on wetland hydrology. At the starting point of our study, an unexpected nitrogen-processing efficiency was observed in Tres Rios aridland wetland in Central Arizona Phoenix Long-Term Ecological Research (CAP-LTER). This constructed treatment wetland is composed of a central open water zone (ca. 21 ha) surrounded by peripheral vegetated marsh zones (ca. 21ha) and receives secondary treated wastewater from Phoenix WWTP; this effluent still contains more Nitrogen than regulations would allow. It was then suggested that this observation was a serendipitous consequence of the large water volume transpired by plants under such a climate. The replacement of transpired water creates a Biological Tide, which preferentially pulls water from the open water zone into the vegetated marsh zone; Nitrogen being transported with this Biological Tide is very effectively removed from the marsh.

The next step is to explore the effects of these peculiar climatic and biological parameters on the hydrodynamics of wetlands. We have tested four main work hypotheses:

• There is a significant influence of the Biological Tide on the wetland hydraulics;
• There is a significant influence of macrophyte community composition and of plant density on the Biological Tide;
• There is a significant influence of the spatial configuration between marsh and open water zones on the resulting hydraulics;
• There is an optimal configuration involving both Biological Tide and spatial configuration to optimize the wetland ecosystem service of water quality regulation.

We will try and define optimal water flow path through open water and marsh zones as well as optimal plant cover features.

To reach this objective we used a modelling approach, as it allowed us to test the different work hypotheses. We performed simulations based on the current Tres Rios constructed treatment wetland (CTW) design. We then calibrated the model with in situ water velocity measurements as a prior step to model validation and subsequent scenario modelling tests. Computation of the velocity field and of the residence time distribution (RTD) – through dye tracer modelling experiments – allowed us to determine whole-system water residence times and to retrieve parameters related to the hydraulic efficiency. We used Salome software to generate the geometry and OpenFoam software to generate the mesh used in the simulations. We used a specific solver for shallow water flow,
shallowWaterFoam, to model the velocity field; we then used a modified version called shallowWaterLagoonFoam (Acary-Robert et al. 2016) that allows for scalar transport modelling (which means dye tracer experiment for us). Using this model, we will ultimately inform both improved management practices for the Tres Rios CTW and future designs that optimize the ecosystem services provided by “working wetlands” in aridland urban environments worldwide.

**T6: GLOBAL RESEARCH INFRASTRUCTURES**

**The Shallow Marine and Coastal Research Infrastructure: A model for Coastal and Marine ILTER sites (ILTER-CMS)**

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The Shallow Marine and Coastal Research Infrastructure (SMCRI) were established in 2016 by the Department of Science and Technology (DST) as part of the South African Research Infrastructure Roadmap (SARIR). The aim was to develop an array of instruments and physical research platforms around the coast of South Africa and its sub-Antarctic Islands to collect long-term reliable data for scientific research to help decision makers formulate appropriate environmental policies to lessen the risk and vulnerability of the coastal zone to climate and global change.

The SMCRI is tapping into South Africa’s geographical advantage by providing access to cutting edge research platforms and data at appropriate spatial and temporal scales in all the coastal biogeographic regions from three oceans to stimulate innovative research and IP generation that is of global relevance. This is achieved through the provision of a suite of LTER platforms consisting of four Sentinel Sites, four satellite Sentinel Sites, Airborne Remote Sensing, Coastal Craft, Acoustic Tracking Array, Underwater Remote Imagery, Science Engagement, Coastal Biogeochemistry Laboratory, Hyperbaric and Research Diving and Data Management.

The value of SMCRI as a model for ILTER-CMS lies in the integration and co-design of these platforms with terrestrial RI’s to link the catchments to the coast, the coast to the ocean observing system and the ecosystem to the socio-economic environment. This will allow for better data integration and analyses among and within ILTER sites and across disciplines. This paper will investigate the challenges, successes and shortcomings of establishing an integrated coastal observing system in a developing country.
Knowledge of species’ large-scale population trends is essential for setting conservation priorities. However, standardizing monitoring programs are only conducted at large-scales for select taxa such as birds and butterflies. Recent studies have suggested declines of insect taxa at some locations in Europe but the generality of these trends across species and regions have not been assessed. We compiled Odonata population data across Germany from different databases, mostly holding citizen science data, to assess the large-scale population trends since 1980. We used occupancy-detection models to estimate the regional annual occurrence of Dragonflies in five German federal states, based on both observations of adults and juveniles (total records = 424993), and examined the modifying effects of species traits on population changes. We found that most dragonfly species’ populations are either stable or increasing, due to increases of warm-adapted species, as well as the recovery of some lotic species. Our study demonstrates the value of citizen science data for large-scale population monitoring.
Understanding environmental systems, their evolution and their interaction with agro-ecosystems is of critical importance in a context of global change where environmental factors impact the yield and quality of agricultural products such as crops and livestocks.

The CEBA initiative (Environmental cloud for the benefit of agriculture) gathers scientists, crop companies and SMEs around the common goal of collecting all relevant information in a centralized repository to monitor environmental systems, predict their evolution and therefore their impact on territories, including targeted agricultural systems, and develop decision support tools for local authorities and farmers.

The Environmental Cloud is structured as a data lake. Data Lakes allow to store relational data like operational databases and non-relational data like mobile apps, IoT devices, and social media. They also give the ability to understand what data is in the lake through crawling, cataloging, and indexing of data.

Legacy environmental data bases are currently being migrated. Unstructured data are processed to the data lake by wireless sensor networks that are under deployment in several environmental sites in Auvergne, including agricultural parcels, an old riverbed, a lake and a former uranium mine labelled as Long Term Socio-Ecological Research Observatory belonging to the French Réseau des Zones-Ateliers and registered in the eLTER Research Infrastructure database of sites (https://deims.org/915cb2eb-ed08-4b02-9d16-1f4d688e912b). Sensor data are collected at site level on gateways using the low-power wide area LoRa network technology that provides secure, bidirectional, low-power, long-range communication through both free and paid network services. Its wireless signals can reach across great distances, delivering tiny packets of data to and from multiple low-power node devices. The Environmental Cloud will also receive unstructured data from instrumented agricultural parcels within the framework of the Territorial Initiative Laboratory (LIT), a living lab led by Céréales Vallée, a cluster of innovative SMEs, and dedicated to innovation in agriculture.

The Environmental Cloud servers are based at the Mesocentre Clermont Auvergne, Clermont Auvergne University computing center hosting France Grilles Auvergrid node since 2010. Thank to regional, national and European structural funds, the computing center is offering new computing resources from January 2019 on a new open stack production cloud that will be available to deploy regional climatic models and run machine learning software to design decision support tools based on the Environmental Cloud data.
Evaluating the impact of modeling uncertainties on decision makers: application to the Maginot’s Water Line resources

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At the watershed level, data and models are key elements for evaluating impacts of climate change and extreme events on water bodies, water availability/usages, and resources management by local decision makers. However, (1) insufficient data in number and accuracy, (2) assumptions and approximations chosen for the modeling of geophysical processes, or (3) external factors such as climate change raise important issues about uncertainty evaluation and modeling. Questioning uncertainties and their multiple impacts should be an important task in the scientific approach, in particular when used as “evidence” for decision-making.

The scientific workflow we describe ranges from data collection to decision making as follows:

Data >> Geophysical modeling >> Uncertainty math. modeling >> Uncertainty evaluation (socio) >> Impact on decision makers

This interdisciplinary methodology, involving science and technology as well as social sciences and humanities, is general and can be adapted to the different scientific themes, at various spatial and temporal scales, proposed in the iLTER Open Science Meeting. The communication exemplifies key-methodological aspects of the proposed workflow on the socio-ecosystem of the Maginot’s water line (Mutterbach watershed, Lorraine, France),

the reservoirs and dams of which were built in 1935 along five of the Mutterbach’s tributaries as water-based defenses conceived to flood the valley. Currently used for leisure and fishery, these large reservoirs could become significant components of water resource management providing effective multipurpose water storage such as irrigation, water supply, and flood control and drought relief, while representing a flooding risk.

Uncertainties we deal with are related to historical climate data (from the ECAD or from reanalysis), to very scarce discharge data, and to the choice of the numerical models and their hypotheses (a 2-reservoirs model and a finite element run-off model). The hydrological functioning of the watershed is studied under particular scenarios for climate chan-
ge and extreme events (droughts as well as floods) as well as changes in the agricultural practices (drainage, irrigation and land use).

Numerical results and uncertainties then are presented as maps and figures to various sociological groups and stakeholders (watershed inhabitants, farmers, fishers, local authorities) to evaluate their risk perception and the impact on further decisions by means of focus-groups and the NUSAP method (notation tool for management and communication of uncertainties in science for policy). Our research aims at identifying stakeholders’ understanding and representations of the technical documents and scientific results from a risk point of view. Meanwhile, we attempt to identify key drivers of adaptive management given climate change effects.

By common agreement with the local authorities, the specific objective of this general methodology is meant to answer the question: What is the impact of uncertainty in the modeling on decision-making for the management of the Maginot’s Water Line resources under plausible effects of the climate change?
T2: CLIMATE CHANGE IMPACT ON ECOSYSTEM PROCESSES

Impact Assessment of Climate Change on Crop Production and Greenhouse Gas Emission in central Taiwan by DNDC model

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Based on the global observation scale and disasters events occurred recently, the trend of climate change manifests persistently significant. It might greatly affect the status and functions of agricultural ecosystem. The aim of this study is to assess the impact of climate change on the production of rice and peanut and greenhouse gases emission in the central Taiwan by DNDC (Denitrification-Decomposition) model. The model was calibrated by data collected from two agricultural sites conducted with long term ecological research. The impact of climate change was simulated under conditions of mean annual warming up to 0.015-0.037°C and CO2 concentration increasing up to 2-6 ppm in near 10 years. The simulation results predict the yields of rice (variety: Tainan no.11) will gradually increase annually due to the enriched CO2 concentration. The increasing extent of yield is around 5-15% under scenarios of variable weathers. The yield of peanut (variety: Tainan no.14) will also slightly increase annually due to warming and the enriched CO2 concentration. But the yields will fluctuate between 600-3000kg/ha caused by the changed rainfall pattern. Since the peanut farming and growth is easily influenced by the rainfall, the fluctuation of Chiko farm with clay soil will present higher than that of Yuinlin farm with sandy soil. The results reveal the production of upland crops might be affected greater than paddy rice under climate change. The adaptation strategies should be evaluated and adopted in advance to mitigate the impacts such as no-tillage and higher furrow practical etc. The emission of greenhouse gases will become higher under climate change. Although the crop residue removal can reduce the emission, but also leads to reduce crop production and soil carbon storage.
Temporal progression of soil nematode community and diversity along rice cultivation process

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As the main grain crop in Asia, rice paddy fields occupy the widest cultivated fields in Taiwan and create the considerable landscape with unique biological community. The biological community, which tightly interacts with the environmental factors, is considerable indicators in reflecting crop health in agricultural systems. The soil nematode assemblage is one of the commonly used indicators. In addition to the plant-pathogenic nematodes, nematodes playing the role in biological agent, nutrition cycle, and spread of microbes have recently been discovered and applied in reflecting effects of heavy metal pollution and agricultural management in soil ecosystem. Our survey of the rice paddy fields in ChiKo Branch Farm, one of the long term ecological research sites located in Chiayi Agricultural Experiment Branch, reveals the temporal progression of nematode assemblages along with the cultivation process. The nematode population radically decreased in the flooded field along with the alternation of trait-based nematode communities and potentially ecosystem functions. Rice transplanting and fertilizing did not obviously affect the nematode population, but it is expected to be gradually recovered after the rice field was dry out. The shifted nematode compositions toward large body size group under disturbance suggested alternative responses in rice paddies in contrast to those from agro-ecosystem in temperate region.
Climate change is expected to trigger an upward expansion of plants in mountain regions and, although there is strong evidence that many native species have already shifted their distributions to higher elevations, little is known regarding how fast non-native species might respond to climate change. By analysing 131,394 occurrence records of 1,334 plant species collected over 20 years in a one of the most-floristically rich areas of the European Alps (Mt. Baldo, north-east Italy), we found that non-natives are spreading upwards approximately twice as fast as natives. Whereas the spread of natives was enhanced by traits favouring longer dispersal distances, this was not the case for non-natives. This was due to the non-native species pool already being strongly biased towards species that had traits facilitating spread. A large proportion of native and non-native species seemed to be able to spread upwards faster than the current velocity of climate change. In particular, long-distance dispersal events and proximity to roads proved to be key drivers for the observed rapid spread. This suggests that temperate montane ecosystems are much more susceptible to plant invasions than currently assumed and that, when human disturbance is high and long-distance dispersal is considered, the speed of spread can be faster than previously estimated. Our findings highlight that invasions by non-native species into native alpine communities are a potentially significant additional pressure on these vulnerable ecosystems that are already likely to suffer dramatic vegetation changes with ongoing warming and increasing human activity in mountain regions.
Global changes affect biological diversity, with major consequences on socio-ecological processes that include biodiversity erosion, species range modifications, pathogen emergence, food security, exacerbated extreme climatic events, explosive urbanization, increased poverty, etc. Africa is considered as particularly exposed and vulnerable to such changes, be they of natural or human-induced origin. In Western Africa, severe drought episodes since the end of the 1960s have translated into a significant decrease of rainfall, even though the Central Sahel has recorded wetter years from the end of the 1990s. At the same time, West Africa undergoes major changes of land use practices, for instance the extension of irrigated perimeters, as an attempt to mitigate drought effects on food security and to increase agricultural production. Urbanization has also been dramatically increasing all over the World, and especially Sub-Saharan Africa where more than 80 urban centres are predicted to reach one million inhabitants by 2025. Following such transformations, good and people exchanges have been increasing in an unprecedented way, thus deeply modifying connectivity patterns.

In many instances, small mammals, particularly rodents, are valuable indicators of these contrasted changes, which may i) deeply impact their distribution ranges, ii) drive abundance changes including outbreaks, and iii) favor biological invasions. Among the species concerned by these changes, many of them are crop- and stored product-pests and some are involved in the circulation and transmission of animal and human pathogens. As such, their colonization of new areas or their local increase in abundance may result in the emergence of serious problems in terms of food security as well as human and animal health.

ObsMiCE, the West African Observatory on small Mammals as indicators of Environmental Changes, implements long-term environmental monitoring that has been initiated during the 1970s to 2000s according to the sites studied. ObsMiCE focus on small mammals as ecological indicators and as target taxa in interaction with humans. ObsMiCE objectives are i) to document long-term changes in biodiversity of small mammals and their associated parasites/pathogens in connection to local and global socio-ecological drivers, including climate variability, land use change, urbanization, increasing exchange networks and associated expansion of invasive species; ii) to secure long-term stewardship and repository of database; iii) to move forward an universal and equitable access to data, knowledge and expertise for academics, socio-economic stakeholders and local populations.
We will present some examples of the ObsMiCE monitoring activities and results in a broad range of ecosystems: harbors and cities (in Benin, Niger and Senegal), pastures and cultivated fields (Senegal and Niger Valleys in Senegal and Mali; Ferlo region in Senegal) as well as natural reserves (Bandia in Senegal). These examples illustrate how ObsMiCE helps to identify drivers of long-term changes in biodiversity, health and food safety that have strong implications in terms of human societies sustainability.

**T5: NEW METHODS, TECHNOLOGY AND INNOVATIVE SCIENCE SUPPORT SERVICES**

**Multi-scale remote sensing for long-term monitoring and conservation management in Doñana LTSER platform**

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One of the major challenges of remote sensing is the upscaling of natural processes. Although there is a huge availability of sensors, the nature of the process to be monitored constrains the upscaling possibilities. This is especially evident for phenological processes such as flowering, fruiting, leaf emergence or fall as well as for defoliation processes. This work will show several solutions entailed for the long-term monitoring program of Doñana LTSER platform in order to scale up the collected in situ information with the use of drone-borne, airborne and satellite images. After a short introduction on the background and rationale we will point out the relevance to complement traditional monitoring techniques with information provided at landscape scale. In Doñana protected area several monitoring protocols have adopted the multi-scale approach either to test the accuracy of remote sensing products or to enlarge the implementation scale. Similar procedures are being set up under the umbrella of eLTER RI for the whole set of eLTER sites.
T2: CLIMATE CHANGE IMPACT ON ECOSYSTEM PROCESSES

Long-Term Ecosystem Research Infrastructure for Carbon, Water and Nitrogen (LTER-CWN)

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Extreme climatic events (ECEs) have been suggested to occur with increasing frequency and intensity in the coming decades, with potentially important direct and indirect consequences for ecosystems and the services they provide to mankind. To detect and attribute impacts of ECEs on ecosystem processes and services they need to be evaluated on the background of the typical interannual range of these processes. Furthermore, co-ordinated observation networks need to be in place to enable rapid-response scientific campaigns to study after-effects and post-disturbance trajectories resulting from climate extremes.

The Long-Term Ecosystem Research Infrastructure for Carbon, Water and Nitrogen (LTER-CWN) network builds on an existing range of outstanding Long-Term Ecosystem Research sites (LTER Austria), which cover the major ecosystem types across Austria (major forest types, managed grassland, wetland) and feature existing long-term data, an extensive record of research studies and a comprehensive research infrastructure. Net ecosystem exchange, ecosystem primary productivity, soil carbon sequestration and fluxes, soil nitrogen fluxes and greenhouse gas emissions as well as fluxes of water and nutrients through the terrestrial systems are being measured on the LTER-CWN sites. Next to the continuous monitoring of these parameters, a mobile platform is being established, allowing for detailed analyses of mechanisms underlying disturbance effects and complex carbon-water-nitrogen cycle interactions in the context of extreme events and their legacy effects. In this frame, novel isotope-laser based techniques will permit an understanding of the in-situ activities of soil organic matter mineralization and of nitrogen transforming micro-organisms and their link to greenhouse gas fluxes.

The infrastructure serves towards 1) obtaining a comparable, internationally top quality standard for the long-term monitoring of major ecosystem processes across these sites with the aim to quantify and analyse their interannual variability and response to the major environmental drivers, 2) providing research platforms and a sophisticated mobile device to apply in ecological experiments and in-situ climate extreme events and disturbances, 3) obtaining a novel understanding of the mechanisms underlying the ecosystem responses to ECEs and their consequences for ecosystem services, and 4) integration of research sites and data in the national and European research arena, particularly the European LTER Research Infrastructure.
Litter and soil organic matter decomposition represents the main biogeochemical processes and as such may serve as an intermodal link between the research disciplines. Within the ongoing TeaComposition initiative we are collecting harmonized data on long-term litter decomposition process and their drivers globally both across terrestrial and aquatic ecosystems. Moreover, through the cooperation with other global initiatives and experimental studies we are seeking to leverage recent joint research as well as to establish a basis towards the circumnavigation of ecological communities.

Current efforts of the initiative are directed towards data collection in underrepresented area, and invitation of modelers familiar with biogeochemical process models as well as other researchers to take advantage of the available decomposition data for addressing further research questions. Hence, within TeaComposition initiative we are very keen to advocate and to ensure the FAIR data practices. Future efforts of the TeaComposition initiative are directed towards the use of the established initiative-network for networking other global ecological studies as well as for transmission of the knowledge between education institutions, researchers, and policy makers.

I would like to talk about current achievements and efforts, and to discuss potential future uses of established TeaComposition initiative.
Greater than the sum of the parts: collaboration in and beyond the U.S. LTER Network

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The year 2020 will be the 40th anniversary of the U.S. National Science Foundation LTER Program, which has grown from a remote vision, to a loosely organized set of research projects, to a dynamic network of 28 research sites across more than a dozen major biomes. For much of its nearly 40 years, hypothesis-driven, place-based research has been the Network’s bread and butter. Integrating that science across sites and biomes has always been seen as important, but the approaches to synthesis have varied and the availability of resources has waxed and waned. A recent update of the LTER Network bibliography allows us to approach the question of “what works” with some degree of rigor. Correlating incentives and mechanisms to support synthesis with the types of cross-site papers produced in each era allows us to identify the most promising approaches for generating fresh ecological understanding. We also ground-truth the results with authors of key collaborative efforts and use the results to inform forward-looking approaches to synthesis and integration in the U.S. LTER and ILTER.
The South African savanna biome is expected to experience changes to its structure and function due to the effects of climate change. For the Kruger National Park (KNP), a protected savanna ecosystem within the lowveld region of South Africa, precipitation pattern shifts, increased temperatures and climate-linked woody biomass increases have already been recorded. Monitoring climate change effects on vegetation is therefore imperative to inform management decisions. Here, we aimed to evaluate the role of precipitation as a driver of vegetation greenness and phenology patterns. We assessed the spatial relationship of vegetation greenness patterns to those of precipitation and the phenometrics, start of season (SOS) and length of season (LOS), for MODIS NDVI time-series data between 2002 and 2015. Using spatial persistence analyses, we further identified the cumulative change trends in vegetation greenness, precipitation and the phenometrics and investigated the spatial correlation of these changes. Mean vegetation greenness showed large spatial correlation to both precipitation patterns and the phenometrics, suggesting that vegetation greenness and phenology patterns in the KNP were primarily driven by precipitation during our study period. About 30% of the KNP landscape area showed persistent (cumulative) vegetation greenness changes between 2002 and 2015. These changes in vegetation greenness, however, showed little spatial association with the cumulative changes in precipitation, season onset and season length. Our results suggest that although the general patterns in vegetation greenness in the KNP landscape are strongly dictated by precipitation, other drivers may have been responsible for the longer term persistent changes in vegetation greenness patterns. Understanding the relationship between the spatio-temporal change patterns of vegetation greenness, precipitation and phenological characteristics could be valuable in separating the precipitation signal from noticeable impacts of local drivers such as fire and herbivores. Our methods provide a useful approach through which vegetation changes can be monitored continuously at the landscape scale. Future work should focus on the relative roles of various drivers on spatio-temporal vegetation greenness and phenology changes.
The Expanded Freshwater and Terrestrial Environmental Observation Network

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The Expanded Freshwater and Terrestrial Environmental Observation Network (EFTEON) is a research infrastructure that is being developed under the South African Research Infrastructure Roadmap (SARIR) program of the Department of Science and Technology. The Expanded Freshwater and Terrestrial Environmental Observation Network (EFTEON) is conceived as a modular highly-networked research infrastructure to support studies on coupled ecological social systems in South Africa. The design concept is based on distributed “nodes” each with responsibility for a core landscape representing an important South African Ecosystem/Human complex. The nodes are intended to include representatives of major biomes in South Africa and human transformed ecosystems. Each of the nodes will have a standard set of automated instruments, measuring the carbon and water cycles and, meteorology and air quality. A suite of standard repeated manual measurements, covering biodiversity, productivity, ecosystem condition, ecosystem service provision and use. Automated instrumentation for the measurement of water quality and supply will occur at each node. A larger set of subsidiary sites associated with each node will have simpler standard automated instruments for climate and fresh water monitoring and repeated manual measurements, including household survey data collection in surrounding communities. A systematic collection of a comprehensive set of remotely sensed data for each landscape is intended to be part of the suite of observation products. The products envisaged from EFTEON include: 1) half hourly fluxes of energy, carbon dioxide and water for a representative site, accompanied by continuous measurements of meteorology, soil moisture, soil temperature and periodic documentation of vegetation, soil and disturbance parameters. 2) Landscape scale observations of land use and land cover including human population, livelihoods, health and use of resources, inputs and disturbances, 3) The hydrological system in the landscape, river flow, daily groundwater recharge, continuous stream chemistry, 4) Population dynamics of representative and important species in the landscape for both terrestrial and freshwater ecosystems. EFTEON contributes to global research infrastructures by providing a terrestrial research infrastructure for socially-relevant ecosystems research based in Africa and the Southern Hemisphere, strongly linked to coastal and marine ecosystems research and global environmental data systems. This presentation will describe progress in the establishment of the EFTEON network.
Ongoing intensification of the hydrological cycle is altering rainfall regimes by increasing the frequency of extreme wet and dry years and the size of individual rainfall events. Despite longstanding recognition of the importance of precipitation amount and variability for most terrestrial ecosystem processes, we lack understanding of their interactive effects on ecosystem functioning. We quantified this interaction in native grassland by experimentally eliminating temporal variability in growing season rainfall over a wide range of precipitation amounts, from extreme wet to dry conditions. We contrasted the rain use efficiency (RUE) of aboveground productivity (ANPP) under conditions of experimentally reduced vs. naturally high rainfall variability using a 32-yr precipitation-ANPP dataset from the same site as our experiment. We found that increased growing season rainfall variability can reduce RUE by as much as 35% during dry years, but that such impacts weaken as years become wetter. During low precipitation years, RUE is lowest when rainfall event sizes are relatively large, and when a larger proportion of total rainfall is derived from large events. Thus, a shift towards precipitation regimes dominated by larger rainfall events, already documented over much of the globe, can be expected to reduce the functioning of mesic ecosystems primarily during drought, when ecosystem processes are already compromised by low water availability.
Beyond species geography: the drivers that erode mountains to collapse

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Due to clear variations in a relatively small area, mountains represent natural laboratories for evolutionary and ecological studies. In a large degree, these variations are driven by changes in climate and soil that occur along altitudinal gradients and influence the ecology, evolution and geography of species. In spite of being old and eroded, the southern Brazilian mountains provide enough variation and heterogeneity to influence species distribution and diversity. The best-known Brazilian mountain range is the Espinhaço (the Backbone mountains). The Espinhaço is a large natural watershed divider of major ecological importance in eastern Brazil. The altitudinal gradient in the Espinhaço Mountains is low when compared to other tall mountains in the world as it only varies from ca. 650 meters to 2,072 meters a.s.l. at the Sun Peak (Pico do Sol). For the past 25 years we have reported on the trends in the distribution of many taxonomic groups (plants, galling and other herbivorous insects, termites, dung beetles, ants, bees, butterflies, arbuscular mycorrhizal fungi, and birds) along the gradient; and searched for the main ecological mechanisms and evolutionary processes to explain them. We have collectively examined the soils, climate and interactions among species to better understand patterns and processes associated with biodiversity changes of key groups of organisms. At same time we have witnessed increasing threats posed by land use change, and lack of governance, which are paving the way to a deadly end of biodiversity and impoverishment of ecosystem services to more than 50 million Brazilians.
The Arctic is already changing rapidly as a result of climate change. Contemporary warm Arctic temperatures and large sea ice deficits (75% volume loss) demonstrate climate states outside of previous experience. Estimates of the amount of organic carbon in Arctic soils have been revised upward, amounting to ~50% of the world’s global soil carbon. Long-term site measurements indicate changes in seasonal carbon uptake and respiration, showing decreasing storage rates. Modeled changes of the Arctic cryosphere demonstrate that even limiting global temperature increases to near 2 °C will leave the Arctic a much different environment by mid-century with less snow and sea ice, melted permafrost, altered ecosystems, and a projected annual mean Arctic temperature increase of +4 °C. Model projections show a 20% decrease in Northern Hemisphere near-surface permafrost area from roughly 15 M km$^2$ at present to 12 M km$^2$ by 2040, with little dependence on the RCP scenario. For RCP4.5, relative to present, there is a 50% loss of permafrost area by 2080. Under, RCP2.6 and 4.5 near surface permafrost area stabilize at the end of the century. Even under ambitious emission reduction scenarios, high-latitude land ice melt, including Greenland, are foreseen to continue due to internal lags, leading to accelerating global sea level rise throughout the century. Future Arctic changes may in turn impact lower latitudes through permafrost greenhouse gas release and shifts in ocean and atmospheric circulation. Arctic-specific radiative and heat storage feedbacks may become an obstacle to achieving a stabilized global climate under the Paris Accord global limit of a less than +2°C increase. This paper will synthesise recent work conducted under the Arctic Monitoring and Assessment Programme (AMAP, Overland et al. 2019).

Adding years, adding certainty? Drivers of temporal change in wild bees and birds in agricultural landscapes

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Which elements of biodiversity and related environmental characteristics should be monitored? In this study conducted within the German TERENO project (Terrestrial Environmental Observatories) as part of the German LTER network we cover several aspects related to abundance and composition of bird and wild bee communities like population trends, traits, community composition and related environmental parameters. While there is a wealth of knowledge about trends in bird populations in Europe, wild bee communities are less accessible and thus it is more difficult to tell how they are affected by landscape characteristics and agricultural practice over time. Wild bees play an important role as pollinators and are expected to respond on small spatial scales, while birds perceive landscapes from the bird’s eye view, responding on a much larger scale. We analyze the temporal impact of landscape quality and land use parameters on these groups in six agriculturally dominated sites of 4x4 km² in Central Germany. In the short term, bee communities are directly affected by abiotic parameters like weather. They show surprising patterns in terms of species richness and abundance in different landscapes, but temporal trends become apparent in the long run after more than six years of trapping. In birds, species richness is not affected, but the number of territories as a measure for abundance declines in time especially in more diverse landscapes.
Several climate-change models for Chilean forest ecosystems predict drastic reductions in rainfall for south-central Chile, specifically during the summer period. Ten years ago, we designed and established a field experiment excluding 30% of summer rainfall (summer drought stress, SDS) to two evergreen, broad-leaved rainforest plots. The goals of this study were to evaluate the ecosystem responses to seasonal reductions in rainfall as predicted by climate change models. We setup four 20x20 m plots in an c. 80 year-old temperate rainforest of Chiloé Island (42 S), at Senda Darwin Biological Station, two plots with rainfall excluded and two control plots. After five years of repeated summer drought, we observed significant differences in “litter phenology”: litterfall was markedly higher in control plots during with a peak during the winter months. In experimental plots, in contrast, litterfall had a second peak during the summer. These differences in litter production reduced the leaf area index in the forest canopy but litter decomposition rates remained relatively unchanged. After eight years, we observed significant accumulated differences in litter decomposition between treatments and recorded marginal differences in bacterial-to-fungal ratios. We argue here that long-term changes in litter quality and quantity, product of reduced summer rainfall predicted by climate change models, could affect nutrient cycling in these Chilean temperate ecosystems, with concomitant consequences for carbon sequestration capacity in soils and biomass. Our results will be discussed in the context of the value of long-term monitoring to understand the dynamics of Chilean temperate forest ecosystems under climate change.
Interactive effects of climate change and eutrophication on mangrove seedling growth and establishment

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The dispersal and wellbeing of seedlings governs to a large extent the spread and survival of mangrove forests. Currently cultural eutrophication and global warming are major challenges endangering the integrity of coastal ecosystems in tropical seascape. However, how these stressors affect seedling growth is not well understood. In a laboratory experiment we grew seedlings of the mangrove Brugieria sexangula in temperature-controlled chambers and investigated single and combined effects of increased temperature (23 and 33°C), sediment organic matter (fish feed) and dissolved nutrients (ammonium) on seedling trait morphology. Seedling survival, growth and leaf number were highest in non-enriched and ammonium-enriched and lowest in the organic matter-enriched treatments, indicating adverse conditions for seedling growth in sediments with high organic matter contents. Opposite to non-enriched treatments, ammonium-enrichment led to higher aboveground compared to belowground biomass. Moreover, combined effects of temperature and ammonium-enrichment caused differences in root morphology with fewer but longer and thicker 3rd order roots, fewer 2nd and no 1st order roots in ammonium-enriched (23°C) compared to non-enriched treatments (33°C). Our results indicate under future stresses of climate change-induced higher temperatures as well as human-induced higher nutrient and organic matter inputs, mangrove seedling survival may be reduced. Possibly seedlings will be less resilient for withstanding storms or sea level rise as a result of a comparatively lower belowground biomass and root complexity. In addition, seedlings having fewer 2nd and 1st order roots, which are an important source of carbon to the sediment, could decrease mangroves’ function as carbon accumulators. This study introduces a new perspective in how local (nutrient) and global (temperature) stresses, and in particular the combined effect of both, may impair the development of seedlings root architecture and what this means for ecosystem scale processes. Adult mangrove trees can be directly negatively affected by these global and local stresses, however if the potential new seedlings which help the forest to recovery are also affected then these stresses are amplified. These effects could be especially important to already temperature-stressed mangrove forests such as those found in arid areas or forests with high anthropogenic nutrient input.
T1: DRivers of Long-term Changes in biodiversity, Ecosystem Integrity and Ecosystem Functions

Cormorant - fishery conflict: an integrated approach (Romanian Lower Danube River waterscapes)

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In the latest reports, policy and public discourses regarding the current status of the inland commercial fishery around Europe a special concern relates to the negative impact of fish eating bird species, in particular Pigmy and Great cormorants. In this context, government officials, managers, fishermen associations and influential expert groups consider the Cormorants as “invasive” or “pest” for the extensive and intensive commercial fishery practiced in Danube delta (DD) and other maintained wetlands (e.g. Small island of Braila (SiBr)) of former waterscapes connected to the lower Danube river stretch, the core of the Romanian inland commercial fishery.

Recently, significant changes in the specific legislation, formerly established for these areas when they became part of the global (World Heritage site, Ramsar site and Biosphere Reserve) or European (Natura 2000) networks, have been proposed and some were already adopted and applied.

Considering these circumstances, we focus our presentation on three questions: 1) which drivers are responsible for the exponential growth of the cormorant population size in DD and SiBr areas? 2) are the cormorant populations, currently, the only or most powerful “enemy or competitor” which strongly limits “sustainable growth” of the inland commercial fishery? 3) how to manage the most critical policy and governance of the conflicts around cormorants?

To answer these questions, we used selected results from previous analyses on long term dynamics of biophysical structure and physical economy (bio-economy) of the Lower Danube River waterscapes (LDRW). In that regard, we focus on three major driving forces: conversion of wetlands into agricultural polders; point and diffuse nutrient inflow; eutrophication, and their trade-offs. Also, we consider the latest reliable estimates of Pigmy and Great cormorants’ populations size and theirs daily consumption rates. Additionally, we compared the estimated fish production potential of current physical economy with the recorded fish catches.

Under the new stabilized functional regime established in late 1980s we explain the continuous reduction of former fish production potential and fish catches, up to current levels, but, also the exponential cormorant population growth from an average of two thousands individuals up to current relative level of 40 thousands. We notice that the population size growth of cormorants follows the increased contribution of plankton dependent fish species to the total fish production potential. Considering a daily consump-
tion rate of 400 grams per individual, we found a total estimated fish consumption of 6kt/year which together with the estimated consumption of other piscivorous birds species, the total fish uptake rise at 8kt/year. Thus, according with the economic criteria, cormorant might be classified as an invasive species.

To answer the third question, we propose a comparative approach of two possible alternatives: the first, consisting in sectoral, short and medium term, and local scale implementation; and the second, based on integrated, long term and large scale adaptive management.

T1: DRIVERS OF LONG-TERM CHANGES IN BIODIVERSITY, ECOSYSTEM INTEGRITY AND ECOSYSTEM FUNCTIONS

The role of scales and attributes considered in farmland bird decline - a bird community change analysis from Northeast Germany

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Birds are considered reliable indicators for the biodiversity of agricultural landscapes. A careful statistical analysis of species occurrence and activity density based on long run monitoring data can support the understanding of recent occurrence patterns and change of bird communities, the discovery of functional mechanisms between bird occurrence and landscape structure and use, and finally the deduction of strategies to protect and promote bird communities. Current study analyzes how the bird community of the Quillow catchment region in North East Germany changed between two multi-annual observation periods (1999 – 2002, 2013 – 2015). Analyses are done from different perspectives: the distribution of species and individuals is accomplished related to single observation points, biotope types or landscape. The distribution of species and individuals is accomplished related to different bird guilds (arable land, grassland, forest, settlement, hedgerow). The results differ with regard on the spatial scales and bird parameters considered: (i) the landscape related overall bird species diversity, do not changed significantly between the two observation periods; the order of species frequency within the landscape do not changed significantly; (ii) the local distribution of bird species changed significantly; the species richness at individual observation points decreased significantly; (iii) the activity density of bird individuals decreased for all all of the most frequent 20 species; (iv) different bird guilds were affected in varying ways; local decrease of occurrence and density was particular obvious for the guilds of the arable land, of hedgerows
and of the grassland. The results suggest that the habitat conditions for birds in the Quillow catchment have changed in a systemic way between the two observation periods (1999 – 2002; 2013 – 2015). The whole bird community is downsized, the temporal and spatial habitat use is reduced. Many species are increasingly restricted to less points in the landscape. This is shown by high increases in variability between the single points. The remnants of singular habitat qualities become a much higher relevance as hot spots for the maintenance of bird species diversity at the landscape scale. Bird activity density on grassland and forest plots decreased much faster than on arable land. The habitat use of habitat specialists is in most cases wider than their typical breeding habitat. The landscape wide distribution of the predominant single species (landscape use) showed a generic decline over nearly all species. This finding suggests that while availability of semi-natural habitats drive mainly the bird species numbers, bird activity densities depend more on the habitat quality. From the results hot spots for bird occurrences, species richness and activity density can be characterized as consisting of a mixture of different habitats. Low amounts of extensive grasslands had higher quantitative positive impacts on bird species richness and activity density than used grasslands and thus can compensate negative impacts from other habitats. Analyses on the impact of land use management are in process.
Whole system diagnostics: a new diagnostic approach to combining the Bulgarian mapping and assessment, validation and monitoring through bioindication

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The current approach to monitoring of environmental pressures on ecosystems and the trends in their development is highly dependent on knowing the nature of said pressures. Being specific for quantifying known pressures comes at the cost of expensive testing for each of them, and such approach is not flexible if pressure sources are unknown or emergent pressure types are not yet identified as measurement methods and protocols.

To amend this shortcoming, we develop a holistic diagnostic approach based on the ILTER Whole System (WS, see Mirtl et.al., 2018) concept and analogies to the Eight Principles diagnostics in Traditional Chinese Medicine (TCM) developed in Gocheva et al (2019). The Bulgarian ecosystem condition and services mapping and assessment methodological framework is based on the WS concept, allowing for unique conceptual compatibility between one-time snapshots during the mapping and assessment phase, targeted visits for in situ validation of discrepancies and long term ecosystem monitoring.

Building on this advantage, we present a cross-ecosystem three-stage bioindication method based on the Specific Oxidative Stress index (SOS, see Yakimov et al., 2018). In the first stage, SOS is calculated in sentinel species as indicator for pressure trends. The detailed investigation would only be needed when the calculated SOS values alerts for developing of stress syndrome in indicator organism, thus they can serve as early warning system for stressful environmental conditions.

The acquired pressure data is cross-calibrated against traditional measurements of pressures known to exist in the affected sites. In the second stage, we use the SOS as input to diagnostic models on the ecosystem condition and pressure trends. We then assess the pressure’s genesis, magnitude and possible impact on the ecosystem condition in a simplified manner following the TCM’s Eight principles diagnostics. The georeferenced nature of such assessment allows for landscape or catchment level analysis of pressure causes across ecosystems and systematic hypothesis building on the nature of the pressures. In the third stage, we verify the hypotheses using targeted analyses by traditional methods.

We present the methods used in the three stages of holistic WS diagnostics and discuss its advantages and next steps towards its implementation.

Keywords: Whole system approach, environmental pressures, oxidative stress, analogy to Traditional Chinese Medicine
T2: CLIMATE CHANGE IMPACT ON ECOSYSTEM PROCESSES

Tropical forest response to global change: studies from the Luquillo Experimental Forest

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The Luquillo Experimental Forest (LEF) is located in northeastern Puerto Rico (US Caribbean). The spatial and temporal variability in the climate at LEF is influenced by large-scale movements of air masses, extreme events, and regional and global climate change. Understanding the way in which organisms and ecosystems respond to gradients of climate and land use intensity is vital to the sustainability of populations, water resources, and ecosystem services. In the LEF, these patterns are expressed in the context of the rich biodiversity of the tropics and the complex interplay of land use, hurricanes, and plant and animal responses to resources and competition. This presentation will focus on how long-term data and manipulative experiments conducted at LEF provide deeper mechanistic understanding of the controls on the structure and functioning of these tropical forests in the context of climate change. Changes in extreme weather patterns, including an increase in hurricane intensity and more frequent drought events are projected to alter the distribution of biota in this tropical forest. Recent studies on cloud base at local and regional scales will be highlighted to help understand tropical montane cloud forest vulnerability to climate change. In addition, recent studies on the effects of the 2017 hurricanes on forest dynamics in Puerto Rico will be presented.
Urban areas—their inhabitants and their infrastructure—are often concentrated in exposed areas like coasts and drylands and thus vulnerable to extreme events. Climate change is driving increasing frequency and magnitude of such events, thus threats to people and infrastructure in cities is one of the prime manifestations of the interaction between these two major components of global change. We present a conceptual framework for urban social-ecological-technological systems (SETS) that integrates three domains: social/equity/governance, environmental/ecological, and engineering/built environment/technology issues. We assert that socioecological systems and socially sensitive engineering approaches that fail to incorporate the third dimension may reduce resilience to climate-related disaster. The Urban Resilience to Extremes Sustainability Research Network is exploring: 1) potential solutions such as green infrastructure and safe-to-fail design, 2) modifications of ecosystem services approaches and vulnerability and resilience assessment under a SETS framing, and 3) participatory visioning of sustainable, resilient futures to guide urban transformation. A SETS approach enriches these activities through sensible balancing of the three domains, evaluating tradeoffs among them and opportunities for emergence that can support transformation. The infrastructure of the future must leverage ecosystem services, improve social well being, and exploit new technologies in ways that benefit all segments of urban populations and are context specific. These contexts are defined not only by the biophysical environment but also by culture and institutions of each place. The SETS conceptual framework is being applied in ten diverse western hemisphere cities to co-develop, with city practitioners, visions of resilient SETS infrastructure for an uncertain future.
Lectures

T1: DRIVERS OF LONG-TERM CHANGES IN BIODIVERSITY, ECOSYSTEM INTEGRITY AND ECOSYSTEM FUNCTIONS

Contribution of LTER sites across the globe to the diversity-stability debate

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We used methodology developed in Bird’s thesis relating diversity, asynchronicity to stability of populations and communities to analyze data from LTER sites across the globe. We presented the idea at the ILTER annual meeting and sent out a call. The research aims to use data from different LTER sites from around the world to build a model that explains what factors contribute to the stability of ecosystems. The long term stability of any given ecosystem is important since it gives an indication as to how the ecosystem will be able to survive and adapt in the face of fast changing conditions, such as global warming and human impact. It is expected that data from LTER sites will provide data about a wide range of different ecosystems from different places in the world. This will allow us to test if different ecosystems in different parts of the world, behave in similar ways and if there is a general model which can explain stability. We will be looking at a number of variables as potential drivers of stability. These will include, but not be limited to, diversity, richness and asynchrony. We then look at differences between plots within a site and compare their stabilities. We test differences between abiotic conditions and anthropogenic disturbances on the ecosystems. We then test via which mechanism (diversity, asynchronicity, population stability) affects the community stability in each plot. We received metadata from 62 LTER sites from 27 countries that have expressed an interest in participating in the research. At present we have received data suitable from four sites and are using this as a pilot. We will show how data from different biomes and ecosystems can be used in the same analysis.
T2: CLIMATE CHANGE IMPACT ON ECOSYSTEM PROCESSES

Aridity thresholds for ecosystem processes concur across a gradient, rainfall manipulations and long-term monitoring in Mediterranean shrubland ecosystems

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Higher temperatures and increased drought are predicted for the eastern Mediterranean region. Ecosystem traits are expected to be affected by climate change, but the pattern of these effects is unclear. Here we analyzed the patterns of change in annual litter decomposition along an aridity gradient (90-780 mm mean annual precipitation) and following rainfall manipulations (-30%, +30%) in Mediterranean shrubland ecosystems. In addition, decomposition and nutrient status of key woody species were monitored at an LTER site during 5-10 years that were characterized by extreme variability in rainfall (280-740 mm). Litter decomposition along the aridity gradient co-varied with decomposition in the rainfall manipulations along the same piecewise function. Annual decomposition decreased slightly with aridity above a threshold of ~580 mm annual precipitation (aridity index 0.42), but declined markedly (~5 times steeper slope) beyond this threshold towards drier conditions. At the LTER site, decomposition varied with aridity in a way similar to the gradient and the manipulations. Decomposition changed little during years above a threshold of ~550 mm annual precipitation (aridity index 0.35), but decreased markedly beyond this threshold. In addition, leaf nutrient concentrations at peak season, a measure of plant nutrient status, in two dominant shrubs at the LTER site displayed a pattern that resembled the ones for decomposition. For example, the annual precipitation threshold for leaf phosphorus and potassium ranged 480-540 mm among the two species. Plant nutrient status remained largely high and stable in years at or above the threshold, but decreased considerably in drier years. The patterns observed in this study suggest that at least some ecosystem traits change little when conditions become drier until a certain threshold is reached, beyond which trait values decrease to a much larger degree.
The Terrestrial Ecosystem Research Network (TERN) is Australia’s national research infrastructure to observe, monitor and support the study and forecasting of continental-scale ecological changes.

Building, consolidating and operating the associated data infrastructure are challenging endeavours. In general, TERN data are classified under two themes: Ecology and Biogeophysical. The Ecology theme relates predominantly to plot-based ecological observations conducted as one-off, repeated surveys and sensor-based measurements. The Biogeophysical theme-related data collections are inclusive of: point-based time-series eddy-covariance based micrometeorological measurements from flux towers; and continental and regional scale gridded data products related to remote sensing, soil and landscape ecology. The user-centric data handling mechanisms for these datasets are different, requiring different data management practices alongside ease of access to data for users bundled with tools and platforms to interrogate, access, analyse and share analysis pipelines.

TERN is developing data e-infrastructure to support holistic capabilities that not only manage to store, curate and distribute data but also enable processing based on user needs, linking consistent data to various analysis tools and pipelines and acquisition of data skills. The infrastructure would allow collaboration with other national and international data infrastructures and ingest data from partners including state and federal government institutes by adopting domain standards for metadata and data management and publications.

For effective data management of plot-based ecology data, we are developing an ontology based on O&M and Semantic Sensor Network Ontology with an extension to support basic concepts of ecological sites and sampling. Besides, controlled vocabularies for observed properties, observation procedures and standard lists for taxa, geology, soils etc. will supplement the ontology.

The biogeophysical data is managed using domain standards in the data and metadata management. Each of the data products is represented in a standard file format and hosted in an OGC standard web services. All datasets are described and catalogued using ISO standards. An overarching discovery portal allows users to search, access and interact with data collections. The user’s interaction with data can be at the collection level, on a spatial map and via web services and Application Programming Interface (API).

TERN has also developed a cloud-based virtual desktop environment, CoESRA, accessible from a web browser to enable easy access to the computing platform with tools for the
ecosystem science community. The advantage is that it allows access to all TERN data in a compute environment for performing analysis and synthesis activities from a single managed platform.

The parallel data skill development program is designed to bridge the knowledge gap on how to use data. This is achieved through a proactive engagement with the user community to offer tutorials, source codes and help on how to access and use TERN data for more effective research outcomes.

T5: NEW METHODS, TECHNOLOGY AND INNOVATIVE SCIENCE SUPPORT SERVICES

Linking local in situ monitoring data and European data bases for mutual advantages – Innovative approaches for monitoring the effects of nature based solutions in the urban environment

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In the framework of a collaboration project involving Hamburg, London, Milano and five further cities, nature based solutions (NBS) are implemented to foster sustainable and socially inclusive urban regeneration. Monitoring the effects of interventions taken is a prerequisite for assessing their performance regarding innovation and sustainable urban development and their potential for cost-effective replication. Related parameters equally involve natural scientific and sociological information.

European data sources can provide ancillary data to local monitoring data, and, likewise, European databases can be enhanced through inputs from local sources for the mutual benefit of stakeholders operating at local and continental levels. A parallel can be drawn to current approaches within LTER which are aimed at adding value to satellite derived data products through the combination with site-based monitoring data for ground truthing capabilities and to enhance its own capacity to apply several socio-ecological metrics across multiple scales. Although the urban environment is not among the most prominent focal areas of LTER, it is frequently addressed in the framework of LTSER, and specifically by several sites and platforms, e.g. the Zone Atelier Environnementale Urbaine in France.

Several issues still need to be resolved, partly stemming from large differences in spatial and in several cases also temporal resolution, but, fortunately, even pan-European data products show increasingly smaller minimum mapping units. The current technical and
legal data management capabilities of municipalities are in many cases not yet sufficient for establishing an operational data flow from and to external data sources. Common metadata standards need to be implemented in order to be compliant with the European standards which most EU data platforms are using and to ensure interoperability, and open data sharing standards are required.

Nevertheless, it has been shown that several practical subject matters can benefit from such data exchange mechanisms, including analyses across scales; boundary conditions which influence the state of the environment and the functioning of ecosystem services within the municipal areas; comparisons between different urban areas in the same vicinity or far apart from each other; and, in either direction – bottom up from local to European and top down from European to local, gap-filling of data, quality testing, and obtaining complementary information for new insights.

Examples are provided for workflows and protocols of integration and interoperability of municipal information systems and European data sources, including Copernicus, European Environment Agency, and Joint Research Centre sources. On a conceptual level, these approaches are shaped to best suit policy processes (new urban Agenda, SDGs) relevant for the pertinent stakeholder groups, researchers, and the citizens affected. On a technical level, protocols were developed for feeding open-sourced municipal data into EU knowledge platforms and mechanism were determined to identify addresses, terms, frequencies, formats and ICT specifications for unhindered transfer.
T4: ADVANCES IN LONG-TERM SOCIO-ECOLOGICAL RESEARCH AND SUSTAINABILITY SCIENCE

Linking Social and Ecological Data to Understand how Pacific Island Fishers Navigate Changing Coral Reefs

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Coral reefs are transforming due to global and local stressors, and millions of coastal people who depend on reefs for their well-being will be compelled to adapt their resource use strategies. However, links between ecological state of the reef and human activities such as fishing remain poorly understood. One opportunity for exploring the reciprocal feedbacks between fishers and reefs arises when an abrupt and dramatic change in ecological state occurs. The responses of local resource users in such cases are critical, as they may sustain ecosystem resilience or amplify the shifts. However, a major challenge for study of social-ecological systems during disturbance and recovery periods is that time series data on the relevant socioeconomic and environmental factors are not always available. Here we combine underwater ecological censuses, catch data, and household surveys to evaluate how reef fish and fishers at the Moorea Coal Reef LTER site in Moorea, French Polynesia responded to landscape-scale loss of coral resulting from a destructive cyclone and an outbreak of crown of thorns sea stars. We identified and sized fish in the catch and on the reef during a nine-year period that spanned the disturbances. We found that the overall biomass of fishable resources changed little over time, but that there were substantial changes in the taxonomic composition of the catch, many of which reflected taxonomic shifts on the reef. To gain additional insight into fishing strategies, we collaborated with fishers who are outfitted with smartphones to self-report their fishing outings with respect to timing, reef areas exploited, and catch. Although we found evidence for high taxonomic selectivity in fishing, less than 20% of households indicated that they changed their fishing practices in response to the disturbances. Our findings have broad implications for implementing effective local-level co-management where resource users, scientists, and conservation practitioners may have different interpretations of what constitutes change in these dynamic systems.
Regional greenhouse gas (GHG) budget of Kokemäenjoki river basin, SW Finland

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Ongoing intensification of the hydrological cycle is altering rainfall regimes by increasing the frequency of extreme wet and dry years and the size of individual rainfall events. Despite longstanding recognition of the importance of precipitation amount and variability for most terrestrial ecosystem processes, we lack understanding of their interactive effects on ecosystem functioning. We quantified this interaction in native grassland by experimentally eliminating temporal variability in growing season rainfall over a wide range of precipitation amounts, from extreme wet to dry conditions. We contrasted the rain use efficiency (RUE) of aboveground productivity (ANPP) under conditions of experimentally reduced vs. naturally high rainfall variability using a 32-yr precipitation-ANPP dataset from the same site as our experiment. We found that increased growing season rainfall variability can reduce RUE by as much as 35% during dry years, but that such impacts weaken as years become wetter. During low precipitation years, RUE is lowest when rainfall event sizes are relatively large, and when a larger proportion of total rainfall is derived from large events. Thus, a shift towards precipitation regimes dominated by larger rainfall events, already documented over much of the globe, can be expected to reduce the functioning of mesic ecosystems primarily during drought, when ecosystem processes are already compromised by low water availability.
T4: ADVANCES IN LONG-TERM SOCIO-ECOLOGICAL RESEARCH AND SUSTAINABILITY SCIENCE

Is socio-ecological research meeting expectations? Results from a case study evaluation of Long-Term Socio-Ecological Research (LTSER) programs in Europe

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Technion - Israel Institute of Technology

Researchers from diverse fields of practice who strive to produce research to address global environmental challenges have often touted a transdisciplinary approach to integrated socio-ecological research. Existing literature about evaluating transdisciplinary research suggests that the assessment process itself is valuable for promoting reflection and dialogue, and that its results can incrementally and iteratively be used for learning and process improvements. However, few evaluations of socio-ecological research have been conducted, and therefore there have been few instances in which assessment frameworks have been tested to determine their usefulness. To address this gap, we created a customized evaluation framework and used it to conduct a multi-site, qualitative, participatory evaluation of several designated socio-ecological study regions across Europe.

We conducted 66 stakeholder interviews using as our case study four designated Long-Term Socio-Ecological Research (LTSER) platforms – Danube Delta LTSER and Braila Island LTSER, Romania; Cairngorms LTSER, Scotland; and Doñana LTSER, Spain. After synthesizing interview data, we returned to the sites to present findings and facilitate focus group discussions with stakeholders in order to incorporate their feedback into our final analysis.

We conclude that while charismatic scientists at the case study platforms have led the charge toward implementing transdisciplinary science, institutional and cultural barriers have limited progress toward meeting the objectives of socio-ecological research. Goals -- such as integrating social sciences research with ecological research, including diverse stakeholders in setting the research agenda and co-producing knowledge, improving knowledge exchange among stakeholder groups, and making data transparent and accessible -- have made limited progress, but have also faced acute challenges. We observe some of the contributing factors to this phenomenon, especially by highlighting local context and the influence of being linked into a European and global research infrastructure. We conclude with reflections about implementing our evaluation methodology, and make recommendations for improving transdisciplinary, socio-ecological research in Europe.
The paper is aimed at the presentation of the integrative approach assessment of environmental land use conflicts. The changes in land use are reflected not only in changes of land cover. They can also induce changes in individual components of geosystem (spheres) and are the main initiation of many environmental problems. From this perspective is important to use broader, more complex approach to the land-structure studies that takes into account also the position and relations in landscape (cause – consequence). Finding he causes and causalities of these changes is very important for the rational land use. The basic tool for suitable landscape utilization is integrated landscape management as a major instrument of sustainable development. It must be based on understanding landscape systematically as geosystem. The every point of the landscape is representing the integrating scope, scene in which all natural resources are occurring as layers (geological sources, water and soil sources, climate, biotic sources, and morphometric parameters) which are mixing together. It is seen as understanding the space as integration of particular natural sources in given area of landscape. Using one source can negatively affect the quality of other sources. For example, intensive use of soil resources can threaten water resources - negative impacts of chemistry, mechanization, and so on. Therefore, land use needs to be assessed on an integrated basis.

From aspect of „sustainability“, the target is to define such landscape management, which would regulate socio-economic development in landscape with its natural, human, cultural and historical potential. It is based on the consistency of supply, which is represented by landscape resources, and demand, which is represented by community needs and requirements. The discrepancy between supply and demand (not respecting the properties of landscape resources) is the determining factor of formation of the environmental problems. The aim of the paper is to present the methodology for the assessment of the environmental land use conflicts, based on integrative approach. Since the problems of the land-use conflicts in our understanding result from ignoring the mutual relationships of all structures and components of the geographical sphere, the object of our assessment is the integrated system of a spatial section of the geosphere. This approach includes the mutual comparison of the abiotic conditions (primary landscape structure), land cover including biotic elements (secondary landscape structure) as well as the legal conditions and limits for development of a territory (tertiary landscape structure). The paper presents application of the methodology in the study area – LTSER Trnava.
Black widows on an urban heat island: hormonal, developmental and behavioral shifts stemming from extreme heat

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As more than ½ of our population now lives in rapidly expanding urban centers, urbanization is a particularly important example of global change, or ‘human-induced rapid environmental change’ (HIREC). The impact that HIREC has on the biota and ecosystems around us has unknown consequences for the long-term sustainability of habitats, particularly for organisms, including humans, trying to inhabit desert locales. Here we seek to understand how a clear and extreme alteration to the urban environment (elevated temperatures stemming from the urban heat island “UHI”) impacts the genetic and endocrine mechanisms underlying the behavior and development of early instar spiderlings of a common urban arthropod pest, the Western black widow spider (Latrodectus hesperus). Specifically, in this talk I will review recent data that document the black widow’s micro-habitat in the desert and city, and use this temperature difference to show that this UHI 1) spikes ecdysone (20E) production, 2) slows development, reduces mass and increases mortality of spiderlings, and 3) alters the web-building and foraging (but not courtship) behavior of black widows.
During the 1930’s Dust Bowl drought in the central United States, grasslands dominated by C4 species with high water use efficiency were transformed by widespread increases in “cool season” C3 grasses. This response is inconsistent with theory and these species’ ecophysiological traits. We imposed four years of experimental drought in C4 and C3-dominated grasslands and documented similar increases in C3 relative to C4 grass biomass, corroborating these historic observations. Across the central United States, grasslands are C4 dominated where precipitation and warm temperatures are strongly coupled. In contrast, C3 grasses flourish where precipitation is less concordant with temperature. By examining historic climate records, we show that extreme drought decouples nominal temperature-precipitation relationships, critically shifting the timing of resource availability from the warmest months to cooler months. This explains how increases in C3 grasses can occur during extreme hot, dry years. These findings highlight how climate extremes, which are expected to increase in frequency in the future, can lead to unanticipated ecosystem consequences.
Climate change drives global shifts in lake thermal habitat

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Climate change has warmed the surfaces of many lakes across the planet. In general, lake warming is expected to shift thermal habitat for lake organisms in time and space with potential consequences for aquatic biodiversity. However, the variability in warming patterns across depth, area, and season causes uncertainty in how bulk thermal habitat in lakes has shifted in response to climate change globally. Fully understanding the change in bulk thermal habitat in lakes would improve our predictions of how organisms may shift their distributions spatially or seasonally to maintain isothermal conditions in the face of lake warming. Here, we quantified the long-term change in bulk thermal habitat in more than 100 globally distributed lakes over the last 4 decades using in situ temperature data. We define bulk thermal habitat to be the amount of lake volume (km³) integrated over a specific time period (e.g. 2001-1-1 to 2001-12-31) which falls within a specific temperature range (e.g. 23-24°C). We found that many lakes have shifts in thermal habitat that could threaten thermal specialists. In many cases, decreases in bulk thermal habitat over specific temperature ranges in some lakes are partially offset by increases in others. The redistribution of life on Earth has arisen as a major ecological response to anthropogenic climate warming. As the Earth warms, lake organisms may shift to new environments to which they may not be well-adapted. Our results demonstrate the extent to which lake shifts, seasonal shifts, and depth shifts can potentially be used to maintain thermal stasis in a warmer world.
Can we sustain ecohydrological regulation in rural landscapes under socio-economic transitions? Case study of the The Pilica River Catchment (LTSER platform, Central Poland)

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Integrity of complex systems, like river catchments, emerges from the balance between intensity of land use and diversity of ecosystems, which primary enables habitats to species and ecospecies, while secondary is responsible for regulation of water and nutrient fluxes, and hence quality of environment. Due to location in landscape depressions, those are water bodies which undergo a cumulative impact of land use practices, becoming ultimate indicators of loss of ecohydrological (water-soil-biota) regulatory feedbacks. The observed outcome is decline of river biodiversity and increased frequency and intensity of cyanobacterial blooms in reservoirs.

Many Central and Eastern European countries entered tough transition process when joining European Union, and switching from top-down regulated into open market. In Poland this process has been pushing agriculture in many regions, from small scale, family farms, towards large – scale industrial food production. It is leading to fast rebuilding of traditional, mosaic landscapes, famous for their biodiversity, into uniform ones, often missing not only ecologically important, but also culturally appreciated elements.

The paper brings together results of long-term monitoring of fish populations in the Pilica River and the Sulejów Reservoir, outcomes of the catchment SWAT modelling focused on identification of nutrient sources and sinks and possible NBS based on landscape elements, and finally socio-cultural studies aimed at identification of key drivers of environmental change, including appreciation of landscape elements and EU instruments. The general framework was provided by resilience and regime shifts model of Kinzig et al. 2006. The final outcome are scenarios defining the critical factors driving landscape changes, the required actions at local and national level to steer the process towards sustainable management, and reflection over the possibility of using ecohydrological NBS to maintain quality of water resources while supporting biodiversity.
T4: ADVANCES IN LONG-TERM SOCIO-ECOLOGICAL RESEARCH AND SUSTAINABILITY SCIENCE

Paving the blue-green way through Polish cities – how much green in green the “S” allows. Lodz LTSER case study

Kinga Krauze
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Urban systems are particularly prone to the nexus type of socio-ecological problems, where space, time and range of perceptions make management choices challenging and usually unsatisfactory to at least some users of the place. Cities attract people with promise of wealth, but simultaneously unstoppable growth accompanied with rigid conventional management system, and often discordant policies, threatens well-being of inhabitants. One of promising approaches has become building of natural capital of cities to strengthen an adaptable component and satisfy stakeholders through multiple functionalities and range of benefits.

The concept of blue-green infrastructure has been complemented with ecosystem service approach to develop currently into nature-based solutions, incorporated into broader idea of green growth and circular economy. Uneasy economic choices and societal and environmental compromises look even more problematic in new democracies tempted with global markets and dream of unlimited growth.

Last couple of years raised awareness of bad and continuously deteriorating living conditions among inhabitants of Polish cities. It was triggered by EU statistics which listed Polish cities among the top most polluted with smog in the world and deepen by the climate change adaptation plans accomplished this year. That brought to the debate an issue of low emission, unsustainable transportation, but also urban greenery and vulnerability of people being i.e. an effect of poverty.

In the City of Lodz, being LTSER platform since 2005, we have analysed the readiness of the elements of socio-ecological system to adjust to new conditions and to adopt the environmental stewardship model at different functional and operational levels of city management. We traced discrepancies between individual, institutional and societal claims and believes, and daily practice, as well as general gaps in policy and management schemes that handicap the resilience of the system.
Due to climate warming, glaciers retreated during the past 150 years in many parts of the Alps and gave way to some of the few opportunities of genuine, natural primary succession. I initiated long-term relevés in four glacier forefields of the Northern Limestone Alps (Dachsteingebirge 2016, Berchtesgadener Alpen 2018), covering a chronosequence of areas were the glaciers retreated approx. 10 years, 40 years, 70 years and >100 years ago, respectively, with 52 relevés all together in an almost balanced design. Using the frequency method, I surveyed the vegetation analysed data of the initial sampling period, namely species richness, vegetation cover and the composition of several traits, based on the TRY database, across the chronosequence. I used linear mixed effects models and multinominal, vector generalized linear models. While it is obvious that cover as well as species richness increased with successional time, traits revealed more pronounced patterns. There is, e.g., an increase in the proportion of insect pollinated species and a decrease in those able to do selfing. Similarly, there is a decrease in the proportion of facultative mycorrhiza over time and an increase in non-mycorrhiza. Using Grime’s Strategy, the proportion of ruderal strategists is low, as expected, and decreases further while the proportions of both competitors and especially stress strategists are higher and even increase during successional stages. Summarizing, the chronosequence revealed changes in the composition of traits from those adapted to colonisation without being dependent on other organisms to compositions that allow for more species interactions.
Occurrence of chigger mites mediating Tsutsugamushi disease and host rodents in the central region of South Korea from 2015 to 2018

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With increasing prevalence and expanding geographic distribution of vector-borne diseases under the influence of climate change, the number of patients with Tsutsugamushi disease (also known as scrub typhus), an endemic disease in Asia, has been increasing every year. Given the increasing likelihood of accidental importation of disease vectors due to the ever-increasing international trade and travel, there is a need to establish a long-term monitoring system for disease vectors. This study was carried out from 2015 to 2018 by collecting wild rodents, the principal natural hosts of chigger mites that transmit tsutsugamushi disease, to investigate their seasonal and environmental patterns and to determine their infection status. In the spring (March, April, and May), during which chigger mite larvae occur, and in mid to late fall (October and November), we collected wild rodents, using Sherman live traps, in five different habitat categories, namely rice paddies, fields, reservoirs, waterways, and hills in and around Gimcheon, Gyeongsangbuk-do, Korea. A total of 225 rodents were collected over 4 years; broken down by species, Apodemus agrarius Pallas, 1771 accounted for 68%, Crocidura lasiura Dobson, 1890 21.3%, Micromys minutus Pallas, 1771 4.9%, Mus musculus Linnaeus, 1758 4.9%, and others 0.8%. Rodents infected with chigger mites accounted for 72.4%, with the number of chigger mites totaling 20,527. The chigger index (CI) by season was 84.1 in the springtime, 134.7 in mid fall, and 162.2 in late fall, demonstrating a high infection rate of chigger mites in rodents during the fall. Over the four years, the CI gradually decreased from 174.5 in 2015, to 114.0 in 2016, 138.7 in 2017, and 48.3 in 2018. The CI by habitat category was 52.2 in rice paddies, 176.6 in fields, 90.0 in reservoirs, 151.8 in waterways, and 224.1 in hills, identifying hills as the most favorable environment for chigger mites. Finally, the CI by rodent species was 140.9 in Apodemus agrarius, 35.0 in Apodemus peninsulae (Thomas, 1907), 14.2 in Crocidura lasiura, 88.4 in Micromys minutus, 49.0 in Mus musculus, and 3.0 in Tscherskia triton De Winton, 1899, identifying Apodemus agrarius as the rodent species with the highest infection rate. Looking at the relationship between the CI and the number of patients with Tsutsugamushi disease over the period of this study, the CI and the incidence showed similar trends from 2015 to 2017. In 2018, however, whereas there was no significant change in the number of patients, the CI sharply fell by 82.3% compared with the previous year, even by 97.8% in late autumn. This may be ascribed to the unprecedented heatwaves and drought in the summer of 2018, but the drastic decrease in the CI had no significant effect on the number of patients. This discrepancy will have to investigated and analyzed in a future study. Among a total of 450 pools of chigger mites collected, 23 pools were found positive for O. Tsutsugamushi. The minimum positive rate was 0.2%, whereby Boryeong type made up 22 pools and Jecheon type 1 pool.
T1: DRIVERS OF LONG-TERM CHANGES IN BIODIVERSITY, ECOSYSTEM INTEGRITY AND ECOSYSTEM FUNCTIONS

Species insurance trumps spatial insurance in stabilizing biomass of a marine macroalgal metacommunity

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Understanding the factors that promote stability of biomass production is a core concept of Ecology. Although many empirical and theoretical studies have investigated stability, in particular its relation with biodiversity, they have focused mainly on local scales. It is unclear whether insights derived from these local-scale studies extend to larger spatial scales. Metacommunity stability is a new concept that includes multiple spatial scales and allows the integration of the multiple hierarchal levels of organization of natural ecosystems: from single populations to multi-species assemblages and from local plots to regions. In this framework, the species-insurance hypothesis predicts that asynchronous dynamics among species should reduce variability when biomass is aggregated either from local species populations to local multispecies communities, or from metapopulations to metacommunities. Similarly, the spatial-insurance hypothesis predicts that asynchronous spatial dynamics among either local populations or local communities should stabilize metapopulation biomass and metacommunity biomass, respectively. In combination, both species and spatial insurance reduce variation in metacommunity biomass over time, yet these insurances are rarely considered together in natural systems. We partitioned the extent that species insurance and spatial insurance reduced the annual variation in macroalgal biomass in a southern California kelp forest based on 13-year time series collected by the Santa Barbara Coastal Long-Term Ecological Research (SBC LTER). We quantified variability and synchrony at two levels of organization (population and community) and two spatial scales (local plots and region) and quantified the strength of species and spatial insurance by comparing observed variability and synchrony to null models of independent species or spatial dynamics based on cyclic-shift permutation. We found that spatial insurance was weak, presumably because large-scale oceanographic processes in the study region led to high spatial synchrony at both population and community-level. Species insurance was stronger due to asynchronous dynamics among the metapopulations of a few common species. In particular, a regional decline in the dominant understory kelp species Pterygophora californica was compensated for by the rise of three subdominant species, Desmarestia ligulata, Chondracanthus spp and Stephanocystis osmundacea. The regional decline of P. californica and the compensatory increase in the three subdominant species was associated with positive values of the Pacific Decadal Oscillation, indicating that differential species tolerances to warmer temperature and nutrient-poor conditions may underlie species insurance in
this system. Our results illustrate how aggregate community properties can be stabilized by species insurance in natural ecosystems where environmental conditions vary over broad spatial scales and further advance our understanding of the factors contributing to metacommunity stability.

T5: NEW METHODS, TECHNOLOGY AND INNOVATIVE SCIENCE SUPPORT SERVICES

Developing a Continental Biodiversity Sensor network using an ‘add-on mode’ approach

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Australia has a somewhat chequered history in biodiversity monitoring with several flagship LTER plot networks providing a deep understanding of ecosystem diversity and function while in other parts of the continent lesser studied species, in remote ecosystems, have been declining without being noticed and, in some cases, going extinct with only a footnote to note their passing. In 2018 a parliamentary inquiry into Australia’s Faunal extinction crisis was scoped to look at the wider ecological impact of faunal extinction across the continent including examining the adequacy of existing monitoring practices. Monitoring biodiversity in Australia is challenging as in terms of biodiversity, scale and human man power Australia is somewhat unique. Australia is one of the 17 megadiverse countries, it is the 6th largest nation and is the only continent operating as a single country. To undertake monitoring of biodiversity using human man power is problematic as Australia has one of the lowest population densities on the planet – eg Northern Territory (1.4 x 10^6 km^2) has 0.2 people/km^2. As a result, for a long while monitoring biodiversity in a consistent manner across the continent has been regarded as an intractable problem – Australia just does not have the resources to deploy people to do what is needed. At the same time Australia is well aware that things need to be done urgently. The time has arrived then to build a national network to monitor biodiversity in Australia but to do this in a smart fashion using sensors, technology and communications. The new network being developed will take advantage of extant long-term sites across the continent and, in ‘add-on mode’, will deploy to each site sensor hardware to monitor biodiversity, microclimate and provide communication solutions. The use of a large number of extant sites (across government, NGOs, Universities, agriculture…) will allow for a robust statistical design and will help to ensure longevity of the network. The use of ‘add-on mode’, rather than establishing sites from scratch, will allow a co-funding model to be used which will make a large scale sensor network to monitor biodiversity at a national scale viable. This talk will go over the early stages in the development of the Australian National Biodiversity Sensor Network.
Effects of typhoons and El Niño-Southern Oscillation events on intertidal seagrass beds over decadal timescales

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As we know little about how disturbances such as typhoons and El Niño-Southern Oscillation (ENSO) events affect seagrass beds, diverse seagrass habitat types (*Thalassia hemprichii*) were surveyed once every three months for 16 years (January 2001 to February 2017) in southern Taiwan, which is regularly affected by typhoons and ENSO events. Environmental, seagrass and periphyton data collected in the wet season before the occurrence of a total of 67 typhoons and those acquired in the wet season of a year without a typhoon were treated as controls. Additional data collected within 30 days after 11 of the typhoons were treated as posttyphoon responses. La Niña and El Niño events had distinct effects on the biomass and growth of *T. hemprichii*. During La Niña years, higher 1) precipitation levels and 2) seawater nitrogen concentrations led to increases in seagrass leaf productivity, canopy height, and biomass. However, the latter simultaneously stimulated the growth of periphyton on seagrass leaves; this led to decreases in seagrass cover and shoot density. There were no significant overall differences in either the environmental data or the seagrass response variables in response to the typhoons. However, the silt/clay content in the sediment were significantly higher after the typhoons. The seagrass aboveground biomass, canopy height and periphyton biomass declined in the more-exposed reef flat sites, while these variables were not affected in the sheltered tide pools. The significant losses in the aboveground portions and periphyton suggest that the typhoon impacts on the intertidal seagrass beds were primarily short-term wind events or storm surges. Relative to the chronic and persistent effects of ENSO, the typhoon effects on the intertidal seagrass beds were dramatic and rapid. While the persistent water quality impacts were more severe during ENSO events, the dramatic physical impacts during the typhoon events were more severe than the nutrient loading elicited by heavy rains. Our long-term dataset revealed that intertidal tropical seagrasses are resilient to typhoons over decadal timescales, possibly as a result of the potential energy storage capacity of the belowground constituents.
Responses of plant functional traits and phenology to climate change in a four-year experiment

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Grasslands are one of Earth’s major ecosystems and provide essential ecosystem services such as forage. At the same time, they are globally recognized for their high biodiversity. For these reasons, semi-natural grasslands are also vital ecosystems in central Europe. However, it is not yet fully understood how climate change – i.e. rising temperature, increased spring and autumn precipitation, and decreased summer precipitation – will affect critical ecosystem functions. Here, the Global Change Experimental Facility (GCEF) in Bad Lauchstädt (Germany) offers a unique opportunity to assess long-term changes. This is prerequisite for drawing realistic conclusions about grassland functioning under future environmental change scenarios, and for implementing mitigation strategies.

In our talk we will present results from the first four years of climate manipulation in the GCEF (2015-2018). At eight occasions (May and August cuts), we sampled plant functional traits of abundant plant species on extensive meadows. This includes specific leaf area, chlorophyll content, vegetative and generative height, and individual biomass. We also recorded plants’ phenological stage on a modified BBCH scale. Effects of altered temperature and rainfall were captured via the Standardised Precipitation-Evapotranspiration Index (SPEI). To compare species responses across years and seasons, we calculated difference values in phenology and functional traits.

We used generalized linear mixed models to investigate the effects of climate treatment, season and SPEI on phenology and plant functional traits; as a random effect, we used sampling event (cut). Results indicate that phenological and functional responses varied considerably among species and year. Treatment effects (such as a delayed plant phenology) were mostly observable in summer, possibly due to an increased water limitation under future climate conditions. While differences between main growth forms (legumes, grasses and forbs) were negligible, we found clear differences in the response of competitive, ruderal and stress-tolerant species, and in the response of wind-pollinated and insect-pollinated species. This study demonstrates that responses in phenology and intraspecific trait variation can already be detected within the first years of simulated climate change. Future observations in this long-term climate change experiment will show whether these initial climate effects will become more obvious, and whether other traits and species will respond at a later stage.
Climate change in Southern Patagonia influencing over forest ecosystem processes and natural regeneration dynamics

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Climate change greatly influenced in extreme ecosystems (e.g. Southern Patagonia) where the season was shortly due to their environmental limitations. Slightly variation mainly influence over season length, affecting the tree and plant growth including reproduction, food availability for mammals, birds and insects, and in consequence over the primary and secondary productivity. The closeness to Antarctica and the influence of both oceans (Pacific and Atlantic) also conditioned the regional climate of the archipelago, where temperature and rainfall patterns were highly correlated different climate phenomena (e.g. ENSO). The objective of this work was to relate changes in climate variables and indexes with forest ecosystem processes and natural regeneration dynamics (primary and secondary productivity, tree mortality, seed production, understory, browsing) in Southern Patagonia, Argentina. We employed long-term data in managed and unmanaged Nothofagus pumilio forests, where year-to-year surveys were conducted in three ranches of Tierra del Fuego and Santa Cruz provinces. We also employed long-term satellite data from MODIS mission (land and sea surface temperature, rainfall, primary productivity net) and climate indexes (ENSO, SAM). Primary productivity net of natural ecosystems are closely related to temperature and rainfall gradients, and extreme events (e.g. ENSO, SAM) influencing over the starting of the growing season, and consequently over the forest and understory growth. Tree mortality in natural stands can be related with climate too, where yearly rainfall (drought during summer) and primary productivity net (stand growth) explain most of the tree losses. Seed production, recruitment and seedling mortality are related to land and sea surface temperature and rainfall gradients, both, during the previous winter and middle summer. Also, understory development were related to the summer length, where food availability decrease in late spring for herbivorous. In consequence, browsing over seedlings due to natural populations of Lama guanicoe increased during these years. Finally, we also related secondary productivity (e.g. forest bird biomass) with primary productivity of forests, and it changed according this variable along the years. Long-term research allowed to understand the observed changes in the forest ecosystem processes and natural regeneration dynamics, in the framework of management proposals and climate change. This monitoring is essential to develop new management and conservation strategies to increase the resilience of the natural forests.
Long-term influence of harvesting over plant understory dynamics and regeneration development in Nothofagus pumilio forests

GUILLERMO MARTINEZ-PASTUR¹; Yamina Micaela Rosas; Vanessa Lencinas; Pablo Luis Peri

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Disturbances have frequently been shown to increase changes in natural communities (e.g. understory plants), and increasing alien plant invasion. Logging was the most common and severe anthropogenic disturbance in Patagonian forests, where regeneration processes need long periods (e.g. up to 15-20 years). Regeneration dynamics were closely related to understory development, and can be sensitive to alien plant invasion (e.g. grasses). The objective was to describe the long-term regeneration dynamics (15 years-after-harvesting) in Nothofagus pumilio forests managed through variable retention (aggregates and dispersed trees), and correlate it with the understory changes (life-forms, origin, etc). Using annually surveyed permanent plots (n = 72), we analyzed temporal changes of understory structure and composition under three site conditions created by variable retention harvesting: retained forest patches of 30 m radius in a density of 1 patch ha-1 (AR), edges of such retained patches (DRI), retained dispersed single trees (DR); and one old-growth primary forests as a control (PF). Natural regeneration dynamics presented different patterns according to the remnant tree overstory, closely related to light and soil moisture availability: (i) seed production was related to canopy closure, but different patterns were observed in managed than unmanaged forests; (ii) recruitment was related to understory, tree shelter and microenvironments (e.g. debris), as well as survival and growth. In brief, AR supported a high cover of understory species that belongs to primary forests, and declined on time due to alien species introduction and other native plants that come from other associate environments. DR and DRI supported much higher cover of alien species, which became dominant few years after harvesting, and the starting to decline due to regeneration growth. Browsing of natural herbivores over tree regeneration, such as Lama guanicoe, were related to understory development, which was higher in DR and DRI, and can be variable along the years. Long-term research allowed to understand the regeneration dynamics, which are the key-factor for the silvicultural management. In consequence, understand the plant dynamics, as well as, browsing pattern along the time was crucial to develop new management strategies to increase the regeneration performance or to understand the regeneration failure in harvested areas.
T1: DRIVERS OF LONG-TERM CHANGES IN BIODIVERSITY, ECOSYSTEM INTEGRITY AND ECOSYSTEM FUNCTIONS

Rainfall anomalies driving fluctuations of biodiversity and ecosystem processes in the Restinga de Jurubatiba National Park, Brazil

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Long-term ecological studies have been developed in a Quaternary coastal plain in Southeastern Brazil (RLaC site), comprising the largest protected restinga remnant (144km²) in South America. Restingas are sandy areas spread along the Brazilian coast comprising a mosaic of open woodland vegetation, spots covered by dry or wet forests, swales and water bodies with high concentrations of dissolved humic substances. Seasonal rainfall seems to be major determinants for the assembling of communities in restingas due the low water retention of sandy soils. As historically abnormal rainfall deficits and excesses are expected to increase in Southeastern Brazil, we have been investigating if such rainfall anomalies have predictable effects on terrestrial and aquatic biodiversity, and ecological processes in restingas. We evaluated whether abnormal rainfall excesses positively affect primary productivity by woody plants, producing more litter, organic carbon, and resources for low vagility small mammals, which would increase their densities. As rainfall might also affect transference of dissolved organic carbon (DOC) from terrestrial to aquatic habitats and regulate the connectivity among seasonally-isolated lagoons, we evaluated if DOC and local fish species richness increased in response to rainfall excesses. Along 2000 to 2018 we monitored litter production, small mammal abundance, DOC concentration and fish species richness in the RLaC site. By contrasting annual precipitation over the study period with the historical mean of 955mm (1970-2000), we distinguished three rainfall scenarios: (1) a precipitation deficit from 2000 to 2003, (2) an excess from 2004 to 2009, and (3) an extended precipitation deficit from 2010 to 2018. We compared parameters among and throughout these scenarios using linear regression and ANOVA models. DOC, fish richness and annual litter production generally decreased in precipitation deficit scenarios. We also found an increase of litterfall in longer dry seasons, suggesting positive effect on leaf abscission, but these results don’t affect the pattern obtained in the three scenarios analyzed, suggesting higher leaf production in rainy years. Among small mammals, responses were varied: a generalist forest species (the black-eared opossum Didelphis aurita), increased its density along the extended precipitation deficit, while two specialist species (the restinga mouse Cerradomys goy-
taca and the four-eyed opossum Philander quica) significantly declined their densities in forested habitats. Results suggest that extended dry years have negative effects on annual primary production, as expressed by reduced litter production, DOC transference to aquatic systems and fish species richness. Next in order, a sequence of dry years might favor generalist species of mammals, such as D. aurita, which could outcompete P. quica and prey on C. goytaca, altering community structure in forests. Therefore, annual rainfall is a major driver of several ecological processes in restingas communities, which affect primary productivity, organic carbon distribution, species richness and abundance in a predictable manner.

T6: GLOBAL RESEARCH INFRASTRUCTURES

ICP Forests: Long-term monitoring of the effects of anthropogenic and natural stressors on forest ecosystems under the UNECE Air Convention

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The International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) was established within the UNECE Air Convention in 1985 in response to wide public and political concern about the extensive forest damage observed in central Europe and North America which had been attributed to increasing air pollution and acidic deposition. Since then, ICP Forests has developed into a multifunctional long-term forest monitoring programme across the UNECE region with 42 member countries participating and produces scientific data and knowledge not only on the impact of air pollution but also on the effects of climate change and other stressors on forest ecosystems.

ICP Forests works at two levels: (i) the systematic, large-scale monitoring network (Level I) provides annual data on forest condition, (ii) the intensive forest monitoring network (Level II) consists of permanent, highly-equipped plots to foster integrative studies on cause-effect relationships based on consistent long-term data series. All in all, ICP Forests collects data on ambient air quality; biodiversity and ground vegetation; crown condition and damage causes; deposition; foliage and litterfall; forest growth; meteorology, phenology and LAI; soil and soil solution. An outstanding feature of the ICP Forests monitoring programme is its high degree of standardization of data collection and quality assurance in each survey and across all member states.

An overview of the ICP Forests programme and its data infrastructure, a summary of results from over 30 years of forest monitoring, latest activities as well as future challenges will be presented.
T1: DRIVERS OF LONG-TERM CHANGES IN BIODIVERSITY, ECOSYSTEM INTEGRITY AND ECOSYSTEM FUNCTIONS

How do plants invade the mountain ecosystem? Drivers of long-term vegetation changes, role of human disturbances

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Mountain ecosystem are relatively untouched ecosystems, however in recent decades they encounter significant changes mainly related to global change and increasing human pressure. Although mountains harbor some of the most valuable ecosystems with high biodiversity, the process of spread of both alien and lowland plants into high altitudes is not sufficiently understood. In our research, we assess long-term spatiotemporal changes of vegetation and soils in last 30 - 40 years at Krkonoše Mts. NP, BR and ILTER site, Czech Republic. We address underlying mechanisms of changes in plant composition, such as alien invasions as well as proliferation of species from lower altitudes into high elevations. We focus mainly on human disturbances, such as effect of roads and other man-made structures on vegetation and soils. They serve as drivers of species movement, and facilitate their establishment and spread into harsh mountain environment. In Krkonoše Mts., long history of human influence and high tourist pressure has markable impact especially on the uppermost areas covered by valuable alpine tundra ecosystem, and the recovery of such low-resilient ecosystem is going to be extremely slow.
AQUACOSM & MESOCOSM.EU: Two networks of experimental aquatic mesocosm facilities offering opportunities to connect ecosystem process studies with LTER findings and activities

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AQUACOSM is an EU H2020-funded network of leading European Aquatic Mesocosm facilities presently including 19 partners with altogether 37 facilities, connecting mountains to oceans from the Arctic to the Mediterranean. A follow-up, AQUACOSM-plus (2020-2024) plans to expand to >50 facilities across the EU and is linked to world-wide cooperation through the MESOCOSM.EU portal, a virtual network of >100 facilities aquatic mesocosm facilities that is rapidly growing. MESOCOSM.EU is a long lasting-low budget network that is a legacy from the marine EU FP7 MESOAQUA (2009-2012) project that has expanded to include mesocosm facilities in all aquatic systems, including rivers, ponds, lakes, estuaries and marine systems.

These networks design large-scale process-based studies for testing present models and long-term trends, in order to understand underlying (ecosystem) mechanisms relating to the present global Grand Challenges (climate change, biodiversity loss, eutrophication, emerging pollutants, etc.). Here we argue that such approaches should be combined with Long Term Ecological Research and monitoring, in order to test the latest environmental models and forecasting, as well as conducting effective ecosystem solution-based experiments to enable effective management in aquatic ecosystems. We further argue that such close connection needs to be established between this network and other RI-networks conducting research and management in all related biomes from earth to atmosphere, with a longer perspective of close integration of these facilities into effective holistic research, and thus effective societal service providers. This presentation aims to contribute to the ongoing debate and planning of closer and more effective RI-collaborations to yield the process-data required to design targeted experiments testing present models. This will eventually yield understanding of the ongoing processes to enable knowledge-based mitigation measures that are needed to tackle the Grand Challenges related to water, the source of life on Earth.
Agriculture adaptation for wetland conservation in Mekong delta – a case study at Tram Chim Ramsar site

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Mekong delta is one of the most focused deltas in the world given its multiple values, dynamics and complexity. The delta is also well-known with its biodiversity at a number of wetland conservation areas. However, in the recent decades, given social – economic development activities in the delta and in the whole basin, the remaining wetland areas are facing with number of threats (e.g. upstream flow changes, wastewater discharge) that cause degradation in both quantity and quality. In addition, current wetland management policy is rather limited in considering social, economic factors of local livelihoods of surrounding wetland areas. The objective of this study has two-fold (1) to investigate water quality status and pollution sources inside and surrounding areas of Tram Chim National Park, a Ramsar Conservation site in the Plain of Reeds, Mekong delta; (2) to explore possible agriculture/aquaculture adaptation measures to protect the Park. We carried out an intensive water monitoring and social survey campaigns during flood and dry season in 2018 and early 2019 to obtain primary data in the areas. The results showed that water quality in the Tram Chi areas are at the considerable threshold and should be seriously considered. Pollution sources from aquaculture and agriculture activities must be controlled more properly. Agriculture/aquaculture adaptations/transformations can be considered as key solutions to cope with these issues. However, social study showed that there is still a big gap for adapting with (or transforming to) better/new cultivation practices for improving the current situations given constraints of finance, technology, social awareness and institutions. This study suggests (1) deploying regular water quality monitoring stations; (2) piloting showed – case sustainable livelihoods; (3) developing community – based wetland and water management; (4) enhancing social – ecological resilience;
Vitality, regeneration, biodiversity and ecosystem function of a water limited conifer forest as affected by manipulation of overstory leaf area: An overview of the first 10 years at the Kedoshim LTER

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Four principal management objectives were defined by the Israeli forest service (KKL) for mature, first generation, multiple-use, pine forests in Israel: (1) Maintain the vitality and longevity of the current forest generation, (2) establish the next generation based on natural regeneration processes, (3) encourage ecosystem biodiversity and complexity and, (4) promote ecosystem function. The Kedoshim LTER site, located in the Judean Mountains, was established in 2008 in order to scientifically address these challenges. A conceptual model based on forest leaf-area dynamics was developed as a basis for understanding consequences of silvicultural treatments and assessing forest condition.

Forest thinning treatments carried out in 2009 throughout a typical mature (40 yr), Pinus halepensis forest have created a range of overstory canopy cover levels as quantified through leaf area index (OS-LAI). The talk presents an overview of the first 10 years through which various aspects of forest vitality, natural regeneration, biodiversity and ecosystem function were monitored along the range of OS-LAI. Microclimatic conditions including solar radiation, temperature, humidity, wind velocity and rain through-fall, depend on overstory cover resulting in a complex, hump-shaped pattern of stand level aridity along the OS-LAI range.

Water status, growth, and survival of mature pine trees were found to be negatively related to OS-LAI indicating pronounced positive effect of thinning on tree vitality and longevity.

Pine (Pinus halepensis) recruitment was negatively affected by OS-LAI while oak (Quercus calliprinos) recruitment was positively affected. However, the growth rate of both species was constrained by increasing OS-LAI.

Total plant richness (altogether, 316 species) was found to be negatively related to OS-LAI while the species richness of various taxonomic groups presented mixed trends - negative for annuals (231), positive for trees (7) neutral for geophytes (36 species) as well as for earthworms (4 species), ants (34 species) and wild bees (80 species). On the other hand, all of the taxonomic groups, except earthworms, presented changes in species composition with respect to OS-LAI. Furthermore, species abundances and behaviors were found to be influenced by OS-LAI.
Biomass production of herbs and woody plants in the forest understory decreased significantly while that of the overstory layer increased with increasing OS-LAI. At the other end, litter decomposition rate decreased with OS-LAI.

Finally, a comprehensive look at the forest leaf area dynamics reveals that 10 years following overstory manipulation the amount of unoccupied growing space is still significantly higher the lower OS-LAI is. Furthermore, patterns of growing space reoccupation depend on OS-LAI leading to variable future stand structures and functions.

T3: ALTERED NUTRIENT CYCLES AND ENVIRONMENTAL POLLUTION

Effect of agricultural long term ecosystem on soil fertility and productivity of crops: continuous lowland rice system at Yunlin branch, TNDARES

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Agricultural long term ecosystem has been set up for 12th years at Yunlin branch, TNDARES. The 9-year-continuous lowland rice system has been included. The long term effect of fertilizer on soil quality and yield would be revealed by monitoring the soil and yield data. The results showed that soil EC was always below 0.6 dS m⁻¹, and soil O.M. was maintained at the range between 0.7 and 2.4%. The soil EC, pH, and soil available Ca and Mg raised in 2014 and soil available P dropped in 2012. The reason of these unusual issues was not known. Because the fertilizer were treated on soil surface, the soil EC, available P and K, and O.M. were highest in top soil (0-15 cm). Soil pH and available Ca and Mg increased with the increase of soil depth. Further study would keep focus on the effect of climate change on other soil quality.

T6: GLOBAL RESEARCH INFRASTRUCTURES

The Hellenic long-term ecosystem research network: where do we stand

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The Greek Long-term Ecosystem Research Network (LTER-Greece) is a collaborative network of scientists and their stakeholders engaged in long-term, site-based ecological, social and economic research in Greece. The vision of LTER-Greece is to improve preservation and sustainable use of ecosystems through the application of long-term, large-scale research in their areas. LTER-Greece was established in October 2016 and it initially consists of 8 Observatories spread across the country: Koiliaris Critical Zone Observatory, Crete; Hydrologic Observatory of Athens; Finokalia Atmospheric Observatory, Crete; Pinios Hydrologic Observatory, Central Greece; Lesvos Biodiversity Observatory, Lesvos Island; Navarino Environmental Observatory, Peloponnese; Samothraki Nature Observatory, North Greece; Samaria Gorge Observatory, Crete.

LTER-Greece is a member of the European and of the International Long-Term Ecological Research Networks. The mission of the latter is to deliver to the scientific community, policy makers, and society in general, sound scientific information and predictive understanding of ecological and socio-economic processes and to provide solutions to current and future environmental problems at local, national, European and global scales.

In the long run, LTER-Greece envisages to contribute solutions to global sustainability challenges identified by Future Earth by providing basic research infrastructures and data that contribute to Europe’s goals for: ensuring safe and secure water, energy and food for all; reducing carbon emissions; creating cities that offer a healthy environment, resilient to natural disasters and a conducive environment to productivity; improving human health; and increasing the ecological and social resilience to environmental change through the development of early warning systems. Currently, LTER-Greece is starting identifying dependencies and complementarities amongst its members so as to develop a nationwide coverage network capable to address real world issues with regards to the environmental and socio-ecological sustainability of the country, in rural and urban environments, safeguarding the terrestrial and aquatic natural resources. LTER-Greece contributes directly in identifying solutions to two major environmental challenges that Greece is currently facing:

- Adaptation to climate change: Greece and the eastern Mediterranean are expected to suffer water resources availability reduction by 40-50% in the 2050-2070 period compared to the present. Towards this direction LTER contributes proposing novel and effective ways of managing irrigation water as a common good, through bottom-up collective approaches and the introduction of a system-thinking perspective.

- Rural Development: LTER Greece is planning monitoring agricultural systems also from a socioeconomic point of view, thus contributing to the debate regarding the support of the overall resilience of such ecosystems.
T6: GLOBAL RESEARCH INFRASTRUCTURES

What can a ‘GERI’ learn from the experiences and strategies of a national observation and research infrastructure in a developing economy?

Johan Pauw; Tommy Bornman; Gregor Feig; Wim Hugo

South African Environmental Observation Network (SAEON)

A sustainable Global Environmental Research Infrastructure (GERI) will require sustainable national and continental scale research infrastructures (RI’s). To ensure equity and comprehensive coverage, a GERI must be cognisant and supportive of the drivers of its members’ RI’s. Insights into the internal dynamics and external contexts of its member RI’s should have heuristic value for the governance of a GERI.

One of the founding members of GERI, the South African Environmental Observation Network (SAEON), started operations in 2002 as the national LTER research program of South Africa. In the years following, growth was consistent and led to the establishment of a national coordinating office and six research nodes covering continental, coastal and offshore marine ecosystems. Over the last three years, this was followed by the establishment of a node for information systems plus three government-funded research infrastructures.

This exponential growth was possible, despite the developing economy status of South Africa, largely by SAEON being recognised for strategically filling gaps in terms of the national need for reliable data in the face of anthropogenic disruptors of social-ecological systems. As a developing country, the South African Government has also recognised the crucial role of infrastructure in developing the economy. Through the efforts of a progressive Minister of Science and Technology, a national programme for research infrastructure (South African Research Infrastructure Roadmap – SARIR) was established following which SAEON became the go-to-operator of large-scale environmental research infrastructure and data-based decision-making platforms. By being in the right place at the right time, SAEON has significantly shifted the environmental science landscape of South Africa.

This paper will offer some organisation-wide indicators of SAEON’s exponential organisational growth. The critical success factors and organisational strategy that contributed to SAEON’s expansion included close relationship with national government, building reputation through demonstrating of public value, an institutionalised distributed network, the provision of services to the researchers and decision makers (public and private), and advanced information management expertise. The key challenges faced by SAEON and its RI’s are not dissimilar to other international RI’s and will be highlighted.
Alien mouflons keep the vegetation of endangered dry grasslands species-rich – results of long-term monitoring of LTER plots in the Czech Republic

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Using exclosures on ILTER plots, the impact of mouflon grazing and weather on dry grassland occurring on shallow soils was studied in the Křivoklátsko Biosphere Reserve (Czech Republic) during the years 2004–2018. The dry grasslands on the southern slopes above deep valley of the Berounka River represent biodiversity hotspots in the study region mostly covered by broadleaved forests. There is a debate on primary or secondary origin of this non-forest vegetation. These parts are strictly protected, however, the alien mouflon (Ovis musimon Pallas) has a strong impact on the vegetation (i.e. via disturbances, feeding damage, eutrophication).

The vascular plant species composition was recorded annually on a total of 350 fenced and 350 control plots, each 10cm × 10cm in size. Treatment, time, and weather data were used as explanatory variables in ordination and correlation analyses. Cover values of species with different life forms and indicator values varied significantly in dependence on the weather conditions of the preceding months. Except of the climate, the game pressure is the main driver connected with vegetation changes. We found that these altered conditions are reflected in the composition of dominant species and certain species traits. In general, annuals responded directly to the current weather conditions whereas perennials reacted to longer-term weather conditions. Some species of vascular plants have shown distinct long-term trends in cover. The species composition fluctuated – a phenomenon that is not directly attributable to weather conditions. In the fenced plots, the herbaceous vegetation cover decreased, mainly due to litter accumulation and partly due to shrub regeneration.

We demonstrate the influence of selected climatic variables (average monthly precipitation sums and temperature means and extremes) on the dry grassland vegetation. However, the behaviour of some species is likely influenced by other, unconsidered environmental factors such as, e.g., nitrogen deposition. At least some parts of the valuable and species-rich habitats could be maintained under high mouflons’ density, but some parts are endangered by eutrophication and mouflons’ grazing. Nature conservation needs to consider both mechanisms and should find their balanced interplay for the sustainable long-term management.

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River Pinios hydrologic observatory-central Greece: a start up LTER site

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Pinios River basin (RPB), located in central Greece, has a spatial extent of ca 11,000km² and is one of the largest productive basins of the country. Agia basin, a 44.5km² marginal sub-basin to RPB, has been selected in 2015 as a field laboratory, and the “Pinios Hydrologic Observatory” (PHO) was established in the same year. Being a rural agricultural area where agro- and eco-tourism progressively expands, Agia bases its socio-economic growth and resilience on water resources sufficiency for high quality and low cost agricultural production, whilst preserving the environmental features of the basin. Groundwater systems are by far the most important source of water to the basin, at least for major water demanding activities.

Main purpose of PHO is the identification and quantification of the major controlling hydrodynamic evolution processes and their transfer at the RPB scale to enable better simulation of hydrodynamics at regional scale, thus enhance modelling capabilities and accuracy. Moreover, PHO was established in order to support the development of innovative water management strategies that can be transferred to larger scales, while the provision of services for stakeholders and general public constitutes one of the main goals of PHO establishment.

PHO currently comprises of: a) 3 fully equipped telemetric climate stations fully covering the altitudinal zones in the basin, b) 12 air temperature loggers, c) 12 groundwater monitoring sites, comprising of groundwater level, temperature sensors (3 equipped with CTD sensors) and groundwater pumping loggers, d) 2 soil moisture monitoring sites both equipped with frequency domain reflectometry sensors, while one also includes a cosmic-ray neutron sensor probe and e) 1 river discharge monitoring station consisting of a non-contact discharge radar and an ultrasonic Doppler. Groundwater quality monitoring is performed quarterly covering a wide spectrum of parameters, while a full-scale soil properties study is due, as are geophysical campaigns to improve understanding of the geometry of groundwater systems.

Operation of PHO will be supported by an integrated system of farm management data collection, so that the on-site measurements will be assessed within a real-life context as to their importance. The data collection system will involve the recording of technical and economic indicators describing main cropping activities, use of resources (land, labor, capital), main products, producer prices, marketing (short and mainstream supply chains) etc. Data measured in PHO are already intensively explored by the regional population and stakeholders for a number purposes. On the long run, the identified and
quantified hydrologic mechanisms may be appropriately and proportionally transformed to the entire RPB contributing to accurate forecasts and thus manage the water resources of RPB, i.e. in a very sensitive and socio-economically critical region of the country. Moreover, successfully applied management and governance practices tried at PHO, may be transferred to regions and basins sharing the same physiographic and socio-economic conditions in Greece and beyond.

T4: ADVANCES IN LONG-TERM SOCIO-ECOLOGICAL RESEARCH AND SUSTAINABILITY SCIENCE

Application of the TeaComposition initiative in an agricultural environment

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The long-term TeaComposition initiative is a worldwide project organized under the umbrella of ILTER to study the decomposition of specific litters (green and red teas) in a large number of sites. The project has raised the interest of the agricultural sector with several questions such as what is the effect of farming practices (tillage, use of natural or chemical fertilizers, etc.) or of the type of crops on litter decomposition. However, for a number of crops (such as cereals, oilseeds, sugar beets), harvesting is done every year and it is not possible to leave the teabags for several years in the soil. The TeaComposition protocole should therefore be adapted for this type of sites.

Since 2017, a large-scale experiment has been set up in the Northeast of France. Some 450 (in 2017) to 650 (in 2018) teabags of each type have been buried in different types of soil used for different crops in about 160 parcels. The incubation duration has been limited to three months, in most cases with an implementation between March and May, depending upon the crops.

Practical questions such as how to bury efficiently the teabags (i.e. to insure the best contact between teabags and soil), how to weigh them simply in absence of high-precision weighing scale, how to retrieve them easily in the parcel or how to protect them from predators, had to be answered.

As litter decomposition is function of soil temperature and humidity, indices has to be defined based on easily obtainable weather data (air temperature, rainfall) at the closest possible weather stations.

Finally the change in the nature of the bags (PET instead of nylon) and the possible dependence of the litter decomposition upon the tea harvest year have encourage the accompanying researchers to run specific tests in lab-scale mesocosms and in the field.

The presentation will discuss the results obtained with the adapted protocole by the farmers and agricultural institutions, as well as how the latter can take into account those results in their farming practices.
Long-term monitoring of of headwater streams water quality in the Vosges Mountains (North-Eastern France)

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The Vosges form a range of medium elevation mountains located in North-Eastern France. Most of them is covered by forest dominated by beech, Norway spruce and silver fir and is drained by numerous headwater streams.

Decades of acidic atmospheric depositions have severely acidified terrestrial and aquatic ecosystems. Despite their location i.e upstream of any anthropogenic activity, acidified streams are typically oligotroph and characterized by permanent or temporal low alkalinity, low pH and elevated aluminum concentrations. Since three decades, the implementation of national and international agreements have notably reduced the SO₂ and NOₓ emissions. Such considerable reductions should help to stop the acidification trend but also to allow recovery of aquatic ecosystems. To monitor the potential recovery of surface water, a long-term monitoring project have been set up in the Zone Atelier Moselle LTSER. It concerns about twenty streams over a distance of 80 km. The sampling stations are all situated

In addition to pH, conductivity, nitrogen species, base cations, major anions, dissolved metals (in particular aluminum) and dissolved organic carbon (DOC) have been monitored between 2002 and 2005 (period 1) and since 2011 (period 2).

Fourteen streams show an increasing nitrates gradient, between 0.5 and 2.5 mg NO₃/L in average, along a South-North direction.

No significant difference in DOC has been observed in average between the two periods for the sixteen streams, which constitute the core of the monitoring project. However streams corresponding to outlets of peatland exhibit large seasonal variations. Since 2011 (period 2) the quality of the dissolved organic matter (DOM) has also been investigated using UV-visible spectroscopy and synchronous fluorescence (with a difference of 50 nm between excitation and emission). The DOM differs in terms of aromaticity, molecular weight and fluorescence signature (protein-like fluorescence, humic-like fluorescence, etc.). The humic-like fluorescence of the outlets of peatland shows a higher seasonal variability than for the other streams.

The data will be discussed with respect to climatic parameters (temperature, rainfall), discharge information and soil nature (granite, sandstone, presence of peatland) and usage (forestry, pasture, presence of roads).
Nitrogen is a modern pollutant and a critical nutrient for living organisms. Over the last century, anthropogenic reactive nitrogen flows surpassed natural turnover rates, therefore significantly altering its biogeochemical cycle. Our study focuses on soil responses to nitrogen additions in a natural grassland from Neajlov catchment (Romanian LTSER site). We used plots of 2 m² for fertilization with NH₄NO₃ to simulate increased bioavailable nitrogen inputs of 0, 5 and 10 kg/ha/year which were fertilized during July 2017 – September 2017. Topsoil samples were collected each month starting from July until May 2018 and analyses were performed in triplicates. For each replicate we measured pH, soil water and organic matter contents. Inorganic nitrogen species were determined using spectrophotometric methods after extraction with KCl. In order to determine enzymatic rates of nitrate reductase and urease, each sample was treated with KNO₃, respectively urea as substrates. Another process we assessed was the mineralization potential of soil microbial community via incubation method under hypoxic conditions followed by ammonium formation. Study showed a slight acidification, more discernable for the highest nitrogen addition, here the mean decline being of 10% compared to reference area. We noted a temporal accumulation of both nitrate and ammonium, especially during fertilization period. As expected, enzymatic rates showed seasonal variation, but we documented lower rates as bioavailable nitrogen increased. We observed strong correlations between soil extracellular enzymes and substrates, which were clearer when warm and cold season were analyzed separately. Urease activity positively correlates with organic matter, R² values of 0.31 (warm season) and 0.41 (cold season), whereas R² for nitrate reductase and N-NO₃⁻ were 0.49, and 0.47 respectively. It is clear that urease was inhibited by end product, values from fertilized plots were significantly lower compared to reference area: 18.66 and 19.97 µg N-NH₄⁺/g dry weight/h versus 26.88 for the control site. Our finding suggest that more subtle responses of nitrogen surplus can be found at soil microbial community level and that a natural ecosystem is more able to absorb the impact of this type of pressure. Moreover, since soil bacteria proved sensitive only over a short period of addition, it is presumable that this resilience is not permanent and detrimental effects can occur following lengthier/continued exposure.

Keywords: LTSER site, nitrogen cycle, soil enzymatic activity
Lectures

T3: ALTERED NUTRIENT CYCLES AND ENVIRONMENTAL POLLUTION

Long-term physical, hydrochemical and biological measurements at the Sylt Roads Marine Observatory (1973-2013), Wadden Sea, North Sea

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The SYLT ROADS Long Term Ecological Research (LTER) pelagic time series covers physical and hydrochemical parameters at five neighboring stations in the Rømø Bight, Wadden Sea, North Sea. Since the time series beginning in 1973 sea surface temperature (SST), salinity, ammonium, nitrite, nitrate and soluble reactive phosphorus (SRP) were measured on a biweekly basis. Other parameters were introduced later. Since the start of continuous sampling in 1984 the sea surface temperature in the Bight has risen by 1.16 °C, with the highest increases during the fall months while the pH decreased by 0.26 units. Summer and fall salinities are generally significantly elevated compared to spring and winter conditions. Dissolved nutrients (ammonium, nitrite, nitrate and SRP) showed periods of elevated eutrophication (1973 – 1998) and de-eutrophication since 1999 while silicate displayed a different development showing higher levels of Si in the winter data since 1999. Interestingly phytoplankton parameters did not mirror these large nutrient changes, as a seasonal comparison of the two eutrophication periods showed no significant differences with regard to chlorophyll. This phenomenon might be triggered by an important change in nutrient limitation during the time series: Until 1988 the phytoplankton was probably primarily limited by silicate, and since 1999 SRP limitation got increasingly important.
T1: DRIVERS OF LONG-TERM CHANGES IN BIODIVERSITY, ECOSYSTEM INTEGRITY AND ECOSYSTEM FUNCTIONS

AN EQUAL TIME SCALE OF REGENERATION CANNOT MIRROR THE LONG-TERM DEGRADATION IN WET GRASSLANDS

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In this contribution, we focus on long-term degradation and regeneration processes in species-rich wet meadow (Calthion) communities. Until the 1960s, they covered large areas in North-Western Europe and provided based on their high biodiversity many key ecosystem functions at landscape level. During the past decades, however, the biodiversity of wet grasslands ecosystems strongly declined due to changes of land management. In this context, abandonment has been identified as one of the main drivers of biodiversity degradation in marginal wet habitats. As a result of this development, this plant community became highly endangered and rare, especially in North-West Germany. The resulting species-poor grasslands, which developed on abandoned sites, and related degradation and succession processes are well-studied in the short term. However, long-term studies in this field and the possible regeneration after re-installing the management has not been investigated yet. To investigate long-term driver effects of both degradation and regeneration processes on the biodiversity of wet grasslands, we conducted a permanent plot experiment in the Oste river valley near Bremen (Germany). The experiment covers 30 years of degradation after undisturbed abandonment and 30 years of regeneration by re-introducing the traditional mowing regime. Starting from extremely species-rich wet meadows in the 1950s species-poor tall-growing grass and forb communities developed. Despite our initial expectation there was no invasion of trees and shrubs in the degradation (abandonment) period. The regeneration period was characterized by the removal of accumulated biomass and litter, which facilitated fast re-establishment of some wet grassland species, but originally frequent character species remain absent. The floristic composition in the regeneration plots still lags behind the originally documented ecosystem condition from the 1950s and did not recover in an equal time scale. Our study highlights the importance of long-term field experiments to validate both the effects of management driven species gains and losses, and limiting factors of long-term restoration success.
Toward the end of the century the Earth dry lands area is expected to grow by 10% from the current extent of ~41% to over 50% of the land surface area, mainly due to decrease in mean annual precipitation (P). This will have a strong impact on ecosystem water yield (the residual between precipitation and ecosystem evapotranspiration, WYe=P-ETe).

Using a mobile lab equipped with Eddy covariance system we measured ETe in forests and non-forested ecosystems along a precipitation gradient in the Eastern Mediterranean, with annual mean P between 750 to 280 mm (with large inter-annual variations).

ETe was always greater in forests than in non-forest areas, irrespective of location. As P decreased from 800-300 to 550-150 mm y⁻¹, ETe remained around 550-75 mm, but WYe decreases sharply. In the driest semi-arid ecosystems ETe was nearly equal to P in both forest and non-forest sites, and WYe was around zero.

For forests to survive, ETe must remain below P. But since the tree ET is a conservative quantity, reducing ETe to adjust to the projected decrease in P requires deliberate thinning, or through uncontrolled tree mortality. Irrespectively, it can be expected that WYe will decrease much faster than P with warming and drying climate in these regions.
Research infrastructure supporting ecosystem research face the immense task of establishing an interconnectability of its data. This task is often limited by different methods limiting scientists to easily produce comparable data sets for large-scale analysis. Using the example of individual tree mortality we here propose the use of a topic-based approach to establish easy to use data sets to answer large-scale questions.

Recent observations in temperate, boreal, and tropical forests indicate that this sustainable provision may be threatened by increasing tree mortality and forest decline. Currently there is, however, no global assessment of forest mortality events which could validate a general global trend in climate change-induced forest decline. Given the importance of global forests for biogeochemical cycles and human welfare there is an urgent need to understand forest responses to changing climate and to predict future forest conditions.

In theory there are multiple data sources providing information on tree mortality: 1) ground based assessments e.g. the monitoring network of ICP Forests and 2) remote sensing products. The latter can identify large-scale changes in forest cover; the spatial resolution, however, is often too coarse to detect individual tree mortality. On the other side field observations from forest inventories or research plot networks detect individual tree mortality but are often not openly accessible, spread across different ownerships, and are based on a variety of methodological guidelines.

Other than interconnecting whole data platforms with a large number of parameters needing to be harmonised and documented, the topic focused use of multiple sources is advantageous. Based on the topic “mortality” parameters can be defined which are potentially useful for the global assessment. Those can individually be classified in dead=1 or alive=0 independent of the source value which would be 100% defoliation within ICP Forests or asset loss within the NFIs. This topic focused analysis provides the opportunity to actively use data from various sources without the need of large scale homogenisation by focusing on a plain yes/no question; where available further information can be added to explain the general starting question.

To address this issue regarding tree mortality the new IUFRO Task Force ‘Global monitoring network of tree mortality patterns and trends’ aims to overcome these limitations by facilitating sharing of knowledge and data and promoting international collaborations between different disciplines concerned with forest assessment, tree physiology and ecological modelling.
The Cerrado savannas cover ~22% of the Brazilian territory. As in other seasonal savannas, natural fires are ignited by lightings. Currently, fires are mostly anthropogenic and occur during the dry season. In 1990, at the Reserva Ecológica do IBGE, an LTER site at Brasilia, Brazil, the Fire Project was implemented to investigate the long-term effects of different fire regimes (season and frequency) in the Cerrado vegetation and ecosystems; the vegetation had been protected from fire for 18 years. Biennial burns at the beginning (June-BJ), middle (August-BA) and end of the dry season (September-BS) started in 1992 and ended in 2008. Quadrennial burns at mid-dry season (QA) lasted from 1991 until 2005. The fire effects in the woody vegetation were studied in 10ha plots: three in cerrado sensu stricto (dense scrub of shrubs and trees with a ground layer dominated by grasses-CSS) and cerrado denso (woodland savanna-CD); for campo sujo (grassland with scattered shrubs and small trees-CS), three plots of 4ha were studied. Here, we review the effects of prescribed burnings only for Cerrado’s woody vegetation at IBGE-LTER site. No long-term studies for species change or effects of repeated fires in the herbaceous layer vegetation were conducted. Before the first burns (1991 and 1992) tree inventories (species, tree height and diameter at 30 cm from soil surface) were conducted in 0.5ha/plot. The same tagged individuals were re-sampled every 2 or 4-years before the burns. Therefore, for the inventory, the results (after 10 biennial or six quadrennial burns) and the control (before) represent the same plot. Before the first fires, 92-99% of trees were alive for all plots. Even presenting adaptative traits against fire, after the first burn, tree mortality was 3-16% at CS, 11-13% at CSS and 15-20% for CD plots. After five biennial burns, the mean tree mortality was high: 19% (BJ), 32% (BA), 44% (BS) and 37% (QA) for CS; 39% (BJ), 45% (BA), 44% (BS) and 46% (QA) for the CSS and 32% (BJ), 34% (BA), 41% (BS) and 55% (QA) for the CD. The number of dead stems (top-kill+dead trees) increases as the dry season progresses: 36% (BJ), 49% (BA), 66% (BS) and 58% (QA) for CS; 36% (BJ), 55% (BA), 73% (BS) and 56% (QA) for the CSS and 43% (BJ), 57% (BA), 72% (BS) and 61% (QA) for the CD. There was no exclusion of species from the plots. On the other hand, top-kill and mortality of lower branches resulted in a simplification of trees’ architecture and reduction of tree height. Both may reduce flower production, decrease fruit survival and the number of high-quality dispersed seeds which may reduce the recruitment of new individuals with severe consequences for species population, as already shown for Qualea parviflora and Q. multiflora. Although vegetative reproduction is considered prevalent in Cerrado vegetation, recruitment via seed bank also contributes to the persistence of the species in Cerrado’s communities. Moreover, the reduction in tree density results in a decrease in litter production and an increase in herbaceous vegetation both of which alter the fluxes of mass and energy as well as ecosystem services.
Towards a LTSER-network-wide harmonized protocol for stakeholder and ecosystem service mapping – the case study of the Arava LTSER platform

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Long term Socio-Ecological Research (LTSER) platforms introduce a transdisciplinary approach linking scientists from multiple disciplines to stakeholders. In addition, LTSER platforms represent broad geographical regions and include diverse cultural, historical, natural, administrative and economic units. This makes it difficult to harmonize management and data collection protocols between the network of LTSER platforms. Presently, only very general schemes for LTSER management, stakeholder approaches and Ecosystem Services (ES) mapping and monitoring exist. Many platforms have conducted stakeholder and ES mappings, but no harmonized method has been developed. Reporting on a stakeholder mapping and integration effort, the goal of this paper is to contribute a case study for deriving potentially universal lessons for a stakeholder and ES assessment scheme for LTSER platforms.

Our network of scientists is involved in the management of the LTSER platform and the creation of a stakeholder – scientist network. We use different media to create visibility for the work of the LTSER platform and catalyze a feeling of platform ownership among the regional stakeholders. Such tools include Facebook posts, open lecture days and WhatsApp groups.

We present the methods used for the stakeholder mapping, stakeholder interviews, and ES mapping highlight, and discuss which approaches worked better than others, like for example stakeholder round tables or single stakeholder interviews. We derive “best-practices” recommendations for the European network of LTSER platforms.

The development and testing of best practices for stakeholder and scientist engagement, ecological and ES monitoring of our LTSER platform will provide an exemplary tool for other platforms. Best practices guidelines should transcend specific platforms and be universally applicable, even if local conditions may demand modifications.
In this work we have examined the effects of different environmental factors on the patterns of species richness in the main functional groups of a 350-ha heathland after abandonment of traditional agricultural practices in 1895 and left without any direct human intervention for more than 100 years ago. The composition of the vegetation differed markedly depending on land-use history. Grass-encroachment resulting from increasing nutrient availability in post cultivated areas as also thoroughly documented in many post-agricultural heathlands whereas dwarf shrub dominance was maintained for more than 100 years without management on the undisturbed most nutrient poor part of the heath. The duration of this legacy on naturally developing community supports the idea of possible feedback mechanisms by which dwarf shrub and grass domination are maintained at the nutrient-poor and the enriched portions of the heathland, respectively.

So far this heathland has been self-maintained as a mosaic of patches of grasses and dwarf shrubs which seem to remain in stable states although tree encroachment slowly takes place. This mosaic creates heterogeneous and diverse vegetation which provides different niches to heathland-associated insect species. The insect assemblies had distinctly different community composition depending on former land-use but also distinctly different from comparable managed heathlands. Long term succession in part of heathlands ultimately increased the diversity at the landscape level.

The presentation will show vegetation data from 100 years survey and further the influence of former land-use and management on present day insect groups.
T6: GLOBAL RESEARCH INFRASTRUCTURES

The Freshwater Information Platform: an online network to facilitate monitoring, data compilation and publishing

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Species distribution data are crucial for understanding biodiversity dynamics and the underlying drivers. This is especially the case for freshwaters, which are among the most endangered ecosystems globally. However, a huge body of data gathered by scientists and water managers is currently difficult to access: systematic data publishing practices have not been fully adopted yet and data embedded in scientific papers and research project websites are often challenging to extract. At the same time, data and knowledge generated through publically-funded research or monitoring programmes are considered a common good.

The Freshwater Information Platform (FIP) aims at pooling freshwater related research information from multiple projects and initiatives to make it easily accessible for scientists, water managers, conservationists and the interested public. The FIP consists of several major components, three of which form its “data publication unit”: The Freshwater Metadatabase (1) collects data characterising and documenting actual datasets. These metadata can easily be published as open access articles in the connected Freshwater Metadata Journal. The Freshwater Biodiversity Data Portal (2) aims at mobilising and publishing freshwater biodiversity data (occurrence records) through GBIF. The use of collected datasets for large-scale analyses and models is demonstrated in the Global Freshwater Biodiversity Atlas (3) that publishes interactive online maps featuring research results on freshwater biodiversity, threats and conservation priorities.

Here, we focus on introducing these components as tool to streamline open access freshwater data publication, arguing it will improve the capacity to protect and manage freshwater biodiversity in the face of global change. We further present linkages to and cooperations with other key initiatives in the field, namely the Alliance for Freshwater Life as well as Freshwater BON.
**T1: DRIVERS OF LONG-TERM CHANGES IN BIODIVERSITY, ECOSYSTEM INTEGRITY AND ECOSYSTEM FUNCTIONS**

**State-dependent driver-response relationships facilitate long-term ecosystem change**

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Many ecosystems have transitioned, often suddenly, from one long-term state to another that typically has different biodiversity and altered ecosystem functions. A profoundly important question is whether the new ecosystem state is maintained by a persistent change in the value of an underlying driver or is trapped in an alternative basin of attraction. In the former case, the non-linear relationship between state variables and environmental drivers remains unchanged from before to after the shift. As such, the system will return to its original state with small relaxation of the parameter across the threshold. The latter situation has far more profound ecological and management implications. Here the relationship between state variables and environmental drivers is not the same before and after the shift, which creates hysteresis in the driver – response relationship. While a small change in a driver can tip the system to a new state, greater relaxation of the parameter is required to reverse the state change, which can trap the ecosystem in the new state. Further, it is possible for a sufficiently large disturbance to flip a system with hysteresis to an alternative basin of attraction without any change in an underlying driver. Obtaining compelling evidence of hysteresis and alternative basins of attraction in nature has been challenging, but much of the growing body of evidence has come from Long Term Ecological Research sites. For example, analysis of LTER time series data for a subset of sites with > 3 decades of data on the abundance of dominant species revealed evidence of hysteresis in the driver-response relationship, with the state dependency in the relationship creating the potential for bistability over some region of parameter space. At the Moorea Coral Reef LTER site in French Polynesia, we asked whether coral-to-macroalgae phase shifts, which have become increasingly common on tropical reefs, can reflect the presence of alternative basins of attraction under the same environmental conditions. We used complementary field experiments coupled with time series data to explore this issue. We first ran Hysteresis Experiments on the fore reef offshore and on lagoon patch reefs to probe whether the relationship between the abundance of macroalgae (response) and herbivory (driver) depended on the initial community state. In both habitats, more herbivory was required to eliminate established macroalgae than to prevent them from becoming established, although the region of bistability created by hysteresis in the driver-response relationship was far below ambient herbivory on the fore reef but not in the lagoon. A subsequent Stability Experiment confirmed that macroalgae behaved as an alternative attractor on lagoon patch reefs. These experiments provided insight into the differing community dynamics between fore reef and lagoon reefs over the past 40 years. Our experimental framework is a powerful tool to probe for multiple attractors, and it can provide useful insight to better manage ecosystem resilience and services.
T1: DRIVERS OF LONG-TERM CHANGES IN BIODIVERSITY, ECOSYSTEM INTEGRITY AND ECOSYSTEM FUNCTIONS

Disturbances in Central Amazonian black-water floodplains caused by climate and land-use changes

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Since 2013, we monitor in the framework of the Brazilian ILTER-program (PELD MAUA – CNPq/FAPEAM) black-water floodplains in two conservation units of Central Amazonia: the Jaú National Park (JNP) and the Uatumã Sustainable Development Reserve (USDR), to study impacts related to extreme hydro-climatic events (floods, droughts) and land-use changes (fire, hydroelectric dams). Black-water floodplains, called igapós, occupy over 120,000 km² in the Amazon basin mainly along the Negro River and its tributaries and are dominated by forest vegetation. Because of a very low input of dissolved and suspended nutrients by the annual flood-pulse, igapós present an extremely low nutrient status and slow population dynamics. Tree species adapt to this regular seasonal flooding pattern by developing sophisticated morpho-anatomical, biochemical and physiological mechanisms. We apply an interdisciplinary approach by combining monitoring data from vegetation in permanent plots distributed along the flood-gradient (total of 20 ha) with remote sensing techniques and dendroecological analyses, to study the impact of disturbances on community structure, biomass stocks and dynamics in igapó floodplains.

In recent decades the intensification of the hydrological cycles in the largest watershed on Earth has caused a substantial increase in the frequency and magnitude of severe flooding and droughts affecting the igapó ecosystems. Extreme drought events render igapó habitats vulnerable to wildfires due to the predominating sandy soils, surface root mats and high amounts of accumulated litter in the forests. During the strong El Niño event in 2015/16 over 1000 ha in the JNP burned, resulting in mass mortality, losses of carbon and other ecosystem services. Changes in the flood-pulse pattern imposed by the implementation of hydroelectric dams have affected the structure, diversity and function of these vulnerable systems by dramatically altering the natural flood-pulse. Downstream of the Balbina hydroelectric dam, implemented in the 1980s in the Uatumã River, we observe a mass mortality of floodplain forests at the lowest topography up to a downstream distance of over 125 km in the USDR. Over 12% of the igapó floodplains...
have suffered mortality in consequence of increased minimum water levels which have maintained permanent flooding conditions during consecutive years. At the highest topographies, flood suppression favored the encroachment of species from the adjacent upland forests (terra firme). Our results emphasize the urgent need for Brazilian environmental regulatory agencies to incorporate downstream impacts in the environmental assessments of several dozen planned dam projects in the Amazon Basin. The synergy between disturbance intensification of the hydrological cycle, increased mortality of floodplain trees and fires in a potentially warmer climate is expected to cause a serious imbalance of floodplain ecosystems resulting in significant loss of biodiversity and ecosystem services.

T3: ALTERED NUTRIENT CYCLES AND ENVIRONMENTAL POLLUTION

Challenges to develop the global assessment guidance for the nitrogen impacts for human and nature

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The increase of global nitrogen cycles has multiple impacts on humans and nature. In most developed countries, too much reactive nitrogen (Nr) has negatively impacted the environment and human health while less Nr limits food production in some developing countries. Globally, excess Nr to the environment has been recognized as one of the urgent global environment exceedances of the current safe-operating capacity of our planet called the Planetary Boundary. As a part of the Towards an International Nitrogen Management System (INMS) project, we are developing a guidance document for Nr impact assessment methodology for humans and nature with international researchers from around the world by collaborating various experts around world including the ILTER (International Long-Term Research Network) researchers. This guidance document aims to provide the individual and integrated methods by which to assess negative and positive impacts of Nr at multiple spatial scales. The ILTER Nitrogen Initiative and the core member have taken a key role on this program. The complex impacts of Nr take place across multiple sectors, contexts and scales, so we developed a comprehensive matrix of both positive and negative impacts linked to WAGES (Water quality, Air quality, Greenhouse gases, Ecosystem & biodiversity, and Soil quality), and food, energy and societal values. The matrix includes various key indicators and their links to available global models. This is a first global comprehensive Nr impacts matrix which will be a useful foundation for interpreting model outputs and policy implications of Nr management. We apply the DPSIR (Drivers, Pressures, States, Indicators and Responses) framework to identify key indicators and their relations for impacts for human and nature. The document will address uncertainty, identify knowledge gaps, and provide policy relevant case studies including the various new ILTER studies across networks regionally and globally.
Longitudinal ecological studies are commonly limited in their spatial grain and extent, relying on regular, continuous global measurements of vegetation properties from satellites to extrapolate to a broader context. This is readily feasible for ecosystems with easily interpretable changes in the temporal vegetation signal, but is far more complex for ecosystems subject to stochastic natural disturbance events and post-disturbance recovery trajectories.

We have developed a time-series model to monitor and predict natural land surface processes and evaluate near real-time changes in the state of a crown fire-dependent and seasonally fluctuating ecosystem, the Fynbos of South Africa. The model allows estimation of above ground biomass, impacts on streamflow, and detection of anomalous vegetation signals such as high mortality, vegetation clearing, or invasion by alien trees. The modelling framework is particularly novel in that it also allows estimation of the factors that drive variation in post-fire recovery, such as climatic, edaphic, or vegetative properties such as plant traits. Our core model is highly flexible and ideal for exploring the drivers of multiple ecosystem functions within one framework. It also tests our understanding of the ecosystem, guiding further sampling and research.
Combining long-term forest ecosystem monitoring with UAV-based multispectral remote sensing in one database

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We explore advantages, challenges, and solutions of bridging the requirements of databases for long-term forest ecosystem monitoring platforms with permanently installed measuring devices e.g. data logger and those for data-intensive multispectral imagery (Near-Infrared, Red, Green) from unmanned aerial vehicles (UAV) flights to quantify phenological development in forestry.

Permanently installed measuring devices are routine on forest ecosystem monitoring sites. They - e.g. weather stations, dendrometers, and sap-flow sensors – continuously measure various environmental factors. The raw data is manageable and can be stored in a relational database without much processing or aggregation. The Thuenen-Institute Institute for Forests Ecosystems’ research facility in Britz, Eberswalde, Germany is such a well-established, long-term forest ecosystem monitoring site. The collected data are managed in a highly structured, relational PostgreSQL database mostly analogue to the international database of the intensive forest monitoring (Level II) of ICP-Forests.

Additionally to the ground based assessments of classical monitoring sites, the research facility is an ideal testing range for new methods and technologies i.e. UAV as nearfield remote sensing platform for operational forest research. Currently, phenological development is assessed through UAV-based remote sensing using multispectral imagery. Weekly flights are performed in the vegetation period for a Scots Pine and a European Beech stand of an area of 0.42 ha and 0.5 ha, respectively. Raw imagery of a regular flight, for instance consists of 700 images of approx. 35 megabyte, challenges data keeping in it its own way: the storage of the raw data has to be organised, the data has to be processed e.g. vignetting correction, geo-referencing, and the data has to be aggregated from numerous individual images e.g. to a single point data cloud per flight. Of course, all important intermediate processing steps and the final aggregated data have to be reproducible and accessible through the database, too.

We developed specific workflows for processing the UAV data including the sustainable storage of raw imagery, flight data, and metadata for each flight. Central element is a workflow using commercial, “big data” cloud computing services for highly intensive computation steps in processing and aggregating the raw data into point clouds.

The connection of both monitoring programs in one database comes with clear constraints e.g. data types of varying sizes, spatial resolution and temporal resolution e.g. 15 minute interval measurements from weather stations vs weekly flights of the UAV. However, harmonised data compiled in one concise database promises benefits in evaluating scientific questions. Existing weather parameters in the database help to evaluate conditions of the remote sensing flight. A successful implementation can be used in perspective as a guideline for the integration of UAV applications to established monitoring plots.
T3: ALTERED NUTRIENT CYCLES AND ENVIRONMENTAL POLLUTION

Integrated Environmental Indicators System to Estimate the Nitrogen Threats by Land Use Change in Coastal Zone Areas of Taiwan

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Environmental indicator system has been fully developed and used as tools to assess the environmental quality, ecosystem vitality, human health, and sustainability. There are numbers of the environmental indicator has been used to measure the environmental performance in represented the different scale of approach such as global, regional, national, and local levels. The concept of integrated environmental performance indicators system can be one of the nitrogen assessment methodologies, and it is derived from the environmental management tools such as ISO 14031 Environmental management - Environmental performance evaluation. OECD (2001) environmental indicator (OECD-EI) has led to several sets of indicators to measure environmental progress, and various sets of indicators to integrate environmental concerns in sectoral policies (e.g. energy, transport, agriculture). Indicators are also derived from natural resource and environmental consumption accounts. The sets of environmental indicators can be used in local, national, regional and even global levels. OECD-EI have been developed to measure nine sets of environmental progress which they are climate change, ozone layer depletion, air quality, waste stream, water quality, water resources, forest resources, fish resources, and biodiversity. The nine sets of environmental issues are all related to nitrogen threats and benefits to the ecosystem and environment. Especially, Assessing N threats and benefits can be extended from water quality (included estuaries and coastal seas) to fish resources, and marine biodiversity. Yale Center for Environmental Law and Policy has published an annual Environmental Performance Index (EPI) report from 2006 until 2018, the EPI is designed based on two objectives (environmental health and ecosystem vitality) within ten issues (included Air Quality, Water & Sanitation, Heavy Metals, Biodiversity & Habitat, Forests, Fisheries, Climate & Energy, Air Pollution, Water Resources, and Agriculture). EPI framework is established in three levels, which they consisted of 2 objectives, 10 issues categories, and 22 indicators in 2018. It is similar to the OECD-EI tool that EPI 10 issues categories are all related to nitrogen threats and benefits to the ecosystem and environment. The objective of this study is (1) using OECD-EI and EPI system to develop an integrated environmental index for nitrogen (EI-N) to estimate the N threats and benefits of nitrogen impact to environment and ecosystem; (2) applying EI-N to evaluate the nitrogen threats by Interactions between land use change and regional development in the coastal zone of Taiwan. We choice four coastal zone area to representing the land use change in a highly developed urban area, mainly agricultural use region, extremely industrialized area, and natural tourist area by simulating the EI-N model to discuss a ten years coastal zone nitrogen impact within environmental factors, economic factors, and social factors. We expected the results can be used to develop the nitrogen governance policy and strategy.
Patterns and drivers of stability in long-term metacommunity data

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Metacommunity ecology focuses on the local and regional scale factors that influence community structure and dynamics. Although the ecological processes that confer community stability at the local scale are well characterized, a deeper examination of stability at the metacommunity scale has only recently begun. Stability at the metacommunity scale will depend on the relationship between temporal environmental variability, spatial heterogeneity, and species dispersal rates. Generally, combinations of these factors that reduce spatial synchrony in community dynamics tend to stabilize aggregate properties at the metacommunity scale, but drivers of compositional metacommunity stability are uncertain.

We used NSF Long-Term Ecological Research (LTER) data to quantify metacommunity variability across a variety of ecosystem and organism types using a novel, multi-scale stability metric focused on compositional variability. We used on-site measurements and remote sensing data to quantify the spatial and temporal variability at each LTER site. We used this environmental data, along with organismal and ecosystem type, to predict metacommunity variability across the LTER network. Metacommunity stability was influenced by temporal variability in temperature and productivity, but the relationship between environmental and metacommunity variability was context dependent. In terrestrial macroorganisms, higher temperature variability was associated with more stable local communities, but because it increased spatial synchrony, more variable temperatures were associated with lower stability at the metacommunity scale. Marine metacommunities showed a weaker relationship with temperature variability, but had higher stability when productivity was more variable. In contrast, more variable productivity was correlated with lower stability in metacommunities of freshwater diatoms. Freshwater and terrestrial metacommunities overall had lower stability at higher latitudes due to higher spatial synchrony, while marine metacommunities were less stable in the tropics. Our work extends the study of aggregate metacommunity stability to include the spatial scaling of compositional stability. Our results suggest that, in natural systems, there appear to be general patterns of metacommunity stability that depend on species traits (e.g., body size), biome (e.g., marine, freshwater, terrestrial), trophic group (e.g., producers, consumers), and spatial/temporal environmental variation.
T3: ALTERED NUTRIENT CYCLES AND ENVIRONMENTAL POLLUTION

Long-Term Trends in Wadden Sea Eutrophication

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The Wadden Sea is a shallow intertidal coastal sea fringing the North Sea coast of the Netherlands, Germany and Denmark and largely protected by barrier islands. It is subject to influences from both the North Sea and from the major European rivers. Nutrient enrichment of these rivers since the 1950’s have exerted a major impact on the ecology including a loss of seagrass, increased phytoplankton blooms and increased green macroalgae blooms. Available long-term data document an increase in eutrophication until the 1980s and a decrease since.

Rivers are the major source of Wadden Sea eutrophication. The nutrient inputs of the major rivers impacting the Wadden Sea continue to decrease at an average pace of about 2.5 % per year for TN and about 5.4 % per year for TP causing increasing NP ratios. During the past decade, the lowest inputs since 1977 were observed but these declining trends are levelling out, i.e., the TP trend has stagnated.

Phytoplankton biomass (measured as Chla) have clearly decreased since the 1980s and presently remain at a low level. In tidal inlet stations with a long-term monitoring, summer phytoplankton levels correlate with riverine TN loads but stations located within the Wadden Sea behave more complex.

Regional differences are observed with highest levels in the southern Wadden Sea and in the mouth of the Elbe estuary and lowest levels in the northern Wadden Sea. Possible explanations for these regional differences will be presented.
All plants need nitrogen (N) to grow, but some need more than others. Most semi-natural habitats, such as peat bogs and moorlands, are adapted to low N availability. Mosses and lichens living in these habitats mostly get their N from the air and therefore are very sensitive to increasing N deposition.

Up to the early 2000s' little was known about the effects of the different levels and forms of N. It was expected that dry deposition, as ammonia (NH$_3$) gas, would have a bigger impact on the vegetation than wet deposition, as nitrate (NO$_3^-$) or ammonium (NH$_4^+$) in rain. To investigate these differences, a manipulation field site at Whim Bog was set up in 2002. Whim Bog is located in the Scottish Borders where N background concentrations are low. N-sensitive mosses, e.g. Sphagnum capillifolium, and lichens, e.g. Cladonia portentosa, are present at the bog as well as the heather Calluna vulgaris.

The experiment has 44 plots with different levels and forms of wet deposition and a gradient of dry deposition at different distances from a line-source.

All treatments are regulated by windspeed/wind direction and rainfall to simulate ‘real world’ conditions and this makes it a globally unique experiment.

An ozone (O$_3$) transect, to study the interaction between O$_3$ and N was added in 2015.

Since 2002, several researchers and students from many different countries have worked at Whim Bog on a range of subjects.

I will discuss the layout of the experiment, the methods of N-application and a selection of the main results.
T1: DRIVERS OF LONG-TERM CHANGES IN BIODIVERSITY, ECOSYSTEM INTEGRITY AND ECOSYSTEM FUNCTIONS

Accessing the importance of matrix elements to maintain biodiversity in remaining areas of the Atlantic Forest biome: a multi-taxa approach in a Brazilian LTER site

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Matrix elements, such as scattered trees and temporary ponds, can function as key elements maintaining biodiversity in landscapes that suffered forest loss and fragmentation. Because of their disproportional importance considering the reduced area they occupy, reduction of matrix elements can lead to reduction of movement of organisms, and consequently of matter and energy, leading to loss of different levels of diversity and ecosystem functionality. Empirical tests of the importance of matrix elements for biodiversity are scarce, as well as studies of long-term consequences of changes in matrix elements, especially in a multi-taxa approach. Here in, we quantified the contribution of scattered trees and temporary ponds to maintain forest-dependent anurans, birds, epiphyte plants, and to the movement of a non-flying small mammal. The importance of scattered trees and temporary ponds is being assessed both observationally and experimentally in the Fluminense Central Mosaic (PELD-MCF), a site of the Brazilian LTER network in southeastern Brazil, comprising areas of Atlantic Forest with varying degrees of fragmentation and disturbance. Experimental ponds located beneath scattered trees had a greater total abundance of amphibians than those located in open pasture. The combination of a local environmental driver (pond hydroperiod) with the presence of scattered trees in the pasture favored the persistence of forest-dependent anuran species in the matrix. For birds, trees located at forest edges and scattered in open pasture varied in richness and taxonomic composition of birds. Scattered compared to forest edge trees sustained communities of birds with different ecological functions, even though the number of functions was similar. For epiphyte plants, species richness and the proportion of forest-dependent species in scattered trees were influenced by both local and landscape drivers: tree size, distance to forest patch and number of scattered trees surrounding focal trees. The non-flying small mammal species studied selected for scattered trees when moving between in the matrix habitat patches. After reaching a tree, the sinuosity of movement paths became more linear, adding an important role of scattered trees as orientation beacons in long distance movements by small mammals across the landscape. These first results demonstrate the importance of scattered trees and temporary ponds in the matrix, as they favor connectivity between populations and assemblages of a variety of taxa across the landscape. These taxa are involved in vital ecosystem pro-
cesses, such as seed dispersal by birds and small mammals, flux of matter and energy between remaining forest patches, and across the landscape. The continuity of these studies and addition of studies on specific ecosystem process (e.g. seed dispersal, nutrient cycling) will allow the evaluation of long-term consequences of changes in land use that are occurring in the region. The current results already point to simple conservation strategies that could have large impacts relative to their cost, such as building additional ponds, planting trees in their surroundings and near forest remnants.

T2: CLIMATE CHANGE IMPACT ON ECOSYSTEM PROCESSES

Uncertainties of estimated litter decomposition rates derived from standard Tea Bags in Northwest Germany

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The decomposition of litter is a key factor for carbon and nutrient cycles in forest ecosystems. Due to global warming, the interaction between climate and litter decomposition is of fundamental interest. In order to separate effects of environmental factors on decomposition from litter quality and litter trait effects, Keuskamp et al. (2013) developed the easy to use, quick, cost-effective and globally harmonized Tea Bag method. The “Tea Bag Index” (TBI), derived from the decomposition of standardized green and rooibos tea after an incubation time of only 90 days, comprises the stabilizing factor S and the decomposition constant k. Keuskamp et al. (2013) stated that in some cases, it is very uncertain if green tea has reached its limit value of decomposition. Böttcher (2004) demonstrated for mineralization studies of organic material that estimated decomposition rate constants (k) may comprise strong uncertainty (about 50%) as a function of incubation length and measurement errors. For quantification of such uncertainties we used data from decomposition experiments at LTER sites in Northwest Germany. The sites are part of the global TeaComposition initiative (Djukic et al. 2018), where incubation periods of 3, 12, 24, and 36 months were studied. We use Monte Carlo simulation techniques and site specific local leaf litter decomposition experiments to quantify uncertainties of estimated decomposition rate constants from the TBI after an incubation time of 3 months. A possible reduction of parameter uncertainty by adapted sample size and incubation period will be evaluated.

References


T3: ALTERED NUTRIENT CYCLES AND ENVIRONMENTAL POLLUTION

Atmospheric deposition of nitrogen, phosphorous, and acid in Chinese ecosystems: dynamics, patterns, and the influencing factors

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The atmospheric deposition of nitrogen, phosphorus, and acid is increasing due to human activities. This may not only bring negative effects on ecosystem, such as biodiversity damage, soil acidification, reducing soil buffer capacity, but also bring positive effects on ecosystems, such as providing nutrient element, increasing crop yields, promoting forest growing, and so on. Therefore, it will be helpful for evaluating the impact of atmospheric nitrogen, phosphorus, and acid deposition to ecosystem processes and functioning to explore their dynamics, patterns, and the influencing factors.

Based on Chinese Ecosystem Research Network (CERN) and other stations, we established the Observation Network of Atmospheric Chemistry Deposition in typical terrestrial ecosystems (China_WD) which consists of more than 50 ecosystems covering forest, grassland, cropland, desert, lake, wetland, and city. The network observes atmospheric nitrogen, phosphorus, and acid deposition simultaneously. Based on the observation data, we quantitatively analyzed the spatio-temporal variability, influencing factors and driving forces of atmospheric nitrogen deposition in China, the spatio-temporal pattern and its influencing factors of precipitation acid deposition, the atmospheric phosphorus deposition, N:P and its ecological implications in typical ecosystems in China.

The results showed that the annual average flux of atmospheric wet deposition (ammonium nitrogen and nitrate nitrogen) in China was about 12.4-13.8 kg ha⁻¹ a⁻¹, significantly higher than that of America and European region; high nitrogen deposition region located in Central China and Southern China, while low nitrogen deposition region located in Northern China, Western China, Neimenggu and Qinhai-Tibetan. The average ratio of NH₄⁺/NO₃⁻ was 1.22 in wet deposition. The main factors that control the spatial pattern of wet nitrogen deposition were nitrogen fertilizer utilization, energy consumption, and precipitation. The average pH value in precipitation was 6.2 in Chinese natural ecosystems and croplands, and the acid deposition exhibited an aggravation trend from north to south, with the most serious region in southwest region; energy consumption and precipitation affect acid deposition significantly. The annual average value of phosphorus deposition in precipitation was about 0.21 kg P ha⁻¹ a⁻¹ in China, the ratio of N:P was 77:1 in atmospheric wet deposition, and the imbalanced input of nitrogen and phosphorus might have impact on ecosystem productivity and biodiversity in Chinese terrestrial ecosystems.
Near-term iterative forecasts of biodiversity change

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Ecosystems around the world are responding to unprecedented rates of environmental change. This in turn presents challenges in how we plan and make decisions to live sustainably within the boundaries set by nature. Change is the new normal and therefore managers in industries such as agriculture, forestry or conservation need up-to-date information on what is going to be happening to biodiversity over spans of days, seasons and years; that is, they need near-term forecasts of biodiversity change as scales relevant to on-ground management, rather than long-term climate-only forecasts. Coupled to the need to adapt to environmental change, the availability of environmental data from satellites and sensors and from national plot-based monitoring infrastructure such as the Australian Terrestrial Ecosystem Research Network is also driving a revolution in how we detect and report on biodiversity change across the continent.

Why forecasting, and why now? Forecasting is embedded in the scientific method, as it involves the cycle of prediction and testing, but repeats these steps in an iterative model that brings in new observations as it goes forward. This capability for near-term forecasting also includes quantitative estimates of the uncertainty around the predictions, again of great value for decision-making. By embedding the discovery about the way the world works into the models that guide management we can accelerate the pace of discovery in the environmental sciences and deliver practical outcomes for society.

Using a series of case studies based on long-term data, we will outline how ecosystem forecasting reveals the extent to which legacy effects from extreme environmental events – prolonged droughts, floods, heatwaves and fires – persist into future years in vulnerable dryland ecosystems. As highly stressed environments are expected to leave increasingly large impacts on flora and fauna and exacerbate desertification, answers are urgently needed to understand and mitigate these impacts.

We will conclude with a discussion about how to improve environmental policy that has to date been largely reliant on evidence about how ecosystems have worked in the past, rather than projections of how they will change in the future, when all policy actions must be implemented.
T6: GLOBAL RESEARCH INFRASTRUCTURES

Sharing Observation and Downscaled Modelling Data using the eLTER Information System

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The assessment of long-term European scale environmental change requires an understanding of how ecosystems function, how they respond to a range of pressures and how resilient they are to such changes. This type of long-term ecosystem research, and evidence based decision making, needs access to documented, quality controlled and accessible data. The eLTER Information System provides a common information management infrastructure for making data from distributed resources available and accessible for users. eLTER is designing a federated data infrastructure, with data stored in existing partner data systems and integrated by a central discovery portal and federated data access components. Its components include:

- A metadata editor and catalogue (DEIMS-SDR) to create, publish and share information on sites, data products, datasets and sensors.
- A common controlled vocabulary (EnvThes) developed to harmonise the structure and content of data shared within eLTER.
- A Central Data Node (CDN) which allows users to register time series data services and upload data. Once this upload is completed, these data can be visualised and accessed through SOS services clients such as the eLTER Data Integration Platform (DIP).
- The Data Integration Portal (DIP) enables users to discover, visualise and access data from multiple sites and sensors.

This eLTER Information System complies with the EU INSPIRE regulations implemented through OGC standards (WFS, WMS, WCS and SOS). The eLTER Information System also provides access to pan-European data products such as EURO-CORDEX regional climate projections. EURO-CORDEX (https://euro-cordex.net/) provides regional climate change information based on an ensemble of regional climate model (RCM) simulations for each eLTER site across Europe. The ensemble consists of dynamically downscaled CMIP5 global climate models (GCMs) for different greenhouse gas concentration trajectories. The timespan of the RCM simulation results is from 1950 to 2100. The EURO-CORDEX regional climate projections have been incorporated within the DEIMS catalogue and will be available for download by users. This talk will describe the eLTER Information System architecture and how both observed and modelled data can be shared by data providers and accessed by users.
Although it is well known that the Global Change affects the environment at many different time and length scales, currently, only very limited knowledge is available on the importance of distinct dynamic events for the long-term development of the environment. We will present the MOSES (Modular Observation Solutions for Earth Systems) observing system, which is being developed to close this gap. From 2017 till 2021, the Helmholtz Association invests approximately €30 million to implement the mobile and modular research infrastructure, which is designed to capture dynamic events such as heavy rains and floods or heatwaves and droughts and to investigate their long-term impacts. First MOSES test campaigns started 2018 and will continue during the next three years. As it is a key issue to develop the event driven observation concept in close cooperation with partners from research and practice, upcoming test campaigns are open for cooperation. Details on the observing system and the current planning of test campaigns are provided on the website: www.moses-observation.de.

There is substantial evidence that climate change will be associated with an increase in frequency, intensity or a shift in timing of weather extremes such as heavy rains and droughts, elevated flooding and extended low water periods, all with as yet unforeseeable environmental and socioeconomic consequences and feedbacks. Such meteorological and hydrological events are restricted in time and they are spatially distinct, but their ultimate impact may be significant for much larger regions (e.g. downstream catchment areas flooded from run-off generation in upstream headwaters) and with delayed effects (e.g. algal blooms in the vegetation periods in coastal zones triggered by legacy nutrient pulses from inland sources). The MOSES observing system is developed to monitor such event chains and the processes they trigger by recording energy, water, greenhouse gas and nutrient cycles on the land surface, in coastal regions and in the atmosphere – but especially the interactions between environmental compartments and the affected ecosystems.

We present a novel event driven observation concept that aims at capturing such events from their origin to their fading and that complements existing data and models from long-term monitoring and observatories. This concept systematically combines mobile and high resolution event monitoring with stationary integrative observation and as such it represents an important addition to existing monitoring networks and satellite missions, which are mostly designed for long-term, large-scale environmental observation. Examples include ICOS (Integrated Carbon Observation System), ILTER (International Long Term Ecological Research Network,) or TERENO (Terrestrial Environmental Observatories).
Coastal wetlands store immense amounts of carbon (C) in vegetation and sediments given their relatively low global area coverage, but this store of C is under threat from climate change. Accelerated sea level rise (SLR), greater inundation, and more frequent periods of droughts will impact biogeochemical cycling in wetlands. Coastal peat marshes are especially susceptible to saltwater intrusion and changes in water depth, but little is known about how exposure to salinity affects organic matter accumulation and peat stability. Within the brackish water portions of the Everglades, open water ponds forming in the middle of marshes has been documented and referred to as “peat collapse” and hypothesized to be the result of a rapid shift in soil C balance, leading to a net loss of organic C and loss of soil elevation. However, the drivers and mechanisms of peat collapse are still not fully understood. Using coupled field and mesocosm manipulation experiments, we measured fresh- and brackish-water marsh responses to elevated salinity, greater inundation, drought, and increased nutrient loading. In the field, we found that elevated salinity only affected net ecosystem production (NEP) when water fell below the soil surface, but did increase root turnover. In the mesocosm experiments we exposed a freshwater marsh to brackish conditions (0 - 8 ppt) and elevated P. NEP was unaffected by elevated salinity but significantly increased with P enrichment. Elevated salinity did not impact root growth, but led to a higher turnover of live to dead roots. This led to a ~2-cm loss in soil elevation within 1 year of being exposed to elevated salinity conditions. When exposing a brackish marsh to more saline conditions (10 - 20 ppt), we found that NEP, plant productivity, and root growth were all significantly decreased with elevated salinity, leading to a shift in the marsh from a net C sink to a net C source to the atmosphere. Elevated salinity did not increase elevation loss, but when coupled with a drought event, elevation loss doubled. Based on the findings from our experiments, we can begin to piece together the drivers and mechanisms of peat collapse. When freshwater marshes are first exposed to elevated salinity, even though aboveground productivity and NEP may be unaffected, soil structure and integrity appear to be negatively affected by salt through a loss of live roots within the soil profile, leaving the peat vulnerable to collapse. This would explain the presence of live sawgrass “pedestals” in the brackish portions of the Everglades where it appears that the surrounding soil has collapsed. Exposing these brackish marshes to even greater increases in salinity further led to a net decline in soil C storage, but did not negatively affect elevation. Although saltwater intrusion into freshwater wetlands may initially stimulate primary productivity through a P subsidy, the impact of elevated salinity on root and soil structure may ultimately be what matters to the survival or collapse of these marshes.
Coping with challenges and obstacles of public participation in the design of a green city. The City of Lodz (Central Poland) case study

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City design for human health and well-being in the face of climate change requires an implementation of green infrastructure in harmony with citizen needs. Consulting the end users in the design process ensures better planning and fulfillment of public needs. The City of Lodz (Central Poland, LTSER platform) not only struggles with environmental problems (floods, urban heat island, low air quality) but also faces social and economic challenges. The city arose in the XIX century, based on natural resources (water and forests) essential for establishing textile industry. Now, it is a typical post-industrial area. It suffered from textile industry collapse in 1990s and unemployment crisis with consequences like population decrease, inhabitants aging, and degradation of public space (large factories, public buildings, commercial and residential houses, common grounds). Currently, city authorities handle the challenge through revitalization of historical city center and enabling space for new commercial investments. In those initiatives, the topic of urban greenery appears, evoking a wide range of reactions among stakeholders.

We traced the ongoing discussion about city greenery to check public involvement and attitudes. We have also asked citizens how they perceive the neighboring public space and benefits it should provide in terms of functionality and ecosystem services. To find answers we conducted surveys and asked citizens to join the participatory design of urban public spaces (backyards, streets, rivers). Additionally, we engaged NGOs and city officials in the discussion. The results provided a range of information, including the general need for greenery and request for particular solutions for improving public space (with reference to orderliness, functionality and specific type of greening measures). The process of collecting data revealed difficulties in community engagement, and what is more surprising, we have encountered barriers in reaching and cooperating with NGOs. It led to modification of our approach and implementation of complementary solutions and methods during the process. The presentation will show lessons learned from the process of co-designing of urban public green space towards a sustainable city with reference to its history and long-term processes.
Climate and land use change are transforming ecosystems around the globe. To better understand and manage the social and ecological challenges caused by these increasingly dynamic and extensive ecosystem transformations, long-term observations are needed globally. The International Long Term Ecological Research (ILTER) Network is the first international network of long-term site-based ecosystem and environmental monitoring infrastructure operating at global scale, building on collaborations across existing national LTER sites. Integrating site-based observations across global environmental gradients (e.g. climate, biogeography) and in large-scale socio-economic patterns is one of the major challenges of leveraging ILTER research to understand the ecological and social consequences of global changes in climate and land use. Here we assess the global representativeness of the current distribution of ILTER sites relative to key ecological and social patterns, to enable more statistically robust global synthesis of long-term trends in ILTER data, and towards better understanding potential gaps in the ILTER network configuration.
Standardization and devices development for vegetation structure and plant growth monitoring in Chinese Ecosystem Research Network (CERN)

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The Chinese Ecosystem Research Network (CERN) was established in 1988 with three core missions including monitoring, research and demonstration. Over the past 30 years, as one of major component of Global Terrestrial Observing System and International Long-Term Ecological Research (ILTER), CERN has grown to be an important research platform for the sites and partners both at home and abroad, which owe greatly to the data measured and collected on long-term and continuous basis, and also the up-to-date facilities and instruments in the field stations that represent the major ecosystem types in China. In terms of long-term scientific monitoring, CERN has become one of the largest and most successful national networks that consist of over 40 field stations, covering eight types of ecosystems (agriculture, forest, grassland, desert, marsh, urban, lake, gulf).

CERN started ecosystem network monitoring in 1998. In order to insure data collected in different time and different places being comparable and make the long-term monitoring effective, CERN always highly emphasize the standardization of ecosystem monitoring from the beginning. For each type of ecosystem stations, CERN formulated universal observing variables and method, and equipped the same instrument set. The Sub-center for Biology of CERN, the management organization for biological monitoring in CERN, published a series of protocol books, including “Survey, observation and analysis of terrestrial biocommunities”, “Protocols for standard biological observation and measurement in terrestrial ecosystems”, “Quality assurance and quality control of data for long-term biological observation and measurement in terrestrial ecosystems”. These books explicitly stated the observing variables and protocols, data format and database structure etc.

Smart, real-time ecosystem monitoring is essentially important for understanding and management of rapidly changing ecosystems. In order to facilitate new techniques, such as Internet of Things (IoT) technology, being introduced into ecosystem monitoring, CERN initiated innovative development of smart devices for ecosystem monitoring in 2016. We developed five devices to make comprehensive observation on key parameters of vegetation structure and plant growth based on new sensor, data logger, long distance wireless sensor network technology. They can make rapid, high-precise, high-frequency, real-time monitoring on vegetation three-dimensional canopy microstructure, community distributed leaf area index, tree diameter, wood density in standing trees, plant phenology.
For many of the environmental issues we are facing, it is no longer possible for a single investigator, or even a team of investigators, to address large-scale ecological questions. Coordinated biogeochemical research based on international collaborative networks are needed. Such networks can address problems at regional and global scales in order to understand ecological patterns and processes, and to develop solutions for environmental management based on sound scientific data. Key components of global change research often include first, long-term research approach is needed; second, large-scale environmental representation; third, a combination of observational research, experimental manipulations, and modeling. In particular, ‘experiments’ permit the formulation of theory. Models are usually built upon theories, and are parameterized by observations and experimental data. Observations can be used to provide validation. All of this reasoning clearly supports the approach of LTER, FLUXNET, ICOS and similar networks.

However, testing theory and models in the same framework employed in their development does not always provide the rigorous testing that is ultimately needed. Instead, models, both numerical, and analytical ones, should be tested in the less ‘conventional’ settings where they are truly challenged and tested for their robustness. The more exotic observational sites that do not always fit the large-scale patterns provide such important test beds. We will review a few of examples from the Yatir site operating at the “dry timberline” for past 19 years, that demonstrate ‘non-conventional’ ecosystem response to environmental conditions, including response to extreme events, changes in phenology, energy flux partitioning, and remote sensing signals, all of which provide demanding challenges to some of our traditional assumption.
The first long-term soil N x P manipulation experiment in a temperate forest system

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Experimental tests of N and P limitation in temperate forest systems are few, and those few have been short-term with very high rates of fertilization. In 2011 we began long-term, low-level additions of N, P, and N+P in 13 forest stands distributed across three sites in the White Mountain National Forest of New Hampshire. At Bartlett Experimental Forest (BEF), which is underlain by granite, we have three young, three mid-aged, and three mature stands. At both Hubbard Brook Experimental Forest (HB), on granodiorite, and Jeffers Brook (JB) on amphibolite (metamorphosed basalt), we have one mature and one mid-aged forest stand. Each stand has four plots treated annually with N (30 kg N/ha/yr as NH₄NO₃), P (10 kg P/ha/yr as NaH₂PO₄), both N and P, and control. These relatively modest rates are designed to alter site fertility while minimizing artifacts associated with high doses of fertilizer. Foliar N:P ratios indicate that most of our sites are P-limited rather than N-limited. Consistent with P limitation, plots receiving P moved into the co-limited range, and those receiving N were even more P limited after 5 years of treatment, according to their foliar N:P ratios. Tree growth responded more to P addition than to N addition in mid-aged and mature stands (P=0.02). These results are surprising because temperate forests on glaciated soils have been presumed to be N limited. Resin-available soil N was reduced by P fertilization, indicating stimulation of microbial immobilization or plant uptake of N, consistent with P limitation. However, soil respiration was reduced by N addition where initial N availability was low, which suggests that root or microbial activity was limited by N. A better understanding of the capacity of ecosystems to balance the acquisition of limiting resources is needed to manage ecosystems in the face of continuing environmental change.
T4: ADVANCES IN LONG-TERM SOCIO-ECOLOGICAL RESEARCH AND SUSTAINABILITY SCIENCE

Change in social-ecological coupling on the Chinese Loess Plateau in recent decades: an insight from long term research on watersheds

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Social-ecological coupling is intrinsic in socio-ecological systems, which taking various ecosystem services flows as one of the fundamental linkage. Changes in external and internal driven forces of the system lead to the shift of coupling forms and intensity. The Loess Plateau in north-central China is the largest geographical subset in the world that covered by thick loess and with high population density (145 people per km²). In the past decades, driven by vast ecological restoration and remedy projects, climate change and social-economic reform, the Loess Plateau is a well-known hotspot of land use/cover change not only in China, but also over the world. This change led to the significant change in ecohydrology, soil erosion and sediment flux, and carbon storage, and the ecosystem nutrient cycling, but the gross grain production. Industries contributing most of the income in this region also turn to others beyond crop planting and grazing. Generally, the avenue and the degree of social-ecological coupling and their spatial pattern on the Loess Plateau experienced a significant change. In this paper, we will reveal the change of social-ecological coupling on the Loess Plateau in the past decades, peculiarly after the launch of Grain for Green Project in 1999, and the regime of this change also a concern. Since watershed is the basic and most effective landscape unit for the restoration intervention on the Loess Plateau, we will reveal the change in avenue and degree of social-ecological coupling of the Loess Plateau through exploration of several representative watersheds with long-term observations by taking the ecosystem services supply of ecosystem, and ES flow to and demands of societies as fundamental indicators to quantify the coupling.
Effects of multiple environmental factors on terrestrial carbon sink in the karst region of southwest China

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The karst region of southwest China has been facing double pressures of environmental deterioration and social poverty. Under the implementation of a series of ecological restoration measures and projects, vegetation growth and carbon stock showed a significant increase in this region. However, how climate, land use change, and other environmental factors contribute to this change has not been well understood. In this study, we investigated the effects of multiple environmental factors (i.e. climate, atmospheric CO₂ concentration, atmospheric N deposition, and land use change) on the trend and interannual variability of net ecosystem productivity (NEP) in the karst region of southwest China during 1981-2010 using the ensemble mean of five models from Multi-Scale Synthesis and Terrestrial Model Intercomparison Project. The result shows that modeled NEP mean significantly increased with the rate of 0.9 TgC/yr from 1981 to 2010. Compared with 1980s, mean annual NEP in 1990s and 2000s increased by 33.4% and 43.6% respectively. The increase of atmospheric nitrogen deposition and CO₂ concentration were the main factors attributing to the increase in NEP, which accounted for 66.6% and 51.4% of the total increase. The impact of climate change was positive in 1980s and 1990s, but negative in 2000s. The contribution of land use change decreased from -56.5% in 1980s to -11.6% in 1990s and turned into a weak positive effect (1.6%) in 2000s. In contrast, the interannual variation of NEP was mainly influenced by climate fluctuation, which could explain 87.5% of the interannual variation of NEP in the past 30 years.
Ecosystems are providing essential services to human society. Food production, freshwater for drinking, clean air, biodiversity support, climate regulation and nutrient cycling, mitigation of natural disasters, regulation of pests and diseases are just few examples of ecosystem services of vital importance. However, there is a significant lack of understanding of the complex interactions between ecosystems and the benefits they bring to society the Ecosystem Services (ES) and the geo- and atmosphere. In recent years strong developments occurred in creating environmental monitoring and observation systems at different scales (GMES, GEO-BON) but global data coverage is still patchy. We present the development of a web based integrated platform for aquatic and terrestrial ecosystems studies that will be used in Braila Islands and Danube Delta Long Term Socio-Ecological Research (LTSER) platforms in Romania.

The platform will permit data sharing available for use, by other researchers and will serve also to conservation policies and implementation of the sustainable development in the area.

The platform design and concept will allow the integration of data gathered at different spatial resolution and time scales and will be further use to enhance the synthesis efforts focused on: ecological modeling (parameterization models) and validation of Earth Observation (EO) data. In the same time the platform will also allow that the coherent integration of large volumes of ecological data, available through different institutions or in data repositories to further serve the synthesis and ecological analysis. The platform will bring benefits for decision-making, natural resource management, education and other purposes. The newly developed, integrated platform is an example of a highly instrumented LTSER site and acting as a prototype for a national distributed monitoring network to support transparent and knowledge-based conservation and management policies.
Assessing Ecosystem Responses to Land-Use Changes by Soil Quality Index

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The change in land use from natural land regarding land used by humans in various areas is critical to the global ecosystem, which in turn affects soil conditions. In order to improve our understanding of land use, our study focuses on soil health assessment and it depends on long term environmental research area near Wadi Nar in Al-Ubeidiya to assess the ecosystem response to land use, including tillage practice. The aim of this study is to evaluate the effects of tillage on soil health for each system (natural, pastoral A, pastoral B) by using soil quality index. Three systems are studied: natural (no-tillage), tillage with the removal of plants (pastoral A) and tillage without the removal of plants (pastoral B).

In order to assess soil health, the chemical, biological and physical parameters of the soil must be analyzed. During our study, soil quality is assessed using the method of registration in each index using the SQI soil quality index, which determines the level of soil degradation, by collecting data on selected chemical, physical and biological indicators for each soil. Numerous statistical calculations were performed, including the PCA analysis, which shows the correlation between transactions in all systems at a given depth.

Soil health assessment was used in detail for each laboratory of chemical, physical and biological indicators based on Cornell’s book.

The result of the soil quality index for natural land is 16, where a number of indicators have been adopted to determine the quality of the soil. The pastoral system A achieves 15.4 while pastoral B has the highest value of 16.3. The result shows that according to the soil quality index, management types including tillage and plant retention can improve soil quality. The higher the values are, the better the soil quality is. The best soil quality index in our study is 39 and the lowest value is 10 based on the equation used to calculate the soil quality index.
T4: ADVANCES IN LONG-TERM SOCIO-ECOLOGICAL RESEARCH AND SUSTAINABILITY SCIENCE

Advances and Challenges in Long-Term Socioecological Research in Brazil

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The Brazilian Long-Term Ecological Research Program (PELD) was funded by the National Council for Scientific and Technological Development (CNPq) inspired by the International Long-Term Ecological Research Network (ILTER) sites in 1997, as a network of research sites that today comprises 34 PELD sites in the seven different biomas of Brazil (Amazonia, Cerrado, Pantanal, Pampas, Caatinga, Atlantic Forest, Marine and Coastal), where data are collected mainly on the composition and dynamics of ecosystems. In these 22 years of existence, a rich research database has been built, allowing a broader comprehension of the relations between biodiversity and long term ecosystem processes, including land use and climate change impacts on biodiversity, associated to scientific production of international expression and human resources formation of excellence, and contributing to the improvement of enviromental and biodiversity management policies. Recent partnerships with the Brazilian Federal Agency for Support and Evaluation of Graduate Education (CAPES) and a number of State Research Foundations have helped improve the network’s funding scheme, strengthening the research capacity. CNPq’s role in promoting monitoring and evaluation meetings and working on the observed results in terms of projects outcomes, knowledge gaps and recommandations has been crucial in helping the network move towards reaching different academic and non scientific audiences, specially policymakers, protected areas managers and varied local communities; and towards knowledge synthesis. Other advances of the Program include integration of national and international colaborative research networks; the application of multi-methodological approaches with interdisciplinary focus; as well as the inception of the Brazilian Synthesis Centre on Biodiversity and Ecosystem Services – SinBiose. As a result, landscape dynamics evaluations, natural resources sustainable management, socioecological components and future cenaries for sociobiodiversity are being investigated, contributing for the Aichi Targets (CDB, 2014; EPANB, 2018) and to the growing trend in socio-ecological research at long-term monitoring plataforms (JAN et al, 2018). Situated in a megadiverse country with an elevated sociodiversity and facing different degrees of biodiversity threatens and loss, the main challenges pointed out and faced by the PELD Program are shared by other brazilian (as PPBio and Sisbiota) and international biodiversity programs. These challenges include knowledge production and synthesis for adressing sustainability challenges; the equal integration of the social and natural sciences; the promotion of the transdisciplinarity and the dialogue of knowledge with traditional people and local communities; participatory monitoring and citizen science; valuing
nature’s contributions to people and promoting the public engagement with biodiversity conservation (VISEU, 2015; JAN et al, 2018; IPBES, 2018; ROQUE et al, 2018), evidencing the importance of ensuring long term financial investments for research sites maintenance and expansion of the Brazilian Long-Term Ecological Research Program (PELD).

T2: CLIMATE CHANGE IMPACT ON ECOSYSTEM PROCESSES

Twenty year trends in precipitation and surface water chemistry of two LTER small forest catchments in Wallonia, Belgium

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The ca. 80 ha forested catchments Robinette and Waroneu are located in the state forest of Hertogenwald, Belgium (50°33′ N, 6°04′ E). Waroneu was covered in the early 1980s, with hardwoods (40%) and Norway spruce (Picea abies (L.) KARST.) (60%). By 2011, the proportions had changed to 38% spruce, 45% deciduous and 17% open areas. Waroneu was limed in 1992 with 3 T/ha dolomite lime and 200 kg/ha potassium sulphate. La Robinette was initially covered with Norway spruce, but following windthrow in the 1990s, and a clear-cut in 1996, it was partially replanted with deciduous species (1998). The geological substratum of both catchments consists of quartzites, quartzo-phyllades and Revnian phyllads, covered with acidic brown soils. Both catchments have been monitored for rainfall, throughfall, soil solution and runoff chemistry since 1992 within the frame of several projects, assessing the effects of liming, clearcut and reforestation with deciduous species. Data are also used within several regional and European assessments (State of the Walloon Environment, calculation of critical loads, effect of air pollutants on ecosystems). Since 2013, 12 intense monitoring plots were installed within the catchments to represent spatial variability and to follow soil quality (Ratcliffe et al., 2018).

Here we present temporal 1992-2014 trends of monthly rainfall, throughfall (under Norway spruce) and bi-monthly runoff data. Data were analyzed with the non-parametric seasonal Mann-Kendall test, adapted for serial dependence, if necessary. Slopes were estimated with the seasonal Kendall slope estimator. The time and number of breakpoints within the time series was estimated with the BFAST algorithm (Breaks For Additive Season and Trend).

No significant global trends were detected in rainfall, throughfall and runoff water volumes in both catchments. One breakpoint for runoff at Robinette, likely related to the clearcut, was detected. A general decrease in acidifying and eutrophying compounds was observed in both catchments, concurrent with an increase in ANC and pH, indicating a progressive recovery from acidification.

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T1: DRIVERS OF LONG-TERM CHANGES IN BIODIVERSITY, ECOSYSTEM INTEGRITY AND ECO SYSTEM FUNCTIONS

Monitoring schemes on Romanian Long-Term Socio-Ecological Research and their implications for further data integration

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European Long-Term Socio-Ecosystem Research (LTSER) is a network of sites and competences aimed at better understanding ecosystems and their dynamics. In order to achieve this goal transdisciplinary research and complex monitoring are needed in order to improve the knowledge about the structure and functions of ecosystems and their responses to different pressures. Romania’s LTSER consist of six large areas covering different types of ecosystems, socio-economical features and climatic gradients. These areas are covering 9.4% of the national territory and contains 30 types of ecosystems (MAES level II) from a total number of 36. We considered for this analysis eight regional monitoring systems that address different components of ecosystems, independent from LTER sites, as following: (1) national meteorological network, (2) air quality monitoring, (3) National Forest Inventory, (4) monitoring of conservation status under Natura 2000, (5) national census of common birds, (7) monitoring schemes under EU Water Framework Directive, and (8) relevant data reported by national institute of statistics. The analysis was aimed at identifying relevant parameters for depicting ecosystem integrity and functions. We grouped these parameters based on their domain, spatial scales and temporal frequencies and checked for the redundancies among different monitoring system. Such an analysis is useful for reusing the existing data within the LTSER sites network for identifying the trends of some ecosystem components (e.g. climate conditions, hydrological regime) as well as optimizing monitoring systems, filling the data gaps and the selection of essential variables.
Situation Analysis of the Global Dryland Ecosystem Programme

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The Global Dryland Ecosystem Programme (Global-DEP) is an international cooperation initiative jointly proposed by various research teams from different countries, with an aim to provide a platform for global research collaboration on dry land ecosystem. To understand the potential demands for Global-DEP, we collected and analyzed general information of a number of international research programmes and UN-led initiatives that are going on in the fields of earth and environmental sciences. Major findings are: i) although not specific to dryland ecosystems, existing programmes and initiatives have paid great attention to them in view of their importance; ii) significant findings and database are available on the conditions of global dryland ecosystems among existing programmes and initiatives; and iii) the links between people and nature, based our latest understanding on them, have been highlighted in the theme of concern and conceptual framework of these programmes and initiatives. As a conclusion, we call for taking an integrated social-ecological approach that brings together natural, social and human science to synthesize the research on global dryland ecosystems. It will not only meet the need of protecting various ecosystems in drylands, but also contribute to various SDGs such as the prevention and control of land degradation, efficient use of water resources, and poverty alleviation.
The stakeholder arguments in biodiversity conservation. Case study - Small Island of Braila Natural Park, Romania

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In the current crisis, displayed to different degrees across multiple spheres (e.g. economic, social, environmental), we are becoming increasingly aware of the undoubted urgency to take measures for our existence and future generations (Rockström et al. 2009). The solutions need to propose useful methods for mitigating causes for the loss of biodiversity, and should consider the structural and functional complexity of natural capital and its resilience under the present pressures. The complexity of the real world (Nicolescu 2014) requires an inter and trans-disciplinary approach (Hirch et al. 2006, Liu 2007, van den Hove 2007, Cash et al. 2013, Young et al. 2014, Buizer et al. 2015), which can be attained by: close collaboration between natural and socio-economic sciences (Holm et al. 2013; Bennett et al. 2016), active cooperation among theory and practice and between academics and decision-making domains (Ewel 2001), and using knowledge from multiple sources (Cash et al. 2003). Recently, biodiversity conservation and ecosystem services approach has been widely used in order to attain the desiderata of sustainability. In this process, arguments used for the implementation of biodiversity conservation measures played a crucial role; the key aspects followed in the present paper are represented by academic and other stakeholders’ contribution to issuing and conveying such arguments.

The paper approaches this by analysing different types of arguments voiced by various stakeholders in achieving biodiversity conservation in the Small Island of Braila Natural Park, emphasizing those that through time lead to the conservation, restoration and sustainable use of biodiversity/Natural Capital activities.

In addition, our study contains diverse social research methods, various types of stakeholders interviewed which, corroborated with previous results for an overall image as close to the reality of socio-ecological systems as possible, supports the complexity approach.

The research findings synthesized in this paper highlighted, on one hand, the central role of academics in the designation of protected areas (at different levels), which obviously must be continued and taken over by other categories of stakeholders, and, on the other hand, the crucial role of traditional knowledge and the need to integrate this type of experience in the overall process of decision making.
Climate change is altering evapotranspiration (ET) across northeastern U.S. forests, with major implications for regional water resources. Significant long-term declines in ET are more likely in warmer areas and significant increases more likely in cooler areas. These heterogeneous ET responses raise the need to precisely understand the controls on ET. Energy is generally assumed to limit forest ET in this cool and humid region, based on the balance of potential ET and precipitation. However, a multivariate analysis of eddy covariance data from regional towers suggests that soil water plays an important role in controlling high ET rates. Further, a sensitivity analysis of multivariate models suggests that ET is highly responsive to soil water changes. This suggests that multivariate understanding is necessary as we forecast changes to ET and the resultant impact on water resources.
Information platform construction for CERN resources management and sharing basing on cloud computing model

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Chinese Ecosystem Research Network (CERN) is administered by Chinese Academy of Sciences (CAS), it is a network of scientists and graduates committed to long-term ecological monitoring, research and demonstration. The information infrastructure of CERN focus on: 1) conducting data integration, management, analyzing and sharing of CERN; 2) consolidating and producing publications on the research outputs of CERN. Categories and inventories amount of CERN's science & technology resources are widely various and very rich which carry on inside management and outside service in an integrated way by 50 distributed-located members all over China. Firstly, this paper expounds the components of S&T resources, then introduces the overall architecture of CERN cloud application system and the key steps to construct the system, especially introduces the information specification of each category and how to collect the standardized data through the data collection system in detail. The paper also analyses that the cloud computing models have unique advantages in the procedure of building and running CERN cloud application system. CERN cloud application system provides a good solution to implement the goal of managing S&T resources high efficiently and publishing S&T resources open and be shared by publics with high performance. Lastly, the paper makes some conclusions and expectations of the CERN cloud application system.
T2: CLIMATE CHANGE IMPACT ON ECOSYSTEM PROCESSES

The response of soil biogeochemistry to drought and hurricanes in a wet tropical forest in Puerto Rico

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Tropical forests across the globe are experiencing novel disturbance regimes with the potential to alter ecosystem processes in ways that could both alleviate or worsen our current climate crisis. Projections of increased frequency and intensity of droughts and hurricanes in tropical forests will likely affect rates of soil carbon (C) and nutrient cycling, with significant implications for the global C cycle. To study the response of soil biogeochemistry to drought in a wet tropical forests, we established a throughfall exclusion experiment in the Luquillo Experimental Forest in Puerto Rico. Following a pre-treatment period, throughfall exclusion using transparent plastic shelters began in March 2017 and continued until November 2018, when shelters were removed. Importantly, six months into the throughfall exclusion, in September 2017, two major hurricanes struck our study site (Irma and María) allowing us to study both the individual and interactive effects of these key disturbances. Throughout our study period (2016-2019), we measured hourly soil temperature, volumetric moisture, and oxygen concentration at three depths (0-15, 15-30, 30-45 cm). We also conducted quarterly soil samplings by depth for soil C and nutrient concentrations, as well as associated biogeochemical variables such as pH and iron. Additionally, soil greenhouse gas fluxes were measured biweekly using manual static flux chambers. Throughfall exclusion had no effect on soil temperature, but significantly reduced volumetric soil moisture from ~0.5 to ~0.3 m3 m-3 at 0-15 cm, resulting in a significant increase in soil oxygen concentrations. Our drought treatment was effective in reducing the redox fluctuations that characterize these soils, maintaining surface soil oxygen concentrations between ~18-21%, in contrast to control soils which experienced mean daily values as low as ~12%. The treatment effect on moisture and oxygen was stronger at the soil surface, while responses at depth (15-45 cm) were of smaller magnitude due to the strong influence of subsurface water flow from the surrounding landscape. Ongoing analyses suggest the observed changes in soil microclimate conditions in response to throughfall exclusion affected redox-sensitive biogeochemical processes (i.e., phosphorus-iron redox cycling), while the significant change in forest structure following the hurricanes (i.e., deposition of litterfall/debris) induced a transient increase soil biological activity due to the sudden pulse of substrate availability.
Effect of increased input of nitrogen and phosphorus to plant community structure and composition in Jalovecká dolina LTER site

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Due to harsh climatic conditions and shallow soils, the alpine grasslands are sensitive to air pollution: the increased input of nitrogen could lead to eutrophication and acidification especially in acid bedrock. To study the effect of increased nitrogen and phosphorus inputs to acid alpine meadow ecosystem, we established the experimental research in the LTER Slovakia site Jalovecká dolina at Mt. Salatín (Tatra National Park, Slovakia) in May 2002. In total, 25 research plots of size 4 m² (2 x 2 m each) were selected and permanently marked in the alpine grassland of alliance Juncion trifidi. The experiment consists of five types of treatment. In three of them is added nitrogen at concentrations of 20, 60 and 150 kg.ha⁻¹ respectively in the form of an water solution of NH₄NO₃, these plots are labelled as “N₂”, “N₆”, and “N₁₅”. The fourth type of treatment is the application of phosphorus at amount of 50 kg.ha⁻¹ in the form of a solution of KH₂PO₄ (labelled as “P”). The fifth type of treatment is the control, without application of chemicals (“C”). The chemicals are applied three times a year in the growing season, with a third of yearly amount applied in each application.

The vegetation structure is monitored using two methods: phytosociological records and pin-point method. For the pin-point method, 100 points are distributed regularly across the plot (distance between points: 20 cm). All vascular plants, mosses and lichens are recorded at each point. The addition of nitrogen to the experimental plots was reflected by the decline (by a lower frequency or abundance) of broadleaf herbs, in particular Campanula alpina and Hieracium alpinum agg. The most striking, however, was the retreat of lichens, mainly Cetraria islandica, by 18-59 % in all plots with addition of nitrogen (N₂, N₆, and N₁₅). The abundance of grasses, especially Festuca supina increased in plots P and N₁₅. The control plots showed lower variability in the coverage of the herbs than other treatments. The overall coverage of the plant community and its vitality decreased in the N-plots. On the contrary, on the plots where phosphorus was added, the plant stand was lush, visibly higher, more dense and with bigger total aboveground biomass than observed in other types of treatment. Phosphorus is a biogenic element, important for plant nutrition and our results indicate that its (low) availability is limiting factor for the plant production in this site.

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T4: ADVANCES IN LONG-TERM SOCIO-ECOLOGICAL RESEARCH AND SUSTAINABILITY SCIENCE

Management of early defoliation phenomena on Korean flowering cherry (Prunus yedoensis Matsum) in South Korea

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Korea flowering cherry (Prunus yedoensis Matsum) is popular with its beautiful flowers and autumn leaves. It can easily be found as a street tree in Korea. Especially, it is one of important attractants to tourists in Southern part of Korea. However, early defoliation has arisen as a major trouble in some area including Gurye County, and changing climate has a negative impact on the tree.

This project has been conducted to investigate potential cause of the early defoliation of the tree, and to find appropriate control measures to the phenomenon. To do this, we have designed an experiment and a comparative research from 2018 in cooperation with the local government. The experiment was done in 3 sections (control, environment-friendly insecticide + disinfectant treatment, environment-friendly insecticide + disinfectant + irrigation treatment) and each section stretched on 1 km long in the similarly affected area. Trees in the control lose their leaves faster than others. On the other hand, there was no detectable difference between the two treatments in the defoliation ratio.

In order to carry out the comparative study, we investigated the seasonal variation in defoliation between Jeju Island and Gurye, both of which have very similar climatic conditions based on the autumn leaves forecast. Leaves started falling from 36th week (5th/Sept) both in Gurye and Jeju Island. However, the amount of fallen leaves was significantly higher in Gurye for 4 weeks until 42th weeks (18th/Oct) from 38th week (19th/Sept).

In the leaves from control, brown shot-hole disease was largely diagnosed. It is the threatening disease causing early defoliation. This study shows that spray is effective to reduce the defoliation in the tree. A long term experimental study will be followed to test whether this measure is sustainable. However, this study is unable to discover other causes of the syndrome. A long term experimental study will be followed to test if this measure is sustainable and whether there are some other factors to the syndrome currently unknown.
T2: CLIMATE CHANGE IMPACT ON ECOSYSTEM PROCESSES

Underestimated ecosystem carbon turnover time and sequestration under the steady state assumption: A perspective from long-term data assimilation

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It is critical to accurately estimate carbon (C) turnover time as it dominates the uncertainty in ecosystem C sinks and their response to future climate change. In the absence of direct observations of ecosystem C losses, C turnover times are commonly estimated under the steady state assumption (SSA), which has been applied across a large range of temporal and spatial scales including many at which the validity of the assumption is likely to be violated. However, the errors associated with improperly applying SSA to estimate C turnover time and its covariance with climate as well as ecosystem C sequestrations have yet to be fully quantified. Here, we developed a novel model-data fusion framework and systematically analyzed the SSA-induced biases using time-series data collected from 10 permanent forest plots in the eastern China monsoon region. The results showed that (a) the SSA significantly underestimated mean turnover times (MTTs) by 29%, thereby leading to a 4.83-fold underestimation of the net ecosystem productivity (NEP) in these forest ecosystems, a major C sink globally; (b) the SSA-induced bias in MTT and NEP correlates negatively with forest age, which provides a significant caveat for applying the SSA to young-aged ecosystems; and (c) the sensitivity of MTT to temperature and precipitation was 22% and 42% lower, respectively, under the SSA. Thus, under the expected climate change, spatiotemporal changes in MTT are likely to be underestimated, thereby resulting in large errors in the variability of predicted global NEP. With the development of observation technology and the accumulation of spatiotemporal data, we suggest estimating MTTs at the disequilibrium state via long term data assimilation, thereby effectively reducing the uncertainty in ecosystem C sequestration estimations and providing a better understanding of regional or global C cycle dynamics and C-climate feedback.
The fluxes of nitrogen (N) in the form of nitrate (NO$_3^-$-N) and ammonium (NH$_4^+$-N) as well as sulfur (SO$_4^{2-}$-S) were measured in throughfall at four ICP Forests, Level II sites in Denmark during periods of 15–31 years. These data were compared with the corresponding concentrations of NO$_3^-$-N and SO$_4^{2-}$-S in the soil solution sampled in 90 cm depth in the mineral soil. The four Level II sites are:

- **Ulborg**: Norway spruce plantation, planted in 1964, soil: nutrient-poor sandy soil, surroundings: forest and heathland, but nearby high-intensive cattle and pig farming may influence the N deposition. Monitoring 1985-2013
- **Suserup**: Beech-dominated seminatural forest with ash and oak, soil: nutrient-rich loam, surroundings: mainly forest and cropland with few farm animals. Monitoring since 2002.
- **Frederiksborg**: Beech plantation, planted in 1964, nutrient-rich loamy soil, surroundings: mainly forest Monitoring since 1985.

The throughfall flux of S decreased over time in all four sites, most notably in the beginning of the period from 1985 to 1990’s. A parallel decrease was observed in the concentration of S in the soil solution. There was for example a fivefold decrease in both the flux of S in throughfall as well as in the soil solution S concentration over the 33 years of monitoring at the Frederiksborg site. In general, we also observed a decrease for NO$_3^-$-N and NH$_4^+$-N, however much less pronounced with larger year-to-year variation. The ratio of NO$_3^-$-N to NH$_4^+$-N in throughfall will be shown and discussed relative to the different N emission sources at the four sites.
Understanding the impacts of natural disturbances on wildlife populations has been a central issue in ecology. The severity of impact of a disturbance (e.g., the degree of population decline resulted from disturbance) is likely to be primarily depend on the disturbance intensity (i.e., strength of disturbance force), but can vary with the type of disturbance and species vulnerability. To reveal how severity of impacts is determined, comprehensive analysis of disturbance severity across the type of disturbance and species is crucial. However, it has not be conducted due to the differences in the physical units of disturbance force among events and difference in the natural temporal variability of population size under non-disturbance condition. Here, we propose new framework of quantifying disturbance intensity and severity, both represented by the return periods, and evaluating the severity based on the intensity. We used a meta-analysis to examine the severity–intensity relationship of various types of disturbance on various species. The severity and the range of its 95% confidential interval showed exponential increase with intensity. This nonlinear relationship suggests that physically intense and rare events may have a catastrophic impact on populations, but their severity cannot be extrapolated from the relationship between intensity and severity of weak, frequent disturbance events. The framework we propose may help to assess the influence of event types and species traits on the severity–intensity relationship, as well as to improve the predictability of the ecological consequences of various disturbance events with unexperienced intensity.
The effects of topo-edaphic factors on 60 years of shrub encroachment in northern Chihuahuan Desert

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Woody plant encroachment has been reported to be an on-going trend in many arid and semi-arid savannas, grasslands, shrublands, and drylands worldwide. Similarly at the Jornada Basin Long-Term Ecological Research site in the northern Chihuahuan Desert, plant communities have experienced a long-term state-change from perennial grassland to shrubland during the last century. However, shrub cover still shows large amount of spatial variation across the basin and remnant grass patches exist in several locations that have resisted the encroachment by woody species. To better understand this transformation, and the underlying mechanisms responsible for the complex vegetation patterns, we created historical and current shrub cover maps using high spatial resolution (~1m) contemporary satellite data images and declassified CORONA imagery from the 1960s. We explore how changes in shrub cover varies with landform, water availability, and soil characteristics. Our study demonstrates the combination of density-independent invasion and density-dependent constraints, and the role of local topo-edaphic factors can outweigh regional drivers (e.g. overgrazing) in affecting shrub encroachment in temperate drylands.
T4: ADVANCES IN LONG-TERM SOCIO-ECOLOGICAL RESEARCH AND SUSTAINABILITY SCIENCE

**Strategic planning for LTER project by National Institute of Ecology in Korea**

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Long-term ecological research (LTER) has gained much attention worldwide to study and predict the adaptation of ecosystems to climate change and to preserve future ecosystems. In order to carry out LTER, the National Institute of Ecology in Korea (NIE) prepared a long-term research plan based on the following 4 strategic goals.

1. Establishment of national representative Supersites and their stable operation: The most important thing in LTER is building infrastructure to continuously accumulate ecological and environmental information. With that in mind, the NIE made a plan to establish Supersites in 6 different areas based on the ecosystem type in Korea. Three supersites have already been built where AWS, CO$_2$ flux tower, and artificial environment control system are running respectively in each of the three for observing ecosystem changes. The rest will be constructed by year from 2020.

2. Performing sustainable national LTER: We conduct basic research supporting national policy based on the infrastructures.

3. Standardization and management of LTER data: Ecological data should be stored and managed in the research data management system (Ecobank) according to international standards and provided to the public.

4. Establishment and operation of long-term ecological joint research and cooperation system: We will establish a network at home and abroad with related organizations to share data and plan for adaptation and prediction of environmental change.

Based on the LTER data produced from the Supersites, the LTER R&D projects will improve the utilization of LTER by promoting autonomous participation of universities, related institutions, and citizen scientists. In this way, we can better understand the ecosystem changes according to the environmental changes and investigate the ecosystem interrelationships to preserve the sustainable natural ecosystem.
T1: DRIVERS OF LONG-TERM CHANGES IN BIODIVERSITY, ECOSYSTEM INTEGRITY AND ECOSYSTEM FUNCTIONS

Can we sustain ecohydrological regulation in rural landscapes under socio-economic transitions? Case study of the The Pilica River Catchment (LTSER platform, Central Poland)

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Integrity of complex systems, like river catchments, emerges from the balance between intensity of land use and diversity of ecosystems, which primary enables habitats to species and ecospecies, while secondary is responsible for regulation of water and nutrient fluxes, and hence quality of environment. Due to location in landscape depressions, those are water bodies which undergo a cumulative impact of land use practices, becoming ultimate indicators of loss of ecohydrological (water-soil-biota) regulatory feedbacks. The observed outcome is decline of river biodiversity and increased frequency and intensity of cyanobacterial blooms in reservoirs.

Many Central and Eastern European countries entered tough transition process when joining European Union, and switching from top-down regulated, into open market. In Poland this process has been pushing agriculture in many regions, from small scale, family farms, towards large – scale industrial food production. It is leading to fast transformation of traditional, mosaic landscapes, famous for their biodiversity, into uniform ones, often missing not only ecologically important, but also culturally appreciated elements.

The paper brings together results of long-term monitoring of fish populations in the Pilica River and the Sulejów Reservoir, outcomes of the catchment SWAT modelling focused on identification of nutrient sources and sinks and possible NBS based on landscape elements, and finally socio-cultural studies aimed at identification of key drivers of environmental change, including appreciation of landscape elements and EU instruments. The general framework was provided by resilience and regime shifts model of Kinzig et al. 2006. The final outcome are scenarios defining the critical factors driving landscape changes, the required actions at local and national level to steer the process towards sustainable management, and reflection over the possibility of using ecohydrological NBS to maintain quality of water resources while supporting biodiversity.
Dongsha island is a part of Dongsha atoll located in South China sea and isolated remotely from other islands at least 200 kilometers away. Earlier study of terrestrial fauna on Dongsha Island is mainly focused on birds and crustaceans but scarce on insects. However, insects is a non-negligible part in terrestrial ecosystem on Dongsha Island. This study conducted a series systematic investigations of terrestrial insects on Dongsha Island in 2008, 2012, and 2017. Malaise trap is the primary sampling method which were supplemented by sweeping, pitfall trap, litter collection, and free-hand collecting. A total of 109,490 individuals belonging to 734 morphological species of 160 families and 18 orders were collected. Among these, 137 species from 54 families were identified to the species level up to date. The dominant taxa on Dongsha Island were Hymenoptera, Hemiptera and Diptera. In each survey, the total number of morphological species is fluctuated between 200 and 300; in contrast, the composition of morphological species varied which suggests a constant occurrence of immigration and extinction events. This study provides a basic knowledge of insect fauna on Dongsha Island and hope to motivate further studies in the near future.
T1: DRIVERS OF LONG-TERM CHANGES IN BIODIVERSITY, ECOSYSTEM INTEGRITY AND ECOSYSTEM FUNCTIONS

Foliar carbon, nitrogen and phosphorus concentrations and fluxes through litterfall in fragments of the Brazilian Northeastern coastal Atlantic Forest

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The Brazilian Atlantic Forest is located on the coast and for centuries suffers from intense logging, formation of agricultural fields, the presence of farms, planting of exotic species and hunting, being exposed to fragmentation and habitat loss. The Northeastern portion of this biome is the most threatened, suffering disturbances and far from having the same species richness of plant and animal from its original cover. However, they can perform important ecosystem services, such as protection of water bodies, reservoir of important nutrients and carbon (C). Therefore, this work intended to provide solid scientific information on mature forest fragments which suffer constant disturbances and a secondary forest, where a restoration program was implemented, all located in the State of Alagoas, Northeast of Brazil. The main objective was to understand how the disturbances and the fragmentation of the northeastern portion of the biome may affect carbon (C) and nutrient cycles, as nitrogen (N) and phosphorus (P). To accomplish this objective, we investigated the concentrations of these elements in leaves and litterfall leaves in 16 0.1-ha mature forest plots, in addition to four 0.1-ha plots in the restored area; quantified the fluxes of these elements through litterfall of a one-year study in the same areas; and compared the nutrients use efficiencies (NUE) in these forest areas with those of other tropical and temperate forests. From the 209 leaves sampled in the studied areas, restoration had the higher averages for N and P concentrations. Comparisons of foliar N concentrations, revealed that the mature forest fragments of this study have lower values compared to Lowland and Montane of the same biome located in the southeast of Brazil, where much more preserved areas are found. Our main finding was that litterfall flux in forest fragments (6 Mg ha-1 yr-1) was higher than the restoration area (2.4 Mg ha-1 yr-1), as expected, but lower than the mean litterfall flux found in more than 100 forest plots scattered over the Atlantic Forest biome (8 Mg ha-1 yr-1). The N litterfall leaves concentration was similar to other tropical forests, and N flux in forest fragments of Alagoas was in the range found in other tropical forests. Accordingly, NUE of N (NUE-N) was similar to NUE-N found in other areas of the Atlantic Forest. The P litterfall leaves concentration was lower than in other tropical forests. As a consequence, the P flux via litterfall was significantly lower, leading to much higher NUE-P in the forest fragments of the Alagoas. Our findings show that there were not much change in N cycles when compared to less disturbed ecosystems, with a rapid ecosystem recovery after disturbances, while P seems to be a very limiting nutrient in the fragments.
T3: ALTERED NUTRIENT CYCLES AND ENVIRONMENTAL POLLUTION

Effect of long-term nutrient addition on the ecological interactions of a woody species of the Brazilian Cerrado

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Herbivory by insects is one of the main types of damage suffered by plants and can be related to their production and concentration of secondary compounds. Moreover, essential elements for biosynthesis of secondary metabolites, like nitrogen, may influence the content of these key compounds in the defense against herbivory. This work has investigated the effects of nutrient additions in a Brazilian savanna (cerrado stricto sensu) on the production of secondary compounds and on herbivory rates in a woody species of Cerrado. In a long-term fertilization experiment (with addition N, P, N + P, liming and, Control), 50 individuals of Blepharocalyx salicifolius (Kunth) O. Berg were studied. From each individual, 20 leaves were collected and scanned to calculate the percentage of herbivory. After drying the leaves, they were pulverized for foliar nutrient analysis, extraction of secondary metabolites and metabolomics analysis, using liquid chromatography coupled to mass spectrometry. The loss of leaf area by herbivores was small, less than 3% on average, and only the liming treatment differed from the control, with more area lost. There was an increase in P concentration in leaves in treatments with P and NP, but nitrogen concentration did not differ from the control and N addition treatment. In metabolomics analysis, 596 compounds were detected, of which 103 had a statistically different production between treatments. Although the highest herbivory rates were found in the liming treatment, the majority of metabolites detected were nitrogenous molecules. This study demonstrates that, despite the low herbivory impact and the similar leaf nitrogen concentration between treatments, the metabolomic tools used were able to identify the influence of nutrient addition on the secondary metabolites. Finally, since the highest herbivory rates occurred in the presence of higher concentration of nitrogenous molecules, it is possible that these have other functions for the plant, such as protection of excess solar radiation or production of compounds against stress.
Soil emissions of NO and N$_2$O from different ecosystems in Scotland

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The atmospheric pollutant nitric oxide (NO), a precursor of atmospheric ozone, and the powerful GHG nitrous oxide (N$_2$O) are produced in soils by chemical and biological processes. However, the impact of soil type, land use and climate on emission rates and ratios of NO : N$_2$O are not well understood.

In order to fill this knowledge gap we collected soils from the eLTER sites Burnsmuir a&b in the Highlands and Lowlands of Scotland (typical 9 different landuses). These locations are lowland heather moorland (A-HM), grass dominated moorland (A-GDM), managed grazed grassland (A-MG), shelterbelt of deciduous trees (A-Sh), heather moorland from a high NH$_3$ deposition experimental area (W-HA) and background area (W-BA) at Auchencorth and Whim Bog; and highland heather moorland (C-HM), grazed grassland (C-GG), pristine pine forest (C-PP) in the Cairngorms. A soil core air-flow-through incubation system coupled with a Teledyne NOX analyser and Picarro G2508 instrument were used to measure NO and N$_2$O fluxes. Soil samples were analysed for pH, soil moisture content (SMC), total C and N, concentrations of NH$_4^+$, NO$_2^-$ and NO$_3^-$.

Emission rates were measured from the intact soil cores at 15°C. Thereafter the response to temperature increases after a simulation of a drought at 20° and 25°C followed by rewetting (equivalent to 5 mm rain) were studied. Soil NO and N$_2$O fluxes varied substantially between the landuses. The largest mean NO emission rates at 15°C (42.8±25.8 µgNO-N m$^{-2}$ h$^{-1}$) were measured from the peatland W-HA receiving a simulated N deposition (~80 kg N ha$^{-1}$ y$^{-1}$), and smallest from the pristine forest C-PP (0.4±0.3 µgNO-N m$^{-2}$ h$^{-1}$). Emissions of N$_2$O varied over a narrow range from 161±3 to 412±73 µg N2O-N m$^{-2}$ h$^{-1}$. Largest N$_2$O emissions (> 300 µg N2O-N m$^{-2}$ h$^{-1}$) at 15°C were observed at A-MG, W-BA, A-GDM and A-HM. Incubation at 20°C and 25 °C stimulated larger NO and N$_2$O release, and rewetting triggered short-term peaks. Changes in emission rates and soil N concentrations in relation to the aforementioned treatments will be discussed.

Preliminary data analysis suggests that:

i) wet-saturated natural peatlands exposed to large NH$_3$ deposition rates are likely a significant source of NO emissions; climate change condition (warming/prolonged drought) may lead to large increases in NO emissions;

iii) rewetting after medium-to-long drought periods increases NO emissions from both natural and managed landuses (exceptions are water saturated peatlands);

iv) temperature elevation increased N$_2$O production; increased rates are likely connected with increased soil mineral N concentrations;
v) rewetting dry soils, especially those with low soil moisture contents (highland C-PP and C-HM and lowland A-Sh), results in higher N\textsubscript{2}O release compared to initial emission rates; vi) rewetting after the drought period at elevated temperature intensifies SOM decomposition leading to increased soil NH\textsubscript{4}+ content triggered by various chemical and microbial processes.

The work was performed under the eLTER TA project ‘Emissions of HONO-NO-N\textsubscript{2}O and its ratio from different ecosystems in UK. Authors thank CEH staff assisting with the soil core collection and soil analyses.

T6: GLOBAL RESEARCH INFRASTRUCTURES

Spiekeroog Coastal Observatory (SCO)

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Stationary or mobile coastal observatories are a key to improve the understanding of coastal processes as well as their interactions with regional and global environmental changes. Especially the intertidal zone is sensitive to climate change and strongly impacted by anthropogenic activities. The German island of Spiekeroog and its surrounding area are part of the Wadden Sea UNESCO world natural heritage site. Spiekeroog is located in the southern North Sea and represents a long-term research site with the integrated time series station Spiekeroog (TSS) in a tidal channel as part of the Coastal Observing System for Northern and Arctic Seas (COSYNA) network. Quality-controlled data of hydrographical and meteorological parameters from TSS-Spiekeroog are provided within online databases since 2002. The Spiekeroog Coastal Observatory (SCO), since 2018 also part of LTER-D, is oriented towards interdisciplinary marine ecosystem research and combines physical, biological and geochemical long-term observations as well as various process studies.

From 2002-2009, long-term changes of hydrodynamic exchanges between the coastal area and the back barrier tidal flat (DFG research group on Tidal Flats) were investigated. Since 2014, a focus on origins and fate of biogeochemical relevant SGD (submarine groundwater discharge) derived constituents in the beach zone and subterranean estuary have been examined within the project BIME (Assessment of ground- and porewater-derived nutrient fluxes into the German North Sea - Is there a „Barrier Island Mass Effect“?). The BEFmate (Biodiversity–Ecosystem Functioning across marine and terrestrial ecosystems) project was conducted from 2014-2018, aiming to quantify dynamics of biodiversity and associated functions of salt marsh and tidal flat ecosystems. For this purpose, a series of experimental islands were set up in the back-barrier tidal flat and mir-
rored by enclosed plots located within the salt marsh. Beginning in January 2019, these set up is operated as part of the new DFG research group DynaCom (Spatial Community Ecology in highly dynamic landscapes: from island biogeography to meta-ecosystems). Several other collaborative projects that make use of the SCO are currently in progress, e.g. Macroplastics Pollution in the Southern North Sea - Sources, Pathways and Abatement Strategies or the Coastal Ocean Darkening (COD) project. Furthermore, the SCO serves as a base for research on data processing and quality assurance utilizing artificial intelligence approaches such as virtual sensors and machine learning. In addition to its role as observatory and exploratory, the SCO serves as an educational platform fostering the dialogue with society, e.g. through exhibitions in the National Park House Wittbülten or various citizen science projects. Thus, the Spiekeroog Coastal Observatory represents an invaluable opportunity benefiting the fields of education, industry, government, and environmental conservation, offering the potential to identify patterns in long-term variability, and enabling scientists to work on interdisciplinary projects on coastal environments under change.
Litter decomposition study in Latvia by using standardized tea bag method

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Litter decomposition is the most important component of the carbon and nutrient life cycle in terrestrial ecosystems. In 2016 the European LTER proposed TeaComposition initiative - the use of a standardized substrate on the plots of member states of the global ILTER network to conduct research on the impact of climate effects, litter quality and land use on litter decomposition intensity across different ecosystems worldwide.

At the beginning of June 2016, two types of tea packs delivered by the Lipton tea producer company UNILEVER were sent to all participants of the experiment:

- Green Tea (ingredients: 89% Green Tea, other- natural flavors)
- Rooibos Tea (93% Roibes Tea, other- natural flavors)

Two study sites were selected within the Engure LTSER ecoregion: pine forest on dry sandy soils, and mixed forest on wet soils. On 29 June 2016 tea bags were placed on both sites according to the protocol provided by TeaComposition initiative. In the first round of experiment the exposed tea bags were delivered to the laboratory after 3 months (29 September 2016), in the second round after 1 year (29 June 2017), followed by the 3rd round in June 2018 and the 4th round 2019 June. The first two series of data from Latvian sites showed similar results to with global scale. Litter quality in the early stages of decomposition is the main factor explaining 65% of the data variation (Djukic et al, 2018).

The results of the two-factor variance analysis (univariate GLM) showed that there were statistically significant differences in the rate of decomposition intensity between green and rooibos tea. No statistically significant difference was found in the rate of degradation intensity between the two sites at the early stage of study.

The analysis of the results from 3rd data series (June 2018) showed statistically significant differences not only between tea types (F=29,543; P < 0,001) but also between experimental sites (pine forest and mixed forest) (F=12,384; P < 0,05). The highest tea bags mass loss was observed in mixed forest on wet soil.

**References:**

Does boreo nemoral pine forest soil mesofauna reacts to climate change? 21-year study in Latvia

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Soil mesofauna is the main component of the boreo nemoral coniferous forest soil fauna, responsible for litter decomposition in these oligotrophic habitats. Changes in the structure of soil fauna due to climate warming could have a significant impact on the forest ecosystem. Soil biodiversity changes on the background of climate warming have so far been studied predominantly in experimentally designed plots with artificial soil temperature and humidity regulation. In 1992, long-term studies on the effects of climate change on the mesofauna of boreo nemoral forests were launched in Latvia. Three pine forest stands of different ages (30-40, 50-70 and 150-200 years) were selected in North Vidzeme Biosphere Reserve (Latvia LTER, Mazsalaca Pine). At the end of August/ beginning of September, 100 soil samples (5 cm$^2$ x 10 cm) were taken by systematic random sampling and microarthropods were extracted by modified high gradient extractor. Enchytraeids (Enchytraeidae) were extracted from 30 soil samples (23 cm$^2$ x 10 cm) by Berman wet funnel techniques. Soil moisture was determined gravimetrically, data on temperature changes were taken from the nearby meteorological station, calculating the sum of positive annual temperatures (> + 4oC) (PTS). During the 21 year study (1992-2012) there were found 67 species of springtails (Collembola) with a total density of 1 800-28 000 ind./m$^2$, 92 species of oribatid mites (Oribatida) with a total density 4000-28 000 ind./m$^2$, 46 predatory Mesostigmata, Gamasina mites with total density of 500-6 000 ind./m$^2$ and 7 species of enchytraeids with a total density of 80 300-11 000 ind./m$^2$, of which more than 95% of individuals belonged to one species Cognettia sphagnetorum. Overall, there was a statistically significant increase in PTS during the study period, but this was mainly due to the temperature changes in the first decade (1992-2002). During the second decade (2003-2012) increase in PTS was no longer detected. Differences between these periods strongly reflected in the structure of springtails and predatory mites. While during the first period NMS ordination yielded in axes significantly correlated with PTS ($r=0.66$, $P < 0.05$) and soil moisture ($r=-0.62$, $P < 0.05$), during the second period soil moisture no longer appeared as a significant factor and the impact of PTS decreased. Instead the differences between the forest sites came out as the determining factor. Species richness of both collembola and predatory mites showed statistically significant decrease during the period of study. Numbers of enchytraeids increased and were positively correlated with soil moisture ($r=0.605$, $P < 0.001$). Oribatid mites ere not affected by changes in PTS and soil moisture.
T2: CLIMATE CHANGE IMPACT ON ECOSYSTEM PROCESSES

Salinization alters nitrogen-cycling microbial communities in coastal freshwater wetland soils

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Soil microbial communities in coastal wetlands rely on anaerobic metabolisms to breakdown organic material. In the absence of oxygen, many use nitrate as a terminal electron acceptor for respiration following one of two major pathways: denitrification (nitrate removal) or DNRA (nitrogen retention). Coastal wetlands are usually effective sinks of nitrate, but their position in the landscape places them at the forefront of global change stressors that may disrupt this important ecosystem service. Salinization, driven by sea level rise, may alter which pathway nitrate will enter as it can reshape the structure and functioning of these microbial communities. To better understand how these microorganisms will respond, we utilized a soil transplant method to simulate salinization. Freshwater wetland soils were encased in nylon mesh bags and relocated to a low-salinity (oligohaline) and moderate-salinity (mesohaline) wetland for in situ incubation. Transplanted soils were collected after 7, 10, 19, and 22 months.

Salinization was achieved as sulfate levels were increased 10-fold in soils at the oligohaline site and up to 100-fold in soils at the mesohaline site. Stable isotope tracing indicated rates of denitrification were lowest in freshwater soils buried at the mesohaline site and that rates of DNRA were the highest in these same soils. To monitor the microbial community response to salinization, the abundances of two nitrate reduction genes were quantified via qPCR. While the abundance of the denitrification gene (nirS) correlated with denitrification rates, no correlation was evident between DNRA gene (nrfA) abundance and DNRA rates. Taken together, these results suggest salinization of freshwater soils will promote nitrogen retention and suppress nitrate removal, potentially exacerbating coastal eutrophication.
T1: DRIVERS OF LONG-TERM CHANGES IN BIODIVERSITY, ECOSYSTEM INTEGRITY AND ECOSYSTEM FUNCTIONS

Long-term changes in river ecosystem functioning: benthic invertebrate case study of River Salaca

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Aim of the study was to investigate long-term changes of the river benthic invertebrate community structural and functional characteristics in the frame of the ongoing climatic changes to assess the river ecosystem functioning. ILTER site River Salaca (96 km long, catchment area of 2250 square kilometres) is located in the northern part of Latvia (Eco-region no 15, Baltic province) in the North Vidzeme Biosphere Reserve, flows from the Lake Burtnieks to the Gulf of Riga, Baltic Sea. River is internationally recognized with high biodiversity and important spawning habitat for natural Atlantic salmon populations. It is moderately anthropogenically impacted. In the drainage basin natural territories dominate (e.g. forests cover 56.17%), impact of agriculture is moderate. Long-term complex hydrobiological investigations since 1982 were done at 3 river reaches of River Salaca in summer vegetation season. In the upper reaches (at outlet from the Lake Burtnieks) and middle reaches, limnophilous benthic invertebrate communities dominate, but at the lower reaches reophilous species communities are characteristic. Decrease of the zebra mussel Dreissena polymorpha abundance at outflow indicates the increasing impact of the eutrophication from the Lake Burtnieks, where annual blue-green algae bloomings are common. At second sampling site, functional feeding group proportion is stable, without significant changes, but at the lower reaches the highest species diversity is characteristic and passive filterers and scrapers dominate. In general, changes in climatic parameters were found, however significant changes in functional feeding group composition and proportion were not found, which allows to conclude that river functioning is stable.
How to monitor a large-scale surface-flow constructed wetland with minimal disturbance?

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The AZHUREV surface-flow constructed wetland is a large-scale demonstration wetland built at the outlet of the Grand Reims (France) wastewater treatment plant (WWTP). Three 20,000 m² basins (rectangular shape with different depth distribution within each basin) have been created: the initial vegetation (mainly P. australis, S. lacustris and G. maxima) density was also different in each basin. Their aim is to polish a part of the treated wastewater (250 m³/h) from the Grand Reims WWTP, as well as to treat part of the Grand Reims stormwater.

The basic monitoring of the wetland is routinely done via sampling at the inlet and the outlet of each basin. However this does not provide information on the spatial distribution of the pollution in the basins, or of temperature and dissolved oxygen. Photographs are routinely taken from the shore but, due to the size of the basins, they do not provide detailed information on the development of the vegetation.

To monitor the basins without disturbance, two drones are used:

• An aquatic drone (Spyboat by CT2MC) which is remotely driven from the shore. It is fitted with a dissolved oxygen probe and a temperature sensor to collect data 10 cm below the surface. It can also collect liquid samples by means of a peristaltic pump. The superstation in oxygen observed with the aquatic drone in spring is correlated with the increase of the photosynthetically active solar radiation and the development of algae in the basins. Later in the year, anaerobic zones are detected under the duckweed-covered surface. The aquatic drone is more difficult to operate when the duckweed layer is becoming thick or when the surface is frozen.

• An aerial drone (type DJI-S900), to better locate dense vegetation beds (especially those of G. maxima) and verify their development. Isolated plants cannot be located easily by the aerial drone.

Satellite imaging (Landsat 8 OLI images obtained from https://glovis.usgs.gov) is also tested. The satellites images are collected every two weeks but cannot be used in presence of clouds. In spite of their 30m resolution, they allow to monitor the variation with respect to time of the vegetation, especially the development of duckweed on the wetland surface.

The poster will present the latest 2019 results obtained with these tools and discuss further their advantages and disadvantages.
Seed addition increases biodiversity and productivity in a previously fertilized low-diversity grassland

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Global land area used for agriculture and pasture is starting to decline, with large areas remaining unused for other economic activities. This provides a unique opportunity for conservation as these former pastures and fields could help maintain local diversity of plants and animals. However, experimental evidence suggests that readily recovering plant diversity might be difficult given the history of fertilization and nutrient pollution in these areas. Because of this, active management might be necessary to restore diversity. Restoration strategies are often designed to address potential obstacles for increasing diversity. Managers often implement combinations of these strategies to increase plant diversity and when possible, use repeated interventions to achieve desired restoration outcomes. While continued interventions can yield faster recovery and the opportunity to adjust management strategies; time and monetary constrains often make it only possible to carry out a single intervention. Here, we examined long-term responses of diversity and productivity to three common restoration strategies more than a decade after a one-time intervention to a grassland that had experienced long-term nutrient fertilization and cessation. The restoration strategies consisted of a full-factorial combination of organic carbon addition, plant litter removal, and seed addition. Results from the first year of the experiment showed that the combination of seed addition and litter removal produced the greatest increase in species richness. However, when sampled thirteen years after the intervention, we found a much simpler story: seed addition was the only treatment to significantly increase plant diversity and productivity. Seed addition also reduced the proportional biomass of two invasive species that become co-dominant in this grassland after sufficient nutrient inputs. Our results suggest that recruitment limitation could be preventing recovery of biodiversity after cessation of nutrient addition and provide a simple strategy that will often help managers increase diversity in areas that are abandoned from agriculture or grazing, but affected by nutrient pollution.
Estimation and analysis of the ratio of transpiration to evapotranspiration in forest ecosystems along the North-South Transect of East China

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The ratio of transpiration to evapotranspiration (T/ET) is a key parameter for quantifying water use efficiency of ecosystems and understanding the interaction between ecosystem carbon uptake and water cycling in the context of global change. The estimation of T/ET has been paid increasing attention from the scientific community in recent years globally. In this paper, we used the Priestly-Taylor Jet Propulsion Laboratory Model (PT-JPL) driven by regional remote sensing data and gridded meteorological data, to simulate the T/ET in forest ecosystems along the North-South Transect of East China (NSTEC) during 2001–2010, and to analyze the spatial distribution and temporal variation of T/ET, as well as the factors influencing the variation in T/ET. The results showed that: (1) The PT-JPL model is suitable for the simulation of evapotranspiration and its components of forest ecosystems in Eastern China, and has relatively good stability and reliability. (2) Spatial distribution of T/ET in forest ecosystems along NSTEC was heterogeneous, i.e., T/ET was higher in the north and lower in the south, with an averaged value of 0.69; and the inter-annual variation of T/ET showed a significantly increasing trend, with an increment of 0.007/yr (p < 0.01). (3) Seasonal and inter-annual variations of T/ET had different dominant factors. Temperature and EVI can explain around 90% (p < 0.01) of the seasonal variation in T/ET, while the inter-annual variation in T/ET was mainly controlled by EVI (53%, p < 0.05).
Invasive plant species are non-native species that are real threat for native ecosystems. They are spreading, creating new generations and changing the vegetation structures of the plant associations. The threats caused by invasive species have become one of the biggest environmental challenges in whole world. Black locust (Robinia pseudoacacia) is one of the most invasive tree in Slovakia. Obtaining timely information about their spatial distribution is demanding for time, money and human resources. A promising method for early mapping and detection of invasive plants is the use of remote sensing. In our research we focused on mapping of Black locust in ILTER locality Báb forest. We used the multi-temporal Sentinel and UAV images to distinguish the spectral signatures of Black locust over the year in different phenophases. Black locust is distinguishable from other tree species because of later foliage and characteristic flowering that starts from April to May. To analyse the expansion of Black locust, we compared the data from the State Forest map from 2008 with classifications from Sentinel 2 and UAV RGB images from 2019. Results of distribution map can be used to target management of areas.
**Impact of excess nitrogen on foliar nutrient content**

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Elevated nitrogen (N) deposition can cause substantial changes in forest ecosystems: for instance atmospheric depositions affect nutrient availability, and can source nutrient imbalances in forest ecosystems. Despite the decline in N deposition in the last 30 years, deposition rates are still high compared to pre-industrial levels in most parts of Europe and future decreases are expected to be small.

To understand the effect of air pollution, intensive forest monitoring plots (Level II) were initiated in the 1980s across Germany as part of the ICP Forests programme (International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests). Collected data includes continuous measurements of deposition (reduced nitrogen compounds (ammonium), oxidized nitrogen compounds (nitrate), etc.) and biannual measurements of the chemical composition of leaves and needles.

In Europe, N deposition increased for several decades until it peaked around 1990. Since, moderate decreases in N deposition have been observed especially in Central and Western Europe where deposition levels are highest. At Level II plots, the mean ammonium deposition (N-NH₄) hardly changed over the last 10 years. Overall, nitrate deposition decreased by 26% and ammonium by 18% between 2000 and 2015.

Foliar N/P ratios present a useful tool to assess the effects of nitrogen deposition on forest trees and provide insight into nutrient imbalances impacting tree vitality and productivity. Here we identify nutrient limitations and surpluses depending on tree species (European beech (Fagus sylvatica), Norway spruce (Picea abies), Oak (Quercus petraea x robur), and Scots pine (Pinus sylvestris)).

Disharmonious N/P nutrition is almost exclusively due to wide N/P ratios, indicating at an oversupply of N. Results show P deficiency defined by critical foliar concentrations published in the literature is found for 52 % of spruce, 44 % of oak, 40 % of beech, and 9 % of pine samples. Of the investigated tree species, beech shows the highest percentage of samples above the critical ratios (47 %). Within the period 1995 to 2015, foliar P concentration significantly decreased in beech (-4.9%) and pine (-2.9%), but remained unchanged in spruce and oak.

These patterns are likely caused by a combination of factors, including changes in mycorrhizal association, fine root structure, microbial activity, tree growth, and foliar mass. Many of these aspects are affected by nitrogen deposition. As the N deposition will likely remain at a high level even after past and expected future reductions in air pollution, we do not expect a quick recovery from unbalanced N-P nutrition. Further investigations will hopefully reveal patterns of larger and smaller susceptibility of Europe’s forests to nutrient imbalances.
T1: DRIVERS OF LONG-TERM CHANGES IN BIODIVERSITY, ECOSYSTEM INTEGRITY AND ECOSYSTEM FUNCTIONS

Tree community composition, but not ectomycorrhizal root exclusion affects soil aggregation in a temperate forest

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Soil aggregates increase the residence time of soil carbon by creating an internal environment that is inhospitable to carbon mineralizing microbes, and it is well documented that the presence of arbuscular mycorrhizal fungi lead to higher rates of soil aggregation in grassland and agricultural systems. It remains unknown whether ectomycorrhizal fungi have similar effects on soil aggregation, despite the disproportionate amount of global carbon stored in ectomycorrhizal soils. We used a trenching design to exclude ectomycorrhizal roots from 6 forest soil plots in each of 3 stands at the Cedar Creek Ecosystem Science Reserve, Minnesota, USA. Stands differed in overstory composition but not soil type. After 2 years of ectomycorrhizal root removal we used a wet-sieving procedure to determine the effects of trenching on aggregation in the top 10 cm of mineral soil. The proportion of soil contained in each size class differed by stand (P < 0.001). In stands containing Quercus species, over half of the soil mass was in 250-2000 μm diameter aggregates, while over half of the soil in Pinus dominated stands was in smaller 53-250 μm aggregates. Perhaps surprisingly, we found no detectable effect of ectomycorrizal root removal on aggregation in any stand, despite it having clear effects on soil fungal communities, litter decomposition rates, soil moisture, and nitrogen availability. In sum, our results suggest that tree community composition may play a larger role than the associated fungal community on soil aggregation in forest soils, but further research is needed to confirm these results.

Temporal Beta-Diversity During Old-Field-Succession

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Within the scope of eLTER, former agricultural fields at four different sites in Germany are monitored since their abandonment in 1987 to 1995. In yearly vegetation surveys the development of plant communities, without any management is recorded till today. Focussing on the species composition and it’s changes, an analysis of temporal beta diversity reveals insights on species loss and gain and their contribution to successional pathways. Comparisons to null models and between sites hint on inherent time depending processes and environmental influences or changes due to random effects. The method here is tested for the dataset and will be extended to an analysis of plant traits and related ecosystem function.
T1: DRIVERS OF LONG-TERM CHANGES IN BIODIVERSITY, ECOSYSTEM INTEGRITY AND ECOSYSTEM FUNCTIONS

Diversity and seasonal activity of ground beetles (Carabidae) and epigeic spiders (Araneae) at forest stands under different management regimes at the ILTER site Báb (SW Slovakia)

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The data derived from long-term ecological studies are highly valuable for understanding, assessment and detection of environmental changes and their causes. The ILTER site Báb (SW Slovakia) has a long history of detailed ecological research. After complex and intensive ecosystem research during 70th and 80th of 20th century, the research continued in restricted extent done by individual researchers. More complex research was re-established again in 2007, when the series of research projects devoted to forest ecosystem changes assessment started.

During 2014, we started the intensive research study of ground dwelling arthropods using the method of pitfall trapping. Ground dwelling invertebrates such as carabid beetles and epigeic spiders are often surveyed with respect of ecosystem changes. These invertebrates have strong potential as ecological indicators as they are readily surveyed in sufficient numbers for meaningful conclusions to be drawn, have a stable taxonomy and, at least in the case of ground beetles, are readily identified. The study was conducted from beginning April to end of October on four permanent plots, and traps were emptied weekly. The four research plots represented basic forest stand diversity concerning management regime and vegetation structure.

More than 80 spider and more than 50 carabid species were identified in samples. The seasonal activity was influenced by temperature, habitat type and by seasonal migration patterns. In the sense of future long term ecological research effectiveness; we tested, if the same/similar seasonal activity pattern is obvious when the data of dominant (14 carabid and 8 spider) species are used only.

On the ground of analysis our preliminary research we can conclude the following suggestions concerning future long-term ecological studies: 1) the seasonal activity of epigeic spiders and ground beetles could be studied when using only data of the most dominant species; and 2) the chosen study plots seem to be adequate considering forest heterogeneity and carabid and epigeic spiders seasonal activity, including migration between forest and clear-cut stands.
Variation of benthic macroinvertebrate communities in mountain wetland from Mt. Jumbongsan, South Korea

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The mountain wetland at Mt. Jumbongsan used to be a rice paddy by clearing forests. After abandoning farming, it has been gradually turning into a natural wetland. However, according to the Climate Change scenario (RCP6.0), the Mt. Jumbongsan area is expected to rise in temperature within 50 years. The elevated temperature will result in desiccation of the wetland. Therefore, this study was conducted for studying the biodiversity in relation to the succession process of the wetland. We identified 16 species in 12 orders of benthic macroinvertebrates from 2016 to 2017. The correlation analysis was done using both taxonomic groups and functional feeding groups (FFGs) of the invertebrates with the 3 environmental parameters of physicochemistry: dissolved oxygen (DO), pH, and water temperature (℃). In the taxonomic groups, the number of Odonata and Plecoptera increases according to the DO level. The number of some species of the taxa increases as the water temperature rises. When looking at FFGs, the number of predators and shredders increases according to the DO level. We need a long-term research to determine whether this result is due to the temporal correlation between the life history of some of the predators and the physicochemical factors, or due to regional specificity. In the future, we will develop an assessment index for preserving mountain wetlands by 1) continuously analyzing the correlation between the conditions of mountain wetlands and benthic macroinvertebrates and 2) installing automatic precipitation meter, water gauge, and water quality measurement system.
T5: NEW METHODS, TECHNOLOGY AND INNOVATIVE SCIENCE SUPPORT SERVICES

Study on Science and Technology Resource Management and Service System of Field Station Based on Cloud Service

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Because of the problems which includes only providing long-term observation data and some scientific research data, incomplete system function, lack of IT staff in stations to maintain the system and so on, original field station information system of national ecosystem research network of China requires to be improved to provide more accurate, convenient, continuous and effective services for the users. Considering the advancement, maintainability, expansibility and characteristics of cloud service, a new system has been designed based on the combination of cloud service end and local end. In the cloud, infrastructure resources, data resources, software resources and other resources are integrated to implement various services such as IaaS, PaaS, and SaaS. The local end mainly realizes the functions related to system personalization, and establishes a local database. Also, a virtual machine provided as the web server for each station as the web server. The new system builds a set of functions including information publishing, resource services, and system management in one system, and has been applied in 51 field stations of the National Ecosystem Research Network of China (CERN). After using the system, the level and efficiency of station resources management and service, and promoted the management and service ability of the stations has been sufficiently improved.
The effect of agricultural managements and landscape on arthropod community in rice paddy ecosystems of Taiwan

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The use of chemical pesticide and fertilizer of conventional agriculture strongly impacts the natural environments and human health. Hence, the sustainable agriculture is an alternative strategy and aims to reduce the deteriorating effect of agriculture on natural ecosystem. Arthropods play an important role in agricultural system and is sensitive to environmental changes. Therefore, the diversity of arthropods is a good indicator to assess the effect of different agricultural management and landscape adjacent to the farms. We surveyed four areas located in mid-northern Taiwan with each including three sampling sites: one sustainable farm, another conventional farm, and the other uncultivated land. The distance between each four investigating area is over 1 km and the interval among three sampling sites is over 100 m but less than 1 km. Investigations by using vacuum sucking machine were carried out over the rice cultivation cycle monthly (February 2018 to June 2018). A total of 28,927 individuals representing 185 morphological species among 13 orders of terrestrial arthropods were collected. The overall arthropod diversity of paddy field is similar between two agricultural practices. However, the natural enemies are more abundant in sustainable paddy field than that in conventional ones. The finding of positive correlation of arthropod community between uncultivated land and farms occurs suggests natural habitat around farms provide a temporary shelter for arthropods living in farms. This indicates that the landscape near farms need to be concerned in the making agricultural policy.
Data quality dimensions for long-term observation of ecosystems — A case study in Chinese Ecosystem Research Network (CERN)

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Data quality is the life of monitoring working. The Chinese Ecosystem Research Network (CERN) was established in 1988 under the auspices of the Chinese government and the World Bank Loan. Through years of effort, it is now well placed to address important issues, serving as a functional network to meet the needs of both the national and international ecological research. The costs of making incorrect scientific inferences based on faulty data can be substantial and far-reaching, and follow-on research may be critically jeopardized. To improve scientific data quality, and provide continuous quality assessment and management, the nature of scientific data and the processes that produce it must be articulated. Although firms are improving data quality with practical approaches and tools, their improvement efforts tend to focus primarily on accuracy, consistency and completeness, with no clear DQ framework and these dimensions having no clear description and measuring method. The purpose of this research is to provide a framework for the management of data quality as it applies to scientific data, specifically those generated by the fieldwork facilities and instrumentation that will populate the data centers of CERN, based on data quality theory. Definitions for data and data quality tailored to the context of ecological research are proposed. This paper develops a list of data quality dimensions that captures the aspects of data quality which are important for ecosystem long-term monitoring.