"Global Change and Biodiversity: Integrating Mechanisms of Interactions, Feedbacks and Scale"

URPP Global Change and Biodiversity Conference

Monte Verità; Ascona, Switzerland.

28 August – 01 September 2016

Program and Abstract Book

TABLE OF CONTENTS

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PROGRAM

Many key challenges that face humanity are due to the impacts of global change on biodiversity and on the functioning and stability of ecosystems and the natural services that they provide. This conference will discuss state-of-the-art methods and achievements in predicting the consequences of changes in global change drivers for biodiversity, ecosystem services and ultimately for human well-being.

Fishbowl Discussions: The goal of the fishbowl discussions is for URPP GCB members and participants to exchange ideas, discuss concepts, potentially advance manuscripts guided by an expert panel on a predetermined topic. The outer circle has the opportunity to pose questions to the inner circle of experts.

Geeking Session: One on one or small group discussions with invited experts.

Ignite Talks: 5 minute presentations of 20 slides, topics focus on new ideas with the goal to problem solve and receive feedback.

Pub Quiz: Informal quiz between 10 randomly drawn teams, questions to be submitted prior to the conference.

Science Café: Topics to be determined prior to the start of the conference, URPP GCB group present a topic and together with the participant groups contributing to solving problems. Participant group moves onto next café after 15 minutes and the next group participate in the discussion with the presenters.

Speed Science: Each person in a pair present themselves (30 sec) and their science (60 sec) and discuss (120 sec), strictly a total of 5 minutes. Goal is to expand network and initiate conversations to be continued in geeking sessions, fishbowl discussions or social events.

Sunday 28 August	
Arrival **Registration**	
from 15:15	Shuttle bus transports guest from main station
16:00 – 17:30	Registration and setting up posters
17:30 – 18:30	Welcome drink (Terrace/Balint)
Welcome Session	Chair: Irene Garonna
18:30 – 18:45	**Welcome Address: Michael E. Schaepman** *'Global Change and Biodiversity.'* (Auditorium)
18:45 – 19:30	**Opening Speaker: Andrew Gonzalez** *'Biodiversity science to address the challenges of global change.'* (Auditorium)
19:30 – 20:30	Dinner
20:30 onwards	Science Pub and Quiz (Open Bar on the Terrace/Dining room)

Monday 29 August	
07:00 – 08:00	Breakfast
Session 1	Chair: Katie Horgan
08:15 – 08:30	**Welcome Address by the CSF: Chiara Cometta and the FMV: Lorenzo Sonognini** (Auditorium)
08:30 – 09:10	**Key Note : Anne-Hélène Prieur-Richard** *'Future Earth, international program on global sustainability.'* (Auditorium)
09:15 – 09:45	**Speed Science** (Terrace/Dining room)
09:45 – 10:15	Coffee Break
Session 2	Chair: Florian Gerber
10:15 – 11:15	**Science Café:** (Balint) *'Earth-World Integration.'* *'Sustainability within the URPP GCB.'* *'Equal opportunities in science.'* *'Global change drivers, expected biodiversity change, and related interactions with climate and society for the URPP sites.'* *'How to foster interdisciplinarity in global change research.'* *'What is biodiversity? How to define biodiversity, biodiversity measurement?'*
11:20 – 12:00	**Key Note: Andrew Skidmore** *'Remote Sensing of EBVs for global change monitoring.'* (Auditorium)
12:00 – 13:30	Lunch
Session 3 (Auditorium)	Chair: Jaqueline Oehri
13:30 – 14:15	**Ignite Session**
13:30 – 13:45	**Florian Altermatt** *'eDNA revolutionizes biodiversity measurements.'*
13:45 – 14:00	**Samuel Abiven** *'Grand Challenges in global change and biodiversity science.'*
14:00 – 14:15	**Simone Quatrini** *'Land Degradation Neutrality, the emerging UN-backed paradigm for responsible investments in natural capital.'*
14:30 – 15:00	Coffee Break

Session 4

15:00 – 16:20 **Fishbowl Discussions**

Topic: **Measuring Biodiversity from Space.**
(Auditorium)
Chair: Susan Ustin Lead: Paul Moorcroft

Topic: **Biodiversity Upscaling**.
(Balint)
Chair: Gabriela Schaepman Lead: Gian Marco Palmero

Topic: **What is the role of experts in Biodiversity and Ecosystem services decision making?**
(Eranos)
Chair: Bernhard Schmid Lead: Rik Leemans

Topic: **The ethics of resource rights and territoriality in the context of genetic resources.**
(Pioda)
Chair: Peter Schaber Lead: Anna Deplazes

Session 5

Chair Auditorium: Daniela Braun
Chair Balint: Stanislav Ksenofontov

16:30 – 17:10 **Key Note: Sarah Elmendorf**
'Leveraging multisite monitoring networks for global change research.'
(Auditorium)

17:10 – 17:40 **Paul Moorcroft**
'Using remote-sensing measurements to constrain terrestrial biosphere model predictions of ecosystem composition, structure and function.'
(Auditorium)

Bernhard Schmid
'Causes and consequences of plant functional diversity within and between populations.'
(Balint)

17:45 – 18:25 **Geeking Session** with:
Andrew Gonzalez (Auditorium)
Anne-Hélène Prieur-Richard (Eranos Room)
Paul Moorcroft (Pioda Room)
Andrew Skidmore (Mandala Room)
Sarah Elmendorf (von der Heydt Room)
Bernhard Schmid (Café)

18:30 – 19:30 Poster Session and Apéro (Balint)

19:30 – 21:00 Dinner

Tuesday 30 August	
07:00 – 08:00	Breakfast
Session 6	Chair Auditorium: Sofia van Moorsel Chair Balint: Carla Guillén Escribà
08:15 – 08:55	**Key Note: Shoko Sakai** *'Changes in the use of Ecosystem Services by local people in rural Borneo.'* (Auditorium)
09:00 – 09:30	**Walter Jetz** *'Remote-sensing based prediction and monitoring of species distributions.'* (Auditorium)
	Fabian Schuppert *'Justice in access to and control over biodiversity: of individual rights, states' territorial jurisdiction and the prospects of global ethical governance.'* (Balint)
09:30 – 10:00	**Tetsukazu Yahara** *'States and trends of plant diversity in tropical forest of SE Asia.'* (Auditorium)
	Ilse R. Geijzendorffer *'Essential Ecosystem Services - variables and sustainable development goals.'* (Balint)
10:00 – 10:30	Coffee Break
Session 7	Chair Auditorium: Ang Cheng Choon Chair Balint: Maitane Iturrate
10:30 – 11:00	**Andrew Latimer** *'Detecting and characterizing biodiversity change using joint species distribution models.'* (Auditorium)
	Howard Epstein *'Recent dynamics of Arctic Tundra vegetation communities and their implications for earth system processes.'* (Balint)
11:10 – 11:50	**Geeking Session** with: Shoko Sakai (Auditorium) Walter Jetz (Balint) Tetsukazu Yahara (Eranos Room) Andrew Latimer (Pioda Room) Fabian Schuppert (von der Heydt Room) Ilse R. Geijzendorffer (Mandala Room) Margaret Torn (Café)

12:00 – 13:30	Lunch
Session 8	Chair Auditorium: Aurélie Garnier Chair Balint: Moritz Reisser
13:30 – 14:10	**Key Note: Margaret Moore** *'Resource frontiers and justice.'* (Auditorium)
14:10 – 14:40	**Janine Baerbel Illian** *'Relevance of interdisciplinary dialogue in biodiversity research - a statistician's point of view.'* (Auditorium)
	Muriel Côte *'Commons and communitarianism in the democratic governance of forest in Burkina Faso.'* (Balint)
14:40 – 15:10	**Whendee Silver** *'Drivers of environmental heterogeneity in tropical forests: essential biodiversity variables.'* (Auditorium)
	Emily Yeh *'Grassland restoration on the Tibetan Plateau and the question of resource frontiers.'* (Balint)
15:10 – 15:40	Coffee Break

Session 9

15:40 – 17:00	**Fishbowl Discussions**
	Topic: **Impact of global change on ecological functioning and future effects on ecosystem services.** (Auditorium) Chair: Astrid van Teeffelen Lead: Ilse Geijzendorffer
	Topic: **Integrating high-throughput sequencing technique to global changes and biodiversity: on phenology and genetic diversity.** (Balint) Chair: Kentaro Shimizu Lead: Eri Yamasaki
	Topic: **Grand challenges in global change and biodiversity science.** (Eranos) Chair: Michael W.I. Schmidt Lead: Samuel Abiven
	Topic: **Frontiers: expansion and containment.** (Pioda) Chair: Benedikt Korf Lead: Norman Backhaus
17:10 – 17:50	**Geeking Session** with:
	Margaret Moore (Auditorium) Janine Baerbel Illian (Eranos Room) Whendee Silver (Pioda Room) Emily Yeh (Mandala Room) Muriel Côte (von der Heydt)
18:00 – 19:00	Poster Session and Apéro (Balint)
19:00 – 20:30	Dinner

Wednesday 31 August	
07:00 – 08:00	Breakfast
Session 10 (Auditorium)	Chair: Fabian D. Schneider Chair: Chengxiu Li
08:20 – 09:00	**Key Note: Bram Büscher** *'Crisis Conservation: saving nature in times and spaces of exception.'*
09:00 – 09:45	**Ignite Session**
09:00 – 09:15	**Maria João Santos** *'Potential of remote sensing to contextualize biodiversity within social-ecological systems.'*
09:15 – 09:30	**Mary O'Connor** *'Biodiversity change over time depends on spatial scale.*'
09:30 – 09:45	**Kentaro Shimizu** *'How can molecular biology become a predictive science?'*
09:45 – 10:15	Coffee Break
Session 11	Chair Auditorium: Jacqueline Oehri Chair Balint: Jennifer Bartmess
10:15 – 10:45	**Franziska Schrodt** *'The biogeography of plant functional traits – a test of data and model selection on the accuracy of functional diversity maps.'* (Auditorium)
	Anne Bjorkman *'Patterns in plant functional traits across the tundra biome over space and time.'* (Balint)
10:45 – 11:15	**Margaret Torn** *'The urgent need to predict, protect, and enhance the global carbon sink.'* (Auditorium)
	Astrid van Teeffelen *'Biophysical and socio-cultural perspectives on ecosystem services and their relevance for European policy.'* (Balint)
11:20 – 12:00	**Key Note: Hilary Allison** *'Ecosystem assessment - where scientists and policy makers meet.'* (Auditorium)

12:00 – 13:30	Lunch

Session 12

13:30 – 14:10	**Geeking Session** with: Bram Büscher (Auditorium) Anne Bjorkman (Balint) Hilary Allison (Eranos Room) Franziska Schrodt (Pioda Room) Margaret Torn (Mandala Room) Astrid van Teeffelen (von der Heydt Room)
15:15	**Excursion**: walk down to Ascona Port, boat trip Isola Brissago **Conference Dinner**: Osteria Nostrana, Ascona Autosilo. Bus back to Monte Verità.

Thursday 1 September	
07:00 – 08:00	Breakfast
Session 13	Chair Auditorium: Alejandra Parreño Chair Balint: Yana Yankova
08:00 – 08:40	**Key Note: Michel Loreau** *'Biodiversity and ecological stability across scales and levels of organisation'* (Auditorium)
08:40 – 09:10	**Michael Purugganan** *'Environmental drivers of plant gene expression: A systems biology perspective.'* (Auditorium)
	Frank Vanclay *'Social impact assessment as a practical tool for managing resource utilization.'* (Balint)
09:15 – 09:45	**David Hooper** *'On beyond S: Why other metrics of biodiversity can tell more about carbon storage than species richness.'* (Auditorium)
09:45 – 10:15	Coffee Break
Session 14	Chair Auditorium: Terhi Hahl
10:15 – 10:55	**Key Note: Jeannine Cavender-Bares** *'Biodiversity in the Anthropocene: global detection, evolutionary legacies, and stewardship.'* (Auditorium)
10:55 – 11:35	**Geeking Session** with: Jeannine Cavender-Bares (Auditorium) David Hooper (Eranos Room) Michel Loreau (Pioda Room) Michael Purugganan (Mandala Room) Frank Vanclay (von der Heydt Room)
11:35 – 11:45	**CSF Early Career Researcher Presentation Award** (Auditorium)
11:45 – 12:00	**Closing Address: Owen Petchey** *'The future of global change and biodiversity.'* (Auditorium)
12:00	Packed Lunch
12:30	Journey home

ABSTRACTS

PLENARY SPEAKERS

Ecosystem assessment - where scientists and policy makers meet.

Hilary Allison
UNEP-WCMC; Cambridge, UK.

This presentation will explore how carefully designed ecosystem assessments can foster dialogue and lead to efforts to improve the health and well-being of biodiversity, ecosystems and the people who depend on them.

An ecosystem assessment is a social process through which the findings of science concerning the causes of ecosystem change, their consequences for human well-bring, and the management and policy options are evaluated. The process is effectively a dialogue between scientists who understand data and information but not the necessarily the policy questions which their data may be able to answer, and policy makers who understand the policy-focused questions which need to be asked about ecosystem health and condition but not necessarily the range of constraints and complexities inherent in the data and information which they hope will answer them. Assessments do not usually engender original research but focus instead on synthesis of data and information to create a compelling analysis of ecosystem status, condition and management options.

A key feature of ecosystem assessments is that they examine processes leading to change, impacts of and responses to change. They therefore focus not just on stocktaking the present but also on analysing possible futures and the policy responses which might change and enhance those futures. The development of future scenarios which can then be used to model plausible futures is therefore often used as a way of making some of those policy choices explicit and the presentation will give some examples of scenarios and modelling developed by UNEP-WCMC.

The presentation will also discuss best practice in undertaking ecosystem assessments from the early exploratory stage (of defining the need, identifying stakeholder needs. scoping the study and its boundaries) through the design stage (of addressing governance, scale, capacity, the key questions to be addressed, the conceptual framework, communications plans and funding needs) to the implementation stage (of assessing links between ecosystem services and human well-being, assessing status and trends, understanding drivers of change, developing scenarios and considering valuation), the role of peer review, the importance of communications and outreach, and the operationalisation of the results through engagement with decision makers.

Relevance of interdisciplinary dialogue in biodiversity research - a statistician's point of view.

Janine Baerbel Illian
The University of St Andrews; Edinburgh, Scotland, UK.

Technical advances have made it easier to collect data on the spatial locations of individuals, and spatially explicit data-sets have become commonly available. This enables us to consider the locations of individuals directly, rather than aggregating them in space and hence ignoring the spatial structure and information contained in it. In other words, the data that reflect spatial structure in ecosystems are patterns formed by the locations of individuals in space, i.e. spatial point patterns. The statistical representation of these is a spatial point process, which models the spatial locations of objects - here individuals or groups of individuals - in space. However, despite often being motivated as models of spatial patterns observed in nature - specifically of trees - publications on spatial point process modelling mainly resided within the statistical literature until rather recently, with only limited applications outside the statistical literature that directly concern or answer ecological (or other scientific) questions. This has changed over the last decade or so, partly due to the improved accessibility of suitable software as well as an improved dialogue between statisticians and ecologists interested in the respective fields. However, point processes are still not considered part of the standard toolbox of statistical methods used by ecologists and the methods are only now being picked up by the ecological community in general - despite ecologists being highly numerate and keen on using appropriate statistical methodology in general.
This talk reflects on the benefits of interdisciplinary work in the light of the ongoing dialogue between ecology and spatial point process modelling. It illustrates how the dialogue has contributed to both areas and highlighted weaknesses in relevant statistical approaches - in the specific context of ecology as well as in applications in general. We outline how interdisciplinary dialogue has improved the relevance of point process methodology using the example of a specific ecological debate that point process methodology has contributed to in recent years, that of opposing theories of species coexistence in ecological communities and how interdisciplinary dialogue has lead to the development of complex statistical methods. We discuss the importance of considering the practicability of the methodology in the context of complex point process models and lead on to a general discussion of what aspects of point process methodology are currently being discussed as a result of an ongoing dialogue between ecologists and statisticians.

Patterns in plant functional traits across the tundra biome over space and time.

Anne Bjorkman
iDiv; Leipzig, Germany.

Identifying and understanding large-scale patterns in functional traits can help us predict the future responses of plant communities and ecosystems to climate warming. This is especially pressing in Arctic and alpine regions, where the rate of warming is nearly twice that of the global average. While several studies have investigated the effects of warming on tundra community composition, it is the traits of these species, rather than their identity, that directly affect ecosystem functioning. We investigated how a range of canopy, leaf, and wood traits vary along climate gradients in the ecosystems beyond the latitudinal and elevational treeline by combining a large tundra vegetation change dataset with trait data from the TRY and Tundra Trait Team plant trait databases. We explored patterns in both among-species (community mean) trait variation and within-species trait variation. We additionally assessed the change in community trait values over the past 25 years in tundra ecosystems. We find that the community trait values associated with resource acquisition are greater in warmer sites, while conservative trait values are disproportionately found in colder sites across the tundra biome. Despite both strong temperature-driven gradients in functional traits and substantial shifts in community composition over the 25 years of the study, community trait values remained relatively stable over time. Thus, short-term shifts in ecosystem function may instead be driven by plasticity in the traits of resident individuals or in the long term by the immigration of novel, warm-adapted species into tundra ecosystems.

Crisis conservation: saving nature in times and spaces of exception.

Bram Büscher
Wageningen UR; Wageningen, Netherlands.

We currently witness a major surge in large-scale resource extraction and wildlife crime around the world, which in turn has triggered new types of conservation responses. Recent political ecology literature points at three reasons why this surge differs from earlier ones and why extraction and wildlife crime should be studied together. First, rising levels of affluence in Asian and other 'emerging economies' have triggered a sharp increase in the demand for fossil, mineral, timber and wildlife resources. Second, new extractive, military and information and communication technologies have rendered resource extraction and wildlife crime more effective, (potentially) lethal and destructive, and its impacts more visible to global publics. Third, they are increasingly overlapping in reality, thereby (further) blurring legal and illegal practices. The result has been a fertile ground for 'crisis conservation': high-pressure situations where urgent action is required to safeguard nature from destruction. The presentation argues that crisis conservation situations should be seen as 'spaces of exception' where rules, norms and ideas about legality are violated by those perpetrating and those countering the threats. These spaces of exception often include violence and therefore dramatically change the frontiers of environmental governance, but exactly how and with what impacts on people and nature is ill understood. Based on initial research on the rhino-poaching crisis in Southern Africa, several suggestions will be explored, especially those at the intersections of 'green violence', race, social media and conservation. I will finish the presentation by laying out plans for forthcoming research that focuses on crisis conservation situations in three countries where iconic species and ecosystems are acutely threatened by globally induced extraction and wildlife crime dynamics: Brazil, Indonesia and South Africa.

Biodiversity in the Anthropocene: global detection, evolutionary legacies, and stewardship.

Jeannine Cavender-Bares
University of Minnesota; Minnesota, USA.

The Earth's biodiversity is undergoing unprecedented changes and extinction in the Anthropocene. These changes require vigilant tracking at the global scale using hyperspectral remote sensing methods integrated with in situ measures of biodiversity and evolutionary history. Using optical signatures to locate plant species within the tree of life is one critical challenge. A second challenge is detecting and differentiating where evolutionary and human legacies have left an imprint of contrasting ecosystem functions despite similar geologic and climatic settings. Meaningful integration and interpretation of hyperspectral data at multiple spatial scales requires collaboration between many different kinds of biologists. These collaborative efforts are essential for management of ecosystem functions on Planet Earth that sustain human well-being in the face of rapid global change.

Commons and communitarianism in the democratic governance of forest in Burkina Faso.

Muriel Côte
University of Zurich; Zurich, Switzerland.

Under what conditions does identity politics arise in the context of forest and biodiversity conservation? This question is important because natural resource management schemes that are devised to work at national levels, and increasingly at international levels, often fail because they are met with property and territorial disputes at the local level that are articulated around claims of indigeneity, autochthony, and more broadly around competing claims 'to have come first' to a particular place.
This paper argues that to be able to understand communitarist disputes as 'more-than-local' they can be seen as cases of the scaling down of political economic tensions in a context of fragmented public authority over forest and biodiversity. This is illustrated through a case of local contested identity politics that arose in the management of forest resources in Burkina Faso, and that is traced back to particular conflicts of interests between public authorities over forest and across diverse scales: between national government and international donors, between central and local governments, and between traditional land custodians. These tensions are illustrated with the case of Burkina but they resonate other contexts in the global south. They aim to generate questions about the extent to which the fragmentation of public authority over forest and biodiversity is a problem, and to open up a discussion about the potential value of mapping out territorial in/congruence in the management of the global commons.

Leveraging multisite monitoring networks for global change research.

Sarah Elmendorf
NEON; Boulder, Colorado, USA.

Current understanding the impacts of anthropogenic influences on biodiversity and ecological processes is limited by a lack of coordinated monitoring that measures both drivers and ecological response variables across a diversity of ecosystem types. I discuss challenges and opportunities for global change biologists working with data from existing monitoring networks, ranging from citizen science datasets to national scale networks, with a particular focus on the US National Ecological Observatory Network (NEON). NEON will provide free and open access ecological data from xxx field sites distributed across the continental US, Puerto Rico and Hawaii for the next 30 years, including in-situ biomonitoring of organisms, populations and communities, measurements of carbon flux and other physical & chemical climate parameters, and lidar and hyperspectral remote sensing products.

Recent dynamics of Arctic Tundra vegetation communities and their implications for earth system processes.

Howard Epstein
University of Virginia; Charlottesville, Virginia, USA.

Arctic tundra vegetation communities have undergone substantive changes over the past several decades, largely in response to climate and disturbance dynamics. These changes have included alterations to species composition as well as to biodiversity, and have frequently led to a switch in community dominants. While the entire arctic tundra biome appears to be undergoing some degree of vegetation change, a rather ubiquitous and biophysically important change has been the accelerated growth and expansion of tall shrubs (e.g. alder, willow, birch). The replacement of short-statured tundra with tall shrubs alters biodiversity through competitive interactions, changes to the micrometeorological environment, as well as influences on herbivore communities. With specific regard to Earth system processes, these ecosystem shifts affect albedo, evaporation, transpiration, CO2 exchange, horizontal snow redistribution, and the overall system energy balance, which has implications for the stability of permafrost. Here, we discuss the recent literature and new field, remote sensing, and simulation modeling studies that examine the implications of vegetation community changes in arctic tundra on key Earth system processes, such as the land-atmosphere exchange of carbon, water, and energy.

Essential Ecosystem services variables and sustainable development goals.

Ilse R. Geijzendorffer
Tour du Valat; Le Sambu, Arles, France.

Sustainable Development Goals aim to reconcile future human wellbeing with the conservation of biodiversity. Although the ecosystem service concept implies a direct link between biodiversity and human wellbeing, currently it is not explicitly used to evaluate the state and progress on human wellbeing. This study identifies the current inclusion of ecosystem services and related key variables into the Sustainable Development Goals and the Aichi Targets and compares the information needed with the information available in national assessments following an essential variables approach. The analysis is done using a framework of Essential Ecosystem services Variables which include "Potential Supply", "Supply", "Use", "Demand" and "Interest" (in line with the current developments in GEO BON). There is good coverage of all ecosystem categories in both policy documents. The top 25% most cited services are: Natural Heritage and Diversity, Capture fisheries, Aquaculture, Water purification, Crops, Cultural Heritage & Diversity and Livestock. The proposed indicators, used for reporting on policy objectives mostly represent information on potential supply, supply or interest, while information on use and demand is underrepresented.
The reviewed assessments included 277 ecosystem services indicators, of which most provided information on provisioning (45%), and regulating services (44%). The remaining 11% of the indicators provided information on cultural services. For regulating ecosystem services, 38 indicators did not provide a measure of the service flow, but rather of the pressure (e.g. amount of NH3 emission) or of the status quo (e.g. current air quality). Neither of these measures provides any information on the actual flow of the ecosystem service. For the top 25% of the services demanded for the monitoring of the policies, there is a strong bias towards indicators on supply, mainly stemming from the crop and livestock provisioning services. Only for very few cases were indicators available for all components of ecosystem service flow and no indicators were available on ecosystem service interactions.
Important information gaps include the thematic and spatial coverage of indicators and underlying data,the inclusion of monitoring of ecosystem service interactions and an approach that enables to monitor ecosystem service benefits to society.

Biodiversity science to address the challenges of global change.

Andy Gonzalez
McGill University; Montréal, Canada.

Determining causes and consequences of biodiversity change is a cornerstone of ecological and evolutionary science and essential for mitigating impact on human wellbeing. Human mediated forms of global change are disrupting the balance of processes maintaining biodiversity from the smallest to the largest spatial scales. We combine theory, experiments and simulations to explain biodiversity change and deepen our understanding of how it impacts ecosystems and the services they provide. In the first part of my talk I will frame the issue of biodiversity change as a scale dependent phenomenon. This perspective, emerging from multiple working groups on this topic, can reconcile different trends in biodiversity seen from local to global scales. Theory and simulations show that altering the scales and rates of colonization and extinction produce scenarios with contrasting scale-dependent expectations for the direction and magnitude of biodiversity trends. Data on diversity change, from diverse taxa and regions, are also scale dependent. These findings calls for a detection and attribution framework akin to that for climate change that can inform cross-scale coordination of biodiversity monitoring, management and policy.

In the second part of my talk I will apply metacommunity theory to show how complex species interaction networks, such as food webs, emerge and reorganize as their component species respond to habitat loss and climate change. I will show how network complexity, and the degree of network reorganization (assembly and disassembly), depends on whether species can disperse to avoid the deleterious effects of habitat loss or shifting climate conditions.

The third part of my talk is about community rescue; the eco-evolutionary dynamics of entire communities responding to environmental change. I will show that communities can adapt to severe stress within an evolving metacommunity. After abrupt and lethal stress, community rescue was most frequent in microbial communities that had previously experienced sublethal levels of stress and had been connected by dispersal. Community rescue occurred through the evolutionary rescue of both initially common taxa, which remained common, and of initially rare taxa, which grew to dominate the evolved community.

I will close with conclusions that draw together these results and identify some recommendations for the conservation and management of biodiversity.

On beyond S: why other metrics of biodiversity can tell more about carbon storage than species richness.

David Hooper
Western Washington University; Bellingham, Washington, USA.

Translating effects of plant diversity on ecosystem processes into effects on ecosystem services often requires understanding multiple ecosystem controls, which may operate differently on different contributing processes. However, plot-scale tests of the effects of plant diversity have only rarely manipulated other factors that also control ecosystem processes. For these reasons, our knowledge of how natural variation in plant traits and diversity affect ecosystem services remains poor. In this talk, I will explore the role of ecosystem state factors (climate, topography, time since disturbance, and organism traits and diversity) on forest carbon storage, as an example of integrating mechanisms from biodiversity-ecosystem functioning (BEF) research with historical insights from ecosystem ecology. We used a series of regression models of increasing complexity to test the roles of abiotic state factors alone and in combination with either diversity, community-weighted mean (CWM) plant functional traits, or both, on four separate ecosystem carbon pools. We also tested the effectiveness of different metrics of tree diversity (species richness, phylogenetic diversity, and functional dispersion of different plant traits) in predicting these different ecosystem C pools.
Models using only abiotic state factors explained the majority of variance in live tree C, litter layer C, and total ecosystem C. Not surprisingly, at the landscape scale, ecosystem carbon storage responded to different abiotic controls on production and decomposition: as soils became poorly drained, litter layer carbon increased exponentially, whereas live tree carbon responded primarily to increasing temperature and precipitation. CWM plant functional traits helped significantly in predicting ecosystem carbon storage, but the traits relevant for pools responding to live biomass were different from those relevant for soil C storage. Diversity metrics were never the best biotic predictors of forest carbon pools. However, for some pools, such as live tree carbon, diversity added significantly to the overall degree of predictability. On the other hand, diversity had negative effects on carbon stocks in the litter layer – the dominant C pool in many sites. Of the diversity metrics we tested, species richness was never the best performing. These results have several implications. First, to expand to landscape scales, BEF studies need to integrate mechanisms from plot-scale studies with known abiotic drivers of ecosystem processes at the landscape scale. Second, where ecosystem services are driven by multiple different ecosystem processes, there's no reason to expect any simple relationship of that service with any one biological metric – either CWM traits or diversity. Finally, it's time to move beyond the expediency of species richness in the quest to understand mechanistic effects of diversity.

Remote-sensing based prediction and monitoring of species distributions.

Walter Jetz
Yale University; New Haven, Connecticut, USA.

Remote sensing combined with biodiversity observation offers an unrivalled tool for understanding and predicting species distributions and their changes at the planetary scale. I will illustrate recently developed high-resolution remote-sensing based layers targeted for spatiotemporal biodiversity modeling, addressing climate, environment, topography, and habitat heterogeneity. Remote-sensing based capture of these putative predictors of biodiversity dynamics provides more a reliable signal than spatially interpolated layers and avoids inflated spatial autocorrelation. The layers result in more accurate models of species occurrence and are more readily able to address the scale and temporal dynamics of processes underpinning species distributions, e.g. when combined with emerging hierarchical, cross-scale models. I illustrate the multiple ways in which this type of information, based on continuously collected data, supports the prediction of not just spatial but also temporal variation in species and their functions. Using the global biodiversity point data record implemented in the Map of Life infrastructure I will showcase new indicators of species distribution and change that demonstrate these new opportunities.

Detecting and characterizing biodiversity change using joint species distribution model.

Andrew Latimer
University of California; Davis, California, USA.

Biological community composition varies in space and time in response to environmental variation, including climate and disturbance. Individual species respond noisily to this variation because their abundance can be strongly influenced by other factors, including dispersal limitation, functional similarity to other species, and long generation times. Abundances of groups of organisms, however, together contain much more information about biodiversity trends and the environmental factors driving them. Data sets on community abundance are fortunately becoming more widespread through government programs (e.g. Swiss National Forest Inventory), citizen science initiatives (e.g. Breeding Bird Atlas) and advances in metagenomics (e.g. microbiome). Multispecies or joint species distribution models offer a probabilistically based way to extract interpretable biodiversity information from such data sets. This talk presents a case study of applying such models to forest trees in the Sierra Nevada mountains of California, demonstrating how these models can be used to characterize community change, including change in biodiversity indices and functional change. Applying these models to ensemble forecasts for mid-21st century demonstrates how change in these biodiversity variables can be decomposed into sensitivity of the community to the environment and rate of environmental change. Because they are statistical models, they also allow mapping and attributing uncertainty in the projections to uncertainty about species environmental responses, and uncertainty about future climate. As a qualitative model check, we compare inferred sensitivity to precipitation and temperature to community sensitivity estimated from time series of Landsat NDVI, and to forest mortality patterns during a recent, severe drought.

Biodiversity and ecological stability across scales and levels of organization.

Michel Loreau
UMR 5321 CNRS & Paul Sabatier University; Toulouse, France.

Biodiversity plays an important role in ecosystem functioning and services. Its role in the stability of ecosystem functioning and services, however, has been obscured by the long-standing controversy over the relationship between diversity and stability in ecology. Recent theoretical and experimental work provides a completely new perspective on this issue. In contrast to classical theory, which is based on stability measures that are largely divorced from empirical data, new theory based on invariability predicts different diversity–stability relationships at the population and ecosystem levels. It also provides a consistent hierarchical framework for studying ecosystem stability across multiple spatial scales. This new theory agrees with empirical and experimental data, and shows that biodiversity plays an important stabilizing role in ecosystems at multiple scales, thereby ensuring the steady provision of ecosystem services to human societies.

Using remote-sensing measurements to constrain terrestrial biosphere model predictions of ecosystem composition, structure and function.

Paul Moorcroft
Harvard University; Cambridge, Massachusetts, USA.

Ecosystem composition and structure are key attributes of the terrestrial biosphere, affecting its current and future carbon, water, and energy fluxes. Information on ecosystem composition and structure has traditionally come from ground-based forest inventories that provide detailed information on the composition and structure of the plant canopy. However, due to their limited spatial extent, forest inventories do not provide a comprehensive picture of ecosystem composition at regional or global scales. In this presentation, we show results from recent analyses in which we evaluated the ability of imaging spectrometry and lidar measurements to constrain terrestrial biosphere model simulations of carbon, water and energy fluxes. Our results suggest that remotely-sensed estimates of vegetation composition and structure provided by these measurements can significantly improve terrestrial biosphere model predictions of the current and near-term future functioning of the terrestrial biosphere.

Resource frontiers and justice.

Margaret Moore
Queen's University; Ontario, Canada.

It is often argued, by scholars in international political theory, international relations and international law, that rights of collective self-determination generate a right to use and control resources. The argument is that, if a group is to have significant control over the collective conditions of their existence, they need to have control over the land in which they live, the water that they drink, the resources that they draw on. This paper accepts the standard view of the relationship between self-determination and resources but then goes on to examine two different justice-related issues that arise in resource frontiers.
By a resource frontier, I mean a frontier between two distinct groups that have different ways of life, or different material and symbolic relations with resources and more generally with the land on which they live. First, there is the issue of justice or fairness between the groups themselves, which may arise, for example, when one group's way of life is more resource-intensive than another group. This raises questions of distributive justice about access to the resource. A second justice issue arises from environmental sustainability concerns, which may suggest that a group's way of life and resource use should be constrained by a harm principle, at least if we think of harm in terms of the medium and long-term survival of people, and their ways of life. Through discussion of these two issues, this paper suggests some principles to limit rights of both resource use and control at the frontiers but one that is sensitive to the different claims and different ways of life of the groups in question.

Future Earth, international program on global sustainability.

Anne-Hélène Prieur-Richard
Future Earth; Montreal, Canada.

A lot of progress has been made during the last decades on understanding the drivers of biodiversity changes and consequences for ecosystem functioning and the delivery of ecosystem services for human well-being. One of the major outcomes of this research relates to the research and methodological needs to design biodiversity and ecosystem management plans to safeguard natural capital for next generations. To design appropriate and successful management plans, the production of knowledge needs to include the following elements: 1) a cross-sectoral approach; 2) a cross-scale approach; 3) a better understanding of indirect drivers, especially those related to different types of value and behavior; and 4) increasing uptake by society of research findings.
This talk will present the Future Earth approach of co-design and co-production of knowledge, and examples of collaborative projects advancing this research agenda. Future Earth, international program on global sustainability, aims at gathering, synthesizing and facilitating the production of scientific knowledge linking disciplines, knowledge systems and societal partners to support a more agile global innovation system building on natural, social and economic capitals.

Environmental drivers of plant gene expression: a systems biology perspective.

Michael Purugganan
New York University; New York, NY, USA.

Plants deal with fluctuating complex environments in part by modulating gene expression patterns. Crop plants have evolved to adapt to various environments, including extreme conditions that trigger stress responses. These environmental responses are mediated by Environmentally-responsive Gene Regulatory Interaction Networks (eGRINs) that plants use to translate complex environmental information into coordinated metabolic responses. The accurate description of global eGRINs is challenging because it is impracticable to directly measure the interactions of all transcription factors (TFs) with the regulatory regions of each of their target genes. We describe these genetic networks in the context of responses to field environments, and discuss possible implications on adaptive responses to climate change.

Changes in the use of Ecosystem Services by local people in rural Borneo.

Shoko Sakai
Kyoto University; Kyoto, Japan.

Utilization of ecosystem services by local people is rapidly decreasing and/or changing throughout the world with economic globalization, the prevalence of a monetary economy, and degradation of ecosystems. Potential causes and consequences of the decrease and changes, however, have rarely examined using quantitative sociological data. In this study, we investigate relationships between changes of the intensity of utilization of ecosystem services by local people and their environments including land covers in Sarawak, Malaysia. In Sarawak, primary forests were exploited by indigenous people through swidden agriculture (slash-and-burn agriculture) and collection of wild animals and plants before the modern economic transformation, which started in the 1960s. In the last few decades, however, commercial logging and the development of oil-palm plantations have changed the land cover drastically. On the other hand, many indigenous people today have migrated to urban areas, or even outside of Sarawak. Village life has also changed in various ways, and local people depend on natural forests less and less. To investigate relationships between forests and local people and their changes, we conducted questionnaire survey in more than 90 villages. In addition, the proportion of the land covered by forests surrounding the villages was estimated based on the land cover map based on satellite images. By analyzing the dataset, we found that decrease of forest cover partly explained decrease of use of provisional services people receive from forests, while other social factors also significantly responsible for the decrease. In spite of decreasing dependency of people on forests for daily consumption, on the other hand, villages with more forest cover tend to have larger population growth rates. In the villages with more forest cover people are more likely to maintain their identity as a member, even if they live and work outside of the village. It may because people still count on the forests to provide their daily bread when they return the village after retirement. Besides, forests may also encourage a sense of attachment to the locality.

Causes and consequences of plant functional diversity within and between populations.

Bernhard Schmid
URPP GCB, Univeristy of Zurich; Zurich, Switzerland.

I will start with examples of plant functional diversity at different levels from within plants, genotypes and populations to between species and demonstrate its effects on ecosystem functioning. Effects of plant functional diversity within ecosystems are related to the abiotic and biotic environment and this can be studied using the concepts of niche and biotope space. Ultimately, plant functional diversity is related to taxonomic and phylogenetic diversity via niche conservatism, constraining convergent evolution of functional traits in multivariate niche space. Expanding the concept of community assembly to "functional diversity assembly" we can study how changes in species composition and abundance, plasticity of functional traits and short-term evolution modify functional diversity and its effects on ecosystem functioning.

The biogeography of plant functional traits – a test of data and model selection on the accuracy of functional diversity maps.

Franziska Schrodt
Max Planck Institute; Jena, Germany.

Plant functional traits (PFTs) are used to calculate functional diversity and form an integral part of studies assessing the link between diversity and ecosystem functioning. Understanding this link is pivotal to gaining mechanistic insight into the potential impact of projected climate change on the world's ecosystems. Yet, ecosystem functional properties are measured at much larger scales than traits and spatially explicit data on PFTs is sparse with the sensitivity of techniques to extrapolate traits from measurements on individual plants to larger spatial scales rarely being tested in conjunction. Using different combinations of PFT data on European tree species and models for trait extrapolation, we calculate functional diversity indices for the European continent and show the range in projected functional trait space resulting from potential sources of error. Linking these functional diversity maps with ecosystem functional properties, we demonstrate how divergent the possible conclusions drawn from differential use of data and models can be.
Discussing the implications of our findings in the face of increasing need for continuous trait data to improve predictions of ecosystems responses to a changing world, we propose solutions to improve the accuracy of functional diversity maps.

Justice in access to and control over biodiversity: of individual rights, states' territorial jurisdiction and the prospects of global ethical governance.

Fabian Schuppert
Queen's University Belfast; Belfast, UK.

The importance of biodiversity for human and non-human well-being is widely documented and acknowledged. It is therefore hardly surprising that biodiversity conservation is often identified as a major step towards securing a better and sustainable future. However, biodiversity conservation in itself already, and of course the use and distribution of the benefits generated by successful biodiversity conservation as well, are deeply normative issues. We therefore require a sound normative framework in order to assess who should have control over biodiversity (conservation), where, and how to distribute access to and the benefits from biodiversity among different groups and claimants. In answering these ethical issues, though, we encounter a whole host of different competing normative claims, including claims stemming from individual rights, claims from states' territorial powers and claims from international and global institutions. In this paper, I will try to disentangle parts of this normative web and highlight the prospects and limits of different approaches and how they relate to each other.

Drivers of environmental heterogeneity in tropical forests: essential iodiversity variables.

Whendee Silver
University of California; Berkeley, California, USA.

Environmental variability is a key determinant of biodiversity at the scale of microns to regions, and thus is important to consider when managing for biodiversity conservation and species adaptation. At the scale of ecosystems, climate, geology and soils, and disturbance history operate alone and in concert to create environmental heterogeneity. Human activities impose an added level of complexity by altering patterns in environmental heterogeneity both directly and indirectly. In this talk, I use examples from humid tropical forests to discuss two drivers of environmental heterogeneity in a changing world: drought and hurricanes. I explore how these drivers are overlain on a diverse biogeochemical matrix resulting in novel environmental conditions, and identify critical gaps in knowledge to better predict resource availability for biodiversity management.

Climate models predict an increase in the frequency and severity of drought in many humid tropical regions with climate change. These ecosystems harbor some of the highest biodiversity on Earth and have been characterized by relatively stable climatic conditions over ecological time, where moisture was rarely limiting. During the 2015 El Niño event, widespread and severe drought occurred in many regions of the Neotropics, providing an opportunity to explore how drought impacts essential biodiversity variables. In one well instrumented rainforest, drought drove strong threshold-type effects in moisture and O2 concentrations across the landscape. Upper topographic zones were disproportionately affected by drying; soil moisture on ridges declined from a mean 45 ± 2% to 13 ± 2% over less than 2 months. Valley soils remained moist, but soil O2 concentrations (an index of aeration) doubled in one week from a mean of 5 ± 2% to 11 ± 1%, and increased by 36 % within the first month of the drought. This led to dramatic declines in inorganic phosphorus availability, a nutrient that is commonly limiting to net primary productivity in these ecosystems (O'Connell et al. submitted). An increase in the frequency of these previously rare events will shift patterns in resource availability across the landscape, affecting plant and microbial function.

Climate change is also increasing the frequency and severity of storm events in some humid tropical forests. Severe storms differentially impact tree species, and this can feed back on carbon and nutrient dynamics. Hurricane Georges in Puerto Rico resulted in large differences in litter inputs across six forest types that exceeded background rates by 50 to 90%. Plantation forests responded differentially than natural ecosystems. Rapid decomposition of storm litter inputs in most forests (<1 y) suggested that these ecosystems were relatively resistant to disturbance. However, data from a long-term hurricane simulation experiment showed significant legacy effects on soil carbon, nitrogen and phosphorus deep into the soil profile (Gutierrez del Arroyo and Silver submitted).

Remote Sensing of EBVs for global change monitoring.

Andrew Skidmore
University Twente; Enschede, Netherlands.

Many of the key challenges that face humanity are due to the impacts of global change on biodiversity and the stability of ecosystems and natural services that they provide. In this presentation, I will discuss the process and progress in using remote sensing for monitoring of essential biodiversity variables to predict the consequences of changes in the global drivers of biodiversity. Essential Biodiversity Variable (EBVs) are defined as the key variables required to observe, understand, and report on change in the state of biodiversity. They sit as a layer between raw biodiversity observations and the biodiversity indicators used in policy, such as the indicators measuring progress towards the CBD Aichi Targets. EBVs provide key guidance to the observation system in terms of what it should measure, and their intermediate position between observations and indicators isolates those indicators from changes in observation technology. Satellite remote sensing can play a crucial role in the measurement of EBVs, particularly for a subset of EBVs which we denote by RS-EBVs. Largely, this is because the global and periodic nature of satellite remote sensing greatly simplifies the acquisition of the needed observations, making RS an ideal method for understanding change at national as well as other scales. Using the EBV framework as a baseline two GEO BON workshops were held to discuss current and future satellite missions and their ability to provide observations useful for generating EBVs. The goal was to create a list of candidate RS-EBVs by carefully considering, amongst others, factors such as an ability to meet policy needs, priority, feasibility, implementation status, spatial resolution and temporal frequency. The list published in Skidmore et al. (2015) contains RS-EBVs that are continuous and biophysical such as leaf area index and species traits, as well as others that use somewhat arbitrary class boundaries, such as land cover and disturbed areas. Also, like some ECVs, a number of RS-EBVs are actually groups of related variables that describe a phenomenon of interest (e.g., plant traits, phenology, disturbance). I will explore progress and challenges in using state-of-the-art remote sensing to retrieve EBVs from remote sensing. With this list as a starting point, the next steps in the process can begin, with the ultimate goal of putting a plan in place to acquire the needed RS observations to generate the related EBVs. The current approach for this process is described. The key organizations for this are the CBD, IPBES, CEOS, and GEO BON, with GEO playing a facilitative role, however the broader biodiversity community is also very important. A key goal is to meet as many as possible of the reporting needs that CBD signatory countries have for the Aichi targets.

The urgent need to predict, protect, and enhance the global carbon sink.

Margaret Torn
Earth & Environmental Sciences Area; Berkeley, California, USA.

One of the most important Earth system processes, from the perspective of climate regulation in the Anthropocene, is the global terrestrial carbon sink. Earth's terrestrial ecosystems absorb roughly one-third of all anthropogenic CO2 emissions from the atmosphere each year, greatly reducing the climate forcing that human emissions would otherwise cause. However, there is great uncertainty about the future trajectory of the global land-based carbon sink, as the relative importance of hypothesized driving mechanisms, currently and in future, is not known. The same highly uncertain processes are also being relied upon by the nearly 117 countries that have said they will count on the land sink to meet their COP21 commitments. Although conventional land management (such as no-till and better forest management) is also important for the UNFCCC CO2 offsets, significant carbon credits are accruing because of background sink processes (i.e., forests that are accumulating carbon because of CO2 fertilization). Moreover, recent studies have concluded that relying on conventional methods alone to achieve promised increases in the carbon sequestration would require too much land, water, and nutrients. Thus, both better understanding and novel approaches are needed. Here we argue for the urgent need to create a predictive capability founded on observations, theory, and models, and to develop biological approaches to enhance the carbon sink. Advances in biological innovation provide an opportunity to develop novel strategies for sink enhancement, with significant co-benefits for healthy soils, resilient and productive ecosystems, and more carbon neutral bioenergy. This presentation will describe the need for a vertically integrated ability to predict, protect, and enhance the terrestrial carbon sink as a grand challenge in earth system science, systems biology, and climate policy.

Biophysical and socio-cultural perspectives on ecosystem services and their relevance for European policy.

Astrid van Teeffelen
VU University Amsterdam; Amsterdam, Netherlands.

The conservation and restoration of biodiversity and ecosystem services requires effective policy measures. What measures can be considered effective, depends on the types of habitats, species and services in question, their current status, associated pressures, and policy objectives. The European Union (EU) plays an important role in biodiversity and ecosystem services conservation across its 28 Member States. Directly, through the Birds and Habitats Directives and the Biodiversity Strategy, but also indirectly, through funding instruments and other policy areas such as the Common Agricultural Policy. The interplay between policy measures, land use and pressures such as habitat loss and climate change determines the fate of European ecosystems, the species they support and the services they supply. Modelling these interplays at larger spatial scales and over several decades, allows assessment of the expected effectiveness of policy measures, in different European contexts for different ecosystem services and biodiversity components. In this talk I present multiple ways in which we have assessed EU policy from an ecosystem services and/or biodiversity perspective. At the same time, most ecosystem services are utilized at regional to local level. Hence, we complement these studies with brief insights from several socio-cultural valuation studies measuring people's perceptions on such policy interventions. Topics addressed include, first, the degree to which No Net Loss targets for biodiversity and ecosystem services are likely to be met through different policy options, highlighting trade-offs and synergies. Second, as biodiversity goals will not be met without considerable habitat restoration efforts, I present Member States' progress in this regard. Third, with climate change being another major threat to biodiversity, we assessed whether the European biodiversity policy is 'fit for purpose' given climate change, and to what degree EU funding allocation aligns with conservation priorities, under current and changing climatic conditions. Lastly, we assessed the importance of considering ecosystem services flows and demand in identifying priority areas, demonstrating the importance of considering ecosystem services flows and demand in priority area identification. Taken together, these studies show the relevance of ecosystem services and biodiversity assessments in a European policy context, and how biophysical and socio-cultural perspectives complement one another in policy assessment.

Social impact assessment as a practical tool for managing resource utilization.

Frank Vanclay
University of Groningen; Groningen, Netherlands.

Natural resource utilization (extraction, exploitation) occurs because of the opportunities presented. These opportunities are not just financial (in the form of returns to the operating companies and national governments) but, especially in the case of developing countries, can also provide significant contributions to much needed social development at local and national scales – at least under certain conditions. However, there are tensions between these opportunities for development and the social and environmental risks and harms that may arise. First, developing countries may need these projects for their economic development. Protecting biodiversity by stopping some extractive projects may come at a considerable economic cost and loss of a social development opportunity. Second, locking land up for biodiversity protection (e.g. the creation of national parks, or green-grabbing) may cause severe social impacts on the people who are evicted from those locations. Finally, extractive projects which are intended to create wealth (for countries as well as the corporate partners), tend to cause harm (often considerable harm), not only in terms of biodiversity loss in an ecological sense, but also in social terms. The social impacts created frequently include the displacement of peoples, destruction of livelihoods, local inflation, impoverishment, loss of community cohesion, loss of social resilience, the creation of conflict – the list goes on and on and on; there are dozens of social impacts that can occur. Social impact assessment (SIA) is the process of managing the social issues of planned interventions. It is an applied field of research and practice (i.e. a paradigm or discourse) that has a 40 plus year history. Originally conceived as a regulatory tool rather like environmental impact assessment (to decide whether regulatory approval should be given), it is now primarily regarded as a tool for managing the social issues at all stages of project development. In my presentation, I will outline how SIA is relevant to the discussion of biodiversity protection. I will outline how social impacts and human rights impacts are created (including by biodiversity projects), and I will advocate on behalf of peoples affected by biodiversity projects. I will highlight the role of social protest as a form of resistance, and will argue that biodiversity projects need to have a 'social licence to operate' just as much as any corporate project. I will highlight the importance of treating communities with respect, and of according local people with the power to give or withhold their 'free, prior and informed consent' (FPIC). Finally, I will emphasize that for biodiversity projects to be successful, they must return benefits to local communities while avoiding harm.

States and trends of plant diversity in tropical forest of SE Asia.

Tetsukazu Yahara
Kyushu University; Fukuoka, Japan.

While tropical forest of SE Asia is being rapidly lost, we are far away from getting reliable estimates of plant species richness in SE Asian forest. This limitation of our knowledge is partly due to infrequent flowering of many tree species in SE Asia; many tree species flower once per ten year or twenty year or even a longer interval. Thus there are many species for which fertile specimens have never been collected and thus taxonomic studies have never been made. To obtain a reliable estimate of species richness in SE Asian forest, we are determining DNA sequences for all operational "species" of vascular plants found within 100 m x 5 m plots that have been placed in 115 locations of SE Asia including Vietnam, Cambodia, Thailand, Myanmar, Malaysia and Indonesia (Sumatra, Kalimantan, Jawa, Sulawesi). The specimens we collected amounted to 24,259 and the number of operational "species" is approximately 19,000, exceeding the estimated richness of tree species in Amazonia (16,000).

To better understand taxonomy of tropical trees in SE Asia, we are studying species richness of Lauraceae because it is the most species-rich tree family in SE Asia. In Machilus and Neolitsea for which we have determined DNA sequences for most of our samples, the proportion of undescribed species exceeded 50%. It is likely that the number of species of Lauraceae in SE Asia will be doubled if detail taxonomic studies will be made.

Species richness per 500 m2 plot varied from 415 at 100 m altitude of Lambir National Park, Malaysia to 29 in 2959m of Gede/Panglango National Park, Indonesia. Species richness is the highest in the middle elevation in six mountains where we placed plots along elevational gradients. Geographically, plots with more than 300 species per 500 m2 are found in Borneo, Sumatra, Malay Peninsula and southern Vietnam.

Species richness data obtained from 115 plots in SE Asia enable us to model species richness as a function of various environmental parameters. GLMM analysis showed that total vascular plant species richness had significant relationships with precipitation, precipitation seasonality, temperature and terrain ruggedness index but no environmental factors had a consistent effect on different growth forms. Temperature had significant effects on all growth forms except for epiphytes; its relationship with species richness was parabolic in trees, shrubs and herbs, but linear in climbers. Precipitation had significant effects only on epiphyte and fern species richness. These findings showed that the relationship between environmental factors and plant species richness varies with growth forms.

While species richness is extremely high in lowland evergreen forest of Borneo and Sumatra, forest coverage is being rapidly lost in those islands; deforestation rate is 2.7% per year in Sumatra and 1.3% per year in Borneo. Forest loss between 1990 and 2010 was 20.3% in Indonesia, with the highest concentration having occurred in Riau of Sumatra and Kalimantan Tengah of Borneo. This forest loss is considered to have resulted in extinction of many plant species, but we need to improve our taxonomic knowledge to get a reliable estimate of species extinction. Major driver of forest loss is the development of oil palm and timber tree plantation. Except for national parks and other protected areas, most remaining forest is within concession areas of private companies. To prevent further loss of plant diversity there, we need to develop consensus and collaboration with private companies towards protection of lowland tropical forest.

Grassland restoration on the Tibetan Plateau and the question of resource frontiers.

Emily Yeh
University of Colorado Boulder; Boulder, CO, USA.

A variety of projects and policies been implemented on the rangelands of the Tibetan Plateau over the past several decades for the purpose of protecting and restoring the grasslands. These include the Rangeland Household Responsibility System, the declaration of the Sanjiangyuan Nature Reserve, "Retiring Livestock, Returning Grasslands" (tuimu huancao), and ecological migration. Most recently, climate adaptation has been added as a rationale for these policies. However, increasing evidence suggests that the policies have negative social effects and exacerbate rather than ameliorate grassland degradation. This presentation reviews these programs and discusses recent empirical evidence that run counter to the key assumptions underlying the policies. It then addresses the question of whether the Tibetan Plateau grasslands are "resource frontiers" from the perspective of local Tibetan concerns about resettlement, as well as by posing the framework of a broader recasting of China's landscapes into various functional roles.

IGNITE PRESENTATIONS

Grand challenges in global change and biodiversity science.

Samuel Abiven
URPP GCB, University of Zurich; Zurich, Switzerland.

Global change and biodiversity topics link together different disciplines like remote sensing, biogeochemistry, aquatic or terrestrial ecology, genomics or political and human geography, to cite a few. From this inter-disciplinarity rise several challenges overarching the individual fields of research. Confronting different time and spatial scales or considering larger perspectives reshuffles the cards of these specific disciplines, and back and forth between these different topics results in defining new grand challenges in global change and biodiversity.
This ignite talk aims at setting the stage for a first glance at these challenges we are compiling in the frame of the University of Zurich Research Priority Program (URPP) "Global change and biodiversity". We are exploring the different axes of the disciplines: the essential biodiversity variables, the earth system processes, the ecosystem services and the resource frontiers. For each of the axes, we identified several challenges, either related to the exploration of new processes, the application of new technologies to other disciplines, the questioning of classical discourse in a new perspective, or the introduction of new means of scientific knowledge acquisition, like practitioner participation. We will propose a series of example that stress the need to get a more holistic opinion about global change and biodiversity challenges.

eDNA revolutionizes biodiversity measurements.

Florian Altermatt
URPP GCB, University of Zurich; Zurich, Switzerland.

One of the biggest challenges in biodiversity science is that the key variable of interest, biodiversity itself, is usually measured only for a restricted set of taxa, that commonly used sampling techniques differ greatly between ecosystems and that sampling is time-intense. This subsequently challenges comparisons of biodiversity and its change across ecosystems at an adequate resolution. Environmental DNA (eDNA) techniques are a novel and highly innovative biodiversity measure potentially resolving many of these challenges. eDNA refers to DNA shed into the environment, and subsequent detection of organisms living there. As such, eDNA has the potential to revolutionize biodiversity monitoring. I will discuss the state and fate of eDNA as a biomonitoring technique, and hypothesize how eDNA based biodiversity measures can be linked to ground-based and remote-sensing based diversity and land-use change measures. I conclude that eDNA-based biodiversity assessments will offer an unprecedented temporal and spatial resolution of biodiversity data.

Potential of remote sensing to contextualize biodiversity within social-ecological systems.

Maria João Santos
Utrecht University; Utrecht, Netherlands.

Global change is a result of the increasing demands of social systems on natural resources and biodiversity. Not only do these pressures affect natural systems, they also can affect the very capacity of natural systems to support both itself (i.e. biodiversity) and the social systems placing those demands (i.e. ecosystem services, or human well-being). This interaction is the basis of the concept of Social-Ecological Systems (SES). However, our understanding of SES has been hampered by the lack of quantitative data, especially in the spatio-temporal context. In my research, I investigate the extent to which can remote sensing fill in this gap and be used to contextualize SES in space and time. I propose that the integration of ecological and social domains through remote sensing offers a systematic, spatio-temporally explicit method, transferable across geographies and scales by using techniques transferable across historic, current and future remote-sensing data. Using paired Mediterranean ecosystems in Portugal and California, I tested a remote sensing driven SES model and found out that:
(1) model of the ecological system (i.e. habitat suitability): model performance was sensitive to the scale of analysis (better for higher resolution data), temporal resolution (better with higher temporal resolution, but temporal resolution varied with the SES), and the importance of a given environmental variable to the species being modeled,
(2) model of the social system (i.e., users and governance): model performance was improved by adding spatial location of villages and boundaries of land use types; however, I could not include governance because this is an a-spatial process.
(3) model of the social-ecological system (i.e. resources): model performance was good when resources were modeled through productivity or the location of resources used by people
Unsurprisingly the description of the ecological system is relatively trivial using remote sensing, while the description of the social system was more challenging. Further, my results show that the resource system can be well modelled with remote sensing, and I think this can provide a key element to measure the feedbacks and interactions between the ecological and social systems. Finally, the assessment of SES through remote sensing may allow to identify the spatial and temporal mismatches between the ecological and the social system, which need to be fully accounted for in SES. In general, there is potential for using remote sensing to understand SES, and this potential is likely to continue as new and more relevant remote sensing data is being collected, it can be easily transferable across multiple resources (such as wood, fuel, food and water), and operationalizing such a framework that couples social and natural sciences is a necessary step to understand global change and how it affects biodiversity and its persistence.

Biodiversity change over time depends on spatial scale.

Mary I. O'Connor[1], Andrew Gonzalez, Patrick Thompson, Jonathan Chase, Amanda Bates, Maria Dornelas, Anne Magurran, Brian McGill, Conor Waldock, Marten Winter
[1]*University of British Columbia; Vancouver, Canada.*

Biodiversity changes over time, and understanding rates of change in the context of human activities is a major challenge. Reports of no net change in species richness at local scales have been difficult to reconcile with observations of changes in diversity at island, country and global scales. Despite the importance of spatial scale to diversity estimates, and theoretical evidence that diversity change varies across spatial scales, the importance of spatial scale has not been integrated into scientific syntheses of biodiversity change. We articulate expectations for how signals of scale dependence emerge in biodiversity change assessments. To test these predictions and explore scale dependence in diversity change observations, we synthesized hundreds of spatially explicit biodiversity change observations from <1m2 to global spatial scales. Synthesized biodiversity change data reveal signatures of variation across spatial scales within major taxonomic groups, with patterns of high variation at local scales, a tendency toward increases at regional scales, and slight proportional declines at the global scale. Interpretation of these patterns remains challenging, due to scale dependent biases in how biodiversity change is estimated, highlighting the need for biodiversity science to employ systematic and scale explicit approaches to assessing biodiversity and biodiversity change in the 21st century.

Land Degradation Neutrality, the emerging UN-backed paradigm for responsible investments in natural capital.

Simone Quatrini
URPP GCB, University of Zurich; Zurich, Switzerland.

Land Degradation Neutrality (LDN) – a concept long advocated for by the United Nations Convention to Combat Desertification (UNCCD) – became a priority of the international community last year with its inclusion in the Sustainable Development Goals (SDG) agenda as a specific target to be achieved by 2030.

LDN can be defined as "a state whereby the amount and quality of land resources necessary to support ecosystem functions and services remains stable or increases within specified temporal and spatial scales". In other words, LDN implies that economic development can be decoupled from natural capital depletion. LDN was conceived to encourage a dual-pronged approach to avoid or minimize degradation of land, combined with measures to restore degraded land, such that losses are balanced by gains.

Is LDN achievable? According to the UNCCD, the annual land footprint of the global economy is estimated at 12 million hectares of land. This adds to an accumulated stock of approx. 2 billion hectares of land already degraded. Achieving LDN will require an optimal mix of interventions designed to sustain and improve the stocks of land-based natural capital and the associated flows of ecosystem services.

The transition to LDN will require huge investments. With estimates of land restoration costs ranging from as little as US$ 33 per hectare to as much as several thousand US dollars per hectare, depending on the specific biome and land degradation severity, it is likely that investments will have to reach several billion US dollars each year.

Where will these additional resources come from? With Official Development Assistance (ODA) for combating desertification projected to remain relatively stable, investments by the private sector will be necessary. While this is in line with what the UN Addis Ababa Action Agenda for financing sustainable development calls for, whether or not LDN will succeed in this endeavour remains to be seen.

Recent market analyses suggest that LDN could bring about a real paradigm shift in the mobilization of private capital for sustainable development, provided that sufficient enabling conditions are put in place in the months and years ahead. It is for this reason that the UNCCD is spearheading the creation of an independent LDN Fund, designed as a public-private partnership for blended finance.

The ambition of the LDN Fund is to leverage, after an initial ramp up phase, more than 50% of capital from private responsible/impact investors. This, thanks to a portfolio that will consist of "triple bottom line" projects that will ensure sufficient financial returns, while generating multiple social and environmental benefits, e.g. food security, environmental protection and sustainable use of natural resources.

How can molecular biology become a predictive science?

Kentaro Shimizu
URPP GCB, University of Zurich; Zurich, Switzerland.

To integrate different disciplines, it would be useful to consider the fundamental difference in assumptions and histories in each discipline. Biology, in terms of both research community and university organization, has long been split into two fields, i.e. molecular biology and organismal biology. In 21th century, genomics is bridging the two, by providing large-scale dataset suitable for modeling and by expanding the scope from model species to ecologically and economically important species. This is opening the way to integrate molecular biology to study global change and biodiversity. I hope to illustrate the principle with a few examples from the URPP GCB.

POSTERS

Evaluation of the mentoring program of the URPP GCB Career and Equal Opportunities Committee.

Samuel Abiven, Jennifer Bartmess, Veruska Muccione, Debra Zuppinger-Dingley
Career and Equal Opportunities Committee (CEOC)
URPP GCB, University of Zurich; Zurich, Switzerland.

The goal of the University Priority Program Global Change and Biodiversity (URPP GCB) Career and Equal Opportunities Committee (CEOC) is to provide the URPP GCB's early career scientists with information regarding opportunities to further their career. In the framework of the CEOC, we initiated a PhD and post-doc mentoring program in 2014 for the early career scientists of the URPP GCB.
The mentoring program focuses on guiding the career development of the early career staff. The mentors offer advice on career development from an experienced outsider perspective. They share negative and positive experiences from their own career path with the mentee. The platform for this exchange of expertise is in a dialogue in which a more experienced person guides a less knowledgeable person. The mentor aims to raise the mentees awareness of which next steps should be taken on their career path.
In 2016 we evaluated the program to determine whether the early career researchers found such a program useful. Approximately 60% of the mentors and the mentees responded to our survey. The majority of the mentees found the program to be an enjoyable experience and made a series of suggestions that they believed would improve the program. The CEOC will use the results of this survey to consider potential improvements to the program in the future.

Assessing state and change of biodiversity using eDNA.

Florian Altermatt
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One of the biggest challenges in biodiversity science is the key variable of interest, biodiversity itself, is usually measured only for a restricted set of taxa, commonly used sampling techniques differ greatly between ecosystems and sampling is time-consuming. This subsequently challenges comparisons of biodiversity and its change across ecosystems at an adequate resolution. Environmental DNA (eDNA) techniques are a novel and highly innovative biodiversity measure which can be applied to river catchments associated to selected test sites of the URPP GCB. eDNA refers to DNA shed into the environment and the subsequent detection of organisms living there. eDNA is therefore predicted to revolutionize biodiversity monitoring. We have developed methods at the forefront of eDNA research, and have established high-end facilities to process eDNA. eDNA based biodiversity measures (α- and β-diversity) can be linked to ground-based and remote-sensing based diversity, and land-use change measures, in order to upscale diversity to the landscape level. Thereby, eDNA-based biodiversity assessments offer an unprecedented temporal and spatial resolution of biodiversity data. Such assessments are most suitable to track biodiversity changes resulting from the major global drivers.

Creating a resource frontier: imagination, accommodation and exclusion.

Jennifer Bartmess
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Creating an oil palm frontier in Sabah, East Malaysian Borneo has depended upon a specific frontier process of imagining places as underutilized but full of potential. This imagination has helped establish narratives and create new structures of authority that are turning tropical forests into frontiers of drastic environmental and social change.
Expansion into traditional frontiers elsewhere has typically required exclusion and erasure of indigenous land claims. In the modern frontier that I describe, planners have reworked rural oil palm development programs to minimally appease and accommodate indigenous land demands. Nevertheless, the frontier remains a place of exclusion of alternative livelihoods and pre-existing modes of production.

Spatio-temporal trends and trade-offs in ecosystem services in Switzerland between 2002 and 2012: a remote sensing based assessment.

Daniela Braun[1], Alexander Damm[2] and Michael E. Schaepman[1]
URPP GCB[1], Remote Sensing Laboratories[2], University of Zurich; Zurich, Switzerland.

Ecosystem structure and functioning is increasingly impacted by natural and human caused environmental change. Understanding and monitoring consequences of such pressures on the spatio-temporal provisioning of ecosystem services (ES) and their trade-offs is essential for decision-making and for implementing adaptive management approaches. Remote sensing (RS) offers a unique monitoring capability of ES and their trade-offs across spatial and temporal scales.
We aim to demonstrate a RS based approach to assess spatio-temporal variations of ES in Switzerland between 2002 and 2012. Our particular objectives comprise (1) the monitoring of provisioning, regulating and cultural ES, (2) the qualitative and quantitative assessment of their changes, and (3) the evaluation of ES trade-offs and synergies over time. Investigated ES are estimated based on mechanistic models using a combined input of RS and in-situ data as well as literature values. Annually aggregated ES change values between 2002 and 2012 are used to identify temporal trade-offs and time lags between ES. Spatial changes are determined using principal component analysis (PCA) and ES correlations.
We conclude with demonstrating the value of obtained spatio-temporal ES information including their trade-offs and synergies for future decision-making in spatial planning and conservation.

Genetic diversity of two tropical trees (Dipterocarpaceae) following enrichment-planting strategy in Borneo: negative impact of planting in monocultures.

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Tropical rainforests are well-known for being the most species-rich of all the terrestrial ecosystems on earth. However, biodiversity in these forests is under threat due to logging and land-use conversion. Many restoration efforts focus on recovering species diversity and forest structure post-logging, but fewer have emphasized genetic diversity within species, which plays an important role in species adaptation and persistence under novel climates and biological interactions. Therefore, we aimed to provide a detailed assessment of genetic diversity among seedlings used for enrichment planting for the restoration of selectively logged forests in Sabah, Malaysia, and to compare it with the levels in naturally regenerating seedlings. We sampled enrichment-planted seedlings from two dipterocarp species (*Shorea leprosula* and *Parashorea malaanonan*) within the Sabah Biodiversity Experiment (SBE) restoration project and compared their levels of genetic diversity with those natural seedlings from the surrounding forests. Our results showed that the genetic diversity estimates (heterozygosity and rarefied allelic richness) varied significantly between natural and enrichment-planted seedlings (df =1, $P < 0.001$), particularly in *S. leprosula*. Interestingly, a reduction of genetic diversity was consistently observed in monocultures relative to the mixed-species plots in both species (df =1, $P < 0.001$) from the enrichment-planting site. This reduction of genetic diversity was likely caused by preferential mortality of genotypes in monocultures over the last 13 years post-planting mortality, relative to that of the 16-species mixtures. The preferential loss may be a result of increased-density-dependent mortality in monocultures, which would likely remove genotypes that are poor competitors (Bagchi et al. 2011, Janzen 1970, Kulmatiski et al. 2012). Therefore, in the future, forest restoration of tropical tree species should adopt more species-rich planting schemes to prevent the loss of within-species genetic diversity associated with low species diversity. This initiative would promote conservation genetics, improve biodiversity and ecosystem functioning and encourage genetic diversity for resistance to future climatic changes.

Mangroves on Aldabra Atoll – stand diversity, structure, and long term area change for a key conservation habitat.

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Mangrove forests are reported to be the world's most threatened ecosystem, so timely and accurate detection of change in mangroves is essential. For Aldabra, a low lying atoll located in the Indian Ocean, rising sea levels poses a significant threat to its coastal ecosystems, including Seychelles' largest area of mangrove forests which provides numerous goods and services to the marine and terrestrial environment of this UNESCO World Heritage Site.
This research aims to assess trends in mangrove species diversity, structure, and distribution on the atoll by understanding the spatial and temporal extent of mangroves on Aldabra. This is achieved through a combination of remote sensing techniques and field plot survey.
For trends over a longer time scale, a post-classification change detection technique is being used to compare mangrove extent from black and white aerial images (1960) to multispectral aerial images (2012), over the same area. On a shorter time scale, habitat classification and multi-temporal habitat change detection using 10 Landsat images captured between 1995 and 2015 is being performed.
Lastly, at the species level, high resolution UAV images are being processed to produce an updated representation of mangrove species composition in a smaller subset of mangrove habitat on Aldabra. The field survey adds critical information on the mangrove diversity and structure in the subarea and reference points with which to validate the accuracy of changes detected.
A total of four mangrove species were reported in the field survey, only three of which occurred in the 39 plots (5m x 5m area per plot) sampled in April-May 2016. The most abundant species is *Rhizophora mucronata* followed by *Ceriops tagal* and *Avicennia marina.* In spite of its lower adundance, *Avicennia marina* occupies a significantly higher basal area than all other species. The average basal area summed per plot is 21(±15.3) m^2/hectare, and comparable to mature mangrove forests stands in South America and East Africa.
The change detection study serves as reference for observing the direction and magnitude of change in plant communities susceptible to key impacts of climate change, providing up-to-date information of ecosystem change on which sound management can be based.

Shifting environmental ranges and biome potential according to the Whittaker Relationship.

Rogier de Jong, Michael E. Schaepman, Irene Garonna
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Robert H. Whittaker classified biome types mainly as a function of Mean Annual Temperature (MAT) and Mean Annual Precipitation (MAP), resulting in the well-known Whittaker plot that has commonly been used for mapping purposes. The same inputs (MAT and MAP), augmented with a radiation proxy, are used in the resource-balance perspective for modeling large-scale vegetation productivity as a function of abiotic factors. These two approaches, used in a temporally dynamic manner, provide indicators of shifts in growth-limiting factors and associated environmental ranges of vegetation, which, in turn, are key indicators for the study of global change and biodiversity.
We present a study in which we used the Whittaker relationship and CRU TS 3.22 climatic data to map regions that showed variable biome potential. These regions are likely to indicate biome transition zones that have been subject to abiotic change and where a change in the vegetation system can be anticipated. At the same time, we used remotely sensed data (NDVI 1982-2012) to study gradients in vegetation dynamics in these zones. Preliminary results show strongest losses in biome potential in (arctic) desert and tundra and with associated gain for taiga, shrublands and tropical seasonal forest. The poster presents the spatial velocities and distribution of these shifts.

Free Prior Informed Consent (FPIC) in the Convention on Biological Diversity (CBD).

Anna Deplazes and Peter Schaber
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FPIC (Free Prior Informed Consent) stands for a principle that takes into account the views, interests and rights of indigenous peoples. The principle requires that these peoples must give their consent to projects that directly affect them. The Convention on Biological Diversity (CBD) too, refers to this principle as PIC in its discussion on fair and equitable sharing of benefits arising from the utilization of genetic resources. PIC has been elaborated in the Nagoya Protocol (NP), which usually discusses it in one breath with MAT (mutually agreed terms). PIC seems to be the more general principle warranting that information is provided and consent obtained, whereas MAT concern conditions of access to genetic resources and the type of benefits that users share with providers. As international treaties, the CBD and NP primarily address biodiversity-rich *states* as providers of genetic resources. But in addition, they explicitly mention that PIC and MAT must also be obtained by affected *indigenous and local communities*. The inclusion of PIC and MAT in the CBD and NP is generally considered to be an important step in taking rights of indigenous and local communities into account. We argue that to do real justice to these communities, the CBD should not only discuss FPIC in the context of access and benefit-sharing but also concerning the other two objectives of the CBD. These objectives are 1) the conservation of biological diversity and 2) the sustainable use of its components. In other documents, the need for implementing FPIC in environmental protection programmes has been recognized (REDD+, FSC). To discuss this also as a part of the CBD is crucial in our view. On the one hand, it would enlarge the circle of communities considered by the CBD and thus increase fair recognition of indigenous and local interests and rights. On the other hand, it may help to correct the problematic idea that justice towards minority communities in biodiversity-rich areas necessarily implies granting them rights to benefits from any genetic resources growing on their territory.

Assessing uncertainty in global change –biodiversity research using multi-scale Bayesian modeling.

Reinhard Furrer, Gabriela Schaepman-Strub, Florian Gerber, Gian Marco Palamara
URPP GCB, University of Zurich; Zurich, Switzerland.

This project aims to improve the understanding of environment–ecosystem relations by linking climate and other abiotic variables with biodiversity. In the project we develop suitable Bayesian hierarchical models (BHMs) in a spatio–temporal framework.
As a first product of the project, Florian Gerber has implemented a space-time gap-filler for NDVI MODIS products, allowing to exploit all types of dependencies in the data. The algorithm performs significantly better in validation settings compared to approaches used in practice when filling large gaps in remote sensing data sets.
Currently our activities are: (i) melding Arctic biodiversity plot level data with the NDVI (a remotely sensed proxy for vegetation activity) and landscape heterogeneity; and (ii) summarizing and integrating statistical methods for scaling biodiversity indices and ecological processes. More information can be found on these posters.
The group also manages the statistical consulting service which is open to all members of the URPP. This statistical assistance amplifies and strengthens the collaboration and mutual exchange of information between all projects.

Predicting effects of multiple environmental changes on community respiration: some complexity… but not too much.

Aurélie Garnier and Owen L. Petchey
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Predicting the future is a challenge for ecologists, especially in the context of global change, when multiple environmental drivers occur simultaneously. Limited evidence suggests that interactions between two or three drivers are important, affecting all ecological levels of organization. But what happens when the number of perturbations increases?
Using a microbial aquatic ecosystem with algae, bacteria, ciliates and rotifers, we examined interactions among four environmental changes: temperature, inorganic nutrient supply (Nitrogen:Phosphorus ratio), carbon enrichment (Protozoan Pellet) and light availability (using shade cloth), in a fully factorial design. First, we observed responses of dissolved oxygen concentration at short (resistance), medium (resilience), and long (return time) temporal scales. And second, we tested three hypotheses about how multiple environmental changes combine (dominant, additive and interactive), and compared the predictions to the observations to assess the predictability of their effects.
Our results were consistent with three general ecological observations: 1) large effects of one dominant environmental change (Vinebrooke *et al.*, 2004), here the carbon enrichment; 2) predictability is lower with increasing the temporal scales of response, probably due to feedbacks observed through the increase in the variability within replicates for the return time; and 3) the resistance and the time to recover increases with the number of perturbations occurring (Niemi *et al.*, 1990).
With our study, we highlighted the necessity of including the interactions between only two environmental changes (independently of their statistical significance) to improve the predictability of short and long-term responses when multiple environmental changes occurring simultaneously.

Disentangling the relative importance of climatic growth constraints on land surface phenology.

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Land Surface Phenology (LSP) is a key indicator of the response of terrestrial ecosystems to global change. Satellite observations have revealed inter-annual variability and trends in global LSP over the past three decades. Identifying the relative importance of climatic growth constraints on LSP is crucial both for understanding past changes in large-scale canopy greenness and for building a predictive framework for phenology.
Analyzing a phenology reanalysis dataset in combination with a remotely sensed Leaf Area Index (LAI) product, we examined three climatic constraints to canopy greenness at the Start- and End- Of the growing Season (SOS and EOS, respectively) over the last three decades. Specifically, we quantified the relative importance of photoperiod, evaporative demand and minimum temperature constraints at SOS and EOS globally and considered their evolution over the 1982-2010 period.
We found significant shifts in the relative importance of climatic constraints in the temperate and boreal biomes, ranging from 1 to 8% during the study period. Results reveal a widespread decrease in the relative importance of minimum temperature at both SOS and EOS over both biomes, resulting in spatially heterogeneous shifts towards moisture and photoperiod constraints. Our findings reveal an increasing influence of the moisture constraint on LSP in most environmental zones, with the strongest increases for EOS and over temperate zones. We discuss key differences in climatic constraints acting at SOS and EOS, which highlight the need for improving the representation of phenology in terrestrial biosphere models.

Linking Arctic plant biodiversity measurements with landscape heterogeneity.

Florian Gerber, Reinhard Furrer, Gabriela Schaepman-Strub
URPP GCB, University of Zurich; Zurich, Switzerland.

Climate warming in the Arctic region triggers changes in the vegetation productivity and species composition of the tundra. To investigate these changes and their feedback to climate, we consider species richness and abundance data of the International Tundra EXperiment (ITEX). As this information is very sparse in time and space, we aim to upscale available records to climatically relevant scales with a remote sensing based characterization of the study sites. More precisely, we relate species richness and evenness derived from the ITEX data to summary statistics describing the landscape heterogeneity, which are derived from an elevation model (ASTER GDEM) and spectral satellite observations (LANDSAT 5 and 7). Preliminary results from the statistical analysis using generalized linear mixed models show that no remote sensing based landscape characterization does significantly explain species richness. Reasons could be a mismatch of the spatial scales, an inappropriate characterization of the test sites through the satellite measurements, incomparable plot measurements from the different test sites and/or too few plot measurements. We are looking forward to presenting our results and getting your inputs.

Phylogenetic structure of remotely sensed functional diversity of a temperate forest.

Carla Guillén-Escribà, Fabian D. Schneider, Andy Tedder, Felix Morsdorf, Eri Yamasaki, Kentaro K. Shimizu, Bernhard Schmid, Michael E. Schaepman
URPP GCB, University of Zurich; Zurich, Switzerland.

Functional diversity of traits (FD) has become one of the most commonly used metrics for the assessment of biodiversity in vegetal communities under global environmental change conditions. Different studies have found evidence of a relationship among the FD of a community, its phylogenetic composition (PD) and functioning. Understanding these interactions requires detailed observations but in-situ approaches are usually spatially constrained, thus exhibiting limited possibilities to be extrapolated to larger scales. With the advent of emerging remote sensing methods for functional traits mapping at local to global scales, the gap of missing trait distribution at larger scales is to be filled. We propose to contribute to filling this gap at the regional scale by using remote sensing data in combination with in-situ sampling at different spatial scales.
Here, we investigate the relevance of remotely sensed local interspecific functional variation of a temperate forest to differentiate vegetation types and species at distant and close phylogenetic distances. Phylogeny of the species was constructed using DNA barcode data. Biochemical and architectural plant traits were retrieved by using canopy spectra and point clouds from airborne imaging spectroscopy (AIS) and laser scanning (ALS) data, respectively. Additionally, trait responses along environmental gradients were detected at intraspecific level to attribute sources of functional diversity within species.
Results show the potential of the simultaneous use of three AIS derived biochemical traits (trait clustering of chlorophyll, carotenoid and leaf water relative content) for vegetation-type classification. Conifers such as *Abies alba* present higher values of leaf water than deciduous trees, which exhibit higher pigment contents. Analyses of inter- and intraspecific variation of different architectural traits as derived by ALS indicate that the *fraction of single echoes* within a tree crown could be one of the architectural traits performing better for vegetation-type classification. Furthermore, seasonal difference of *maximum height (leaf-on/leaf-off)* could be a good predictor for species.

Plants selected in low- and high-diversity communities show variation in response to co-evolved arbuscular mycorrhizal fungi.

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Changes in plant species composition due to biodiversity loss can alter how species compete with one another. For instance, recent research has shown that long-term maintenance of low- and high-diversity plant communities leads to the selection of plants specifically adapted to the corresponding plant diversity. The selection for different types in differing diversity environments is presumed to have occurred by the sorting out of genotypes from a large initial standing variation. Although negative soil feedbacks have been shown to incur pathogen-induced selection pressure in plant monocultures, the potentially counteracting role of symbiosis between plants and arbuscular mycorrhizal fungi (AMF) is not well known. We investigated the growth responses of low- and high-diversity adapted plants to different AMF communities using progeny of eight grassland plant species that had undergone 12 years of selection in either monocultures (monoculture types) or mixtures (mixture types) in the Jena Experiment. We grew the plants in a glasshouse on sterile soil that we inoculated with (1) AMF extracted from the corresponding plant monocultures or (2) mixtures, (3) an externally produced ubiquitous AMF, *Rhizoglomus irregulare*, or (4) no AMF. We found that AMF communities from plant mixtures were on average more beneficial to plant biomass production than AMF communities from plant monocultures. Moreover, mixture-type plants, in contrast to monoculture-type plants, were on average more dependent on the AMF extracted from the field site of the Jena Experiment. However, the dependency on generalist AMF *R. irregulare* did not differ between mixture and monoculture types. These results suggest that co-evolution of AMF and host plant results in more beneficial mutualism in diverse plant communities in comparison with monocultures. This may affect the competitive ability of host plants in diverse plant communities and demonstrates that changes in species composition may have cascading selection pressure on associated trophic groups of species.

Aldabra Atoll, Seychelles.

Dennis Hansen
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Aldabra Atoll, Seychelles, is a UNESCO World Heritage Site and the world's second-largest raised coral atoll, measuring 34×12 km with a land area of 155.4 km^2. The climate is subtropical with annual mean temperatures of 24–28°C and distinct wet and dry seasons (mean annual rainfall: 950mm). Aldabra is the only oceanic island test site, thus bringing a relatively simple, tractable ecosystem to the table. With an average height of only 4–8 m.a.s.l., and with declining rainfall, Aldabra is at the very frontline of global change. Its ecosystem is dominated by the presence of more than 100,000 giant tortoises, the world's largest surviving population. The main research focus on Aldabra is the interplay between giant tortoises, vegetation, and climate.

Change in drought regime on Aldabra Atoll and impacts on important tortoise resources.

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Project 1 of the URPP aims to investigate how biodiversity change affects and is affected by vegetation-climate interactions. The Aldabra Atoll is a UNESCO World Heritage Site managed by the Seychelles Islands Foundation and has the largest population of giant tortoises (*Aldabrachelys gigantea*) remaining in the world, at about 100,000. As such an important biological resource, it is important to monitor how climate change is affecting their habitat. Using monthly rainfall data collected from 1969-2013, we calculated the Standardized Precipitation Index (SPI) to identify droughts over this time period. While previous research found that yearly rainfall has decreased during this time, we found that the frequency of SPI-defined drought on Aldabra is increasing. To understand how increased drought frequency may influence tortoise habitat, we used MODIS Normalized Difference Vegetation Index (NDVI) as a proxy for vegetation activity to investigate vegetation response during the varying drought/non-drought periods from 2000-2013. Using Z-scores, we looked at variation of the mean monthly NDVI and compared this data to the droughts during this same period. Across all of Aldabra, we found that mean Z-scores decreased from the mean during most drought periods, and increased above the mean during most non-drought periods, suggesting that vegetation is highly responsive to rainfall. Using a previously derived habitat map, we extracted Z-score pixels for several vegetation types on Aldabra (mangrove forests, open mixed scrub and grasslands, and pemphis scrub) to investigate how they responded during these times. We found that, overall, open mixed scrub and grasslands had the lowest Z-scores during drought periods, and the highest during non-drought periods, followed by pemphis scrub and mangroves. Increasing drought frequency could thus impact tortoises by frequently decreasing main food (open mixed scrub and grasslands) or shade resources throughout the year, which may influence tortoise feeding strategy, individual movement, tortoise distribution, and population dynamics.

Whose natural capital, whose services, who benefits?

Katie Horgan
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Natural capital is located locally but services flow regionally, nationally and internationally to multiple beneficiaries. The very specific perceptions of international researchers about what these benefits might be both complement and contrast with local expert opinion. We conducted qualitative interviews with international researchers and local experts working on a number of research sites across the globe. These interviews highlight the key ecosystem services at the research sites and the wider ecosystem, elucidate who the beneficiaries of these services are and highlight potential impacts of future climate change.
This poster illustrates the different perceptions of researchers and local experts, the locations of beneficiaries of ecosystem services and potential threats to the system and consequently to societies.

Tundra shrubs: risky investors in the nutrient market under climate change.

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Temperature is increasing and will keep rising in the Arctic as a consequence of global change. Climate warming is suggested as the main driver of the observed arctic shrub expansion, although nutrient enhancement might also be an important contribution to this expansion. Nutrient enhancement is expected through processes such as nitrogen mobilization and deposition. The resulting shrubification may have consequences on biodiversity and climate, especially through feedbacks with the radiation budget, such as decrease in the albedo. A better understanding of shrub expansion mechanisms, including growth rate patterns, plant trait variation and trade-off shifts, and their sensitivity to climate is needed in order to quantify related feedbacks. Here, we present results of a warming and fertilization experiment. We hypothesize that shrubs will grow faster, become more productive and less conservative in their nutrient strategies under climate change. To test our hypotheses, we sampled six individuals of four shrub species from thirty experimental plots and measured several leaf and plant traits related to growth and biomass production. Our results show that shrubs grew faster, producing more biomass mainly with fertilization, while the effect of soil warming was not significant. Shrubs also changed their resource acquisition strategy from a conservative towards a rapid acquisition, following the leaf economics spectrum. Individuals under fertilization treatment had thinner leaves with less dry matter content and smaller carbon to nitrogen ratio, but with a larger surface and higher leaf nutrient content. All these changes in growth, biomass production and traits might affect the radiation budget, through changes in the absorptance, reflectance and transmittance of the shortwave radiation by leaves and branches, and reduce the species diversity due to light and resource competition. In turn, these vegetation-vegetation and vegetation-radiation interactions are expected to generate important feedback to climate change.

Vegetation type influences the radiation budget and soil heat flux in the Arctic tundra – measurements and modelling across scales.

Inge Juszak[1], Maitane Iturrate-Garcia[1], Jean-Philippe Gastellu-Etchegorry, Michael E. Schaepman[1], Gabriela Schaepman-Strub[1]
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Vegetation is an important control on the exchange of water, carbon, and energy between the atmosphere and permafrost soil in the Arctic. While solar radiation is one of the primary energy sources for warming and thawing permafrost, the amount of shortwave radiation reaching the soil is reduced by vegetation shading. Climate change has led to greening, species compositional changes, and shrubification in many Arctic tundra regions and further changes are anticipated. These vegetation changes feed back to the atmosphere as they modify the surface energy budget. However, canopy transmittance of solar radiation has rarely been measured or modelled for a variety of tundra vegetation types. We assessed the radiation budget of dominant vegetation types at the Kytalyk field site in North-East Siberia (70.8 N, 147.5 E) with field measurements and 3D radiative transfer modelling and linked it to soil heat fluxes. Our results show that Arctic tundra vegetation types differ in canopy albedo and transmittance, as well as in soil heat flux and active layer thickness. Tussock sedges transmitted on average 56% of the incoming light and dwarf shrubs 27%. For wet sedges we found that the litter layer was very important as it reduced the average transmittance to only 6%. We found that permafrost thaw was more strongly related to soil properties than to canopy shading. The parameterized 3D radiative transfer model (DART) allows quantifying effects of the vegetation layer on the surface radiation budget in permafrost areas. The model can account for diverse vegetation types and variation of properties within types. Model output indicated that both, albedo and transmittance, also depend on the spatial aggregation of vegetation types. Our results highlight small scale radiation budget and permafrost thaw variability which are indicated and partly caused by vegetation. As changes in species composition and an increase in biomass can influence thaw rates, small scale patterns should be considered in assessments of climate-vegetation-permafrost feedbacks.

To fish or not to fish?: vulnerability of fishing communities of Arctic Siberia to environmental change and socio-political transformations.

Stanislav Ksenofontov, Norman Backhaus, Gabriela Schaepman-Strub
URPP GCB, University of Zurich; Zurich, Switzerland.

One of the crucial natural resources for the Arctic indigenous communities of Siberia is fish. Fish is important not only as food, but also as a cash income. Moreover, fish plays an important role in the social fabric of the local people. However, recent climate change in the Arctic has challenged fishing activities (ACIA, 2005). In addition, the livelihoods of Arctic communities are affected by other factors such as changing fishing and hunting regulations, depopulation, and challenges of living in a remote area.

This study assesses the vulnerability context of these communities. We hypothesize that climate change related trends (such as increasing temperature and altered seasonality), and shocks, such as the breakdown of the Soviet Union or new fishing regulations, increase Arctic peoples' vulnerability and compromise the sustainability of their livelihoods.

This research is based on interviews performed in four Arctic settlements in North Eastern Siberia in the Russian Republic Sakha (Yakutia), where Eveny and Evenki - both part of the Tungus ethnic group - and Yakuts (Turkic ethnicity) live. 34 qualitative in-depth interviews with officials, experts as well as local people were performed in 2014 and a quantitative standardized questionnaire with 204 dwellers was carried out in 2015.

The research shows that over the last decades local people observe changes in weather patterns: warmer winters, colder summers, and an increasing unpredictability of the weather. They also reported about early arrivals of spring, which causes earlier river break ups. Moreover, some community members observed a late freeze up of ice, and this hinders winter fishing. Participants of the interviews reported a significant decrease of caught fish. Members of all communities stated that river levels had essentially increased and thus were a reason of fish numbers to decline. Fishing regulations introduced after the USSR collapse confronted the fisherpeople with quotas and temporal limitations. Most of the local people stated that regulations and policies hinder their fishing activities. While traditional adaptation of fishing techniques to seasonally changing conditions might increase adaptation potential to future conditions under climate change, fishing regulations appear to limit the adaptation potential.

Monitoring functional traits of Alpine vegetation on the Qinghai-Tibet Plateau using multi-sensor remote sensing.

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Plant functional traits can be used to study the interactions between plants and ecosystem functioning as well as the response of plants to various environmental pressures. Continuous monitoring of plant functional traits dynamics on a large spatial scale is important to understand the mechanisms of ecosystem function degradation, especially on the Qinghai-Tibet Plateau. In this study, we investigated spatiotemporal trends of functional traits (i.e., chlorophyll content (Chl), leaf area index (LAI) as a proxy of leaf size, aboveground biomass as a proxy of leaf mass) in the eastern part of the Qinghai-Tibet Plateau based on the combined analysis of multi-sensor satellite data and field observations at three spatial scales (ground-truth data at 1 m, Landsat at 30 m, MODIS at 500 m). Then we explore how the climatic and soil variables control trait variations over space and time. The preliminary results show that Chl, LAI and biomass has positive linear trend in 15 years (2001-2015). Precipitation, soil PH and temperature explain 75% of Chl variation. Chl of wide ranging species community have more correlation with climatic variables than those of narrow-ranging species community.

Tibetan Plateau, Haibei.

Chengxiu Li and Bernhard Schmid
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The Tibetan Plateau covers an area of approximately 2.5×106 km2 with a diverse terrain and average elevation of more than 4'000 m a.s.l. It is characterized by complex interactions of atmospheric, cryospheric, hydrological, geological and environmental processes that bear special significance for the earth's biodiversity, climate and water cycles. These processes are critical for the well-being of the people inhabiting the plateau and the surrounding regions. The ecosystem on the Tibetan Plateau is considered to be particularly vulnerable and sensitive to all relevant global change drivers, among which land use change, climate change. Ecosystem degradation over many years has been mainly manifested in a decrease of vegetation cover and a shrinkage of alpine meadows, leading to adverse impacts on ecosystem function, reflected in losses in both primary productivity and species diversity[4].
The national field observation station, "Haibei Alpine Meadow Ecosystem Research Station" (Haibei Station, 37.48N, 101.21E), is located in the Eastern part of the Tibet Plateau. UZH and the North-West Institute of Plateau Biology of the Chinese Academy of Sciences have signed a Memorandum of Understanding for collaboration, facilitating work at the Haibei field site.
In order to understand the mechanisms of ecosystem function degradation, we are interested in how global change drivers control plant functional traits variation over space and time. To test the consequences of species loss under warming environmental conditions, we experimentally assembled plant communities differing in biodiversity with plant populations from different elevations. In addition, we also look at how these may impact human well-being. Through qualitative interviews with researchers and local experts, we are assessing the ecosystem services of the Tibetan Plateau. Our key aim is to have an understanding of who benefits and how from the Tibetan Plateau ecosystem. We can then gain some insights into how these benefits, and therefore populations, might be affected by global change.

The Laegeren forest - an experimental super-site within easy reach.

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The Laegeren site is located at N47º28‘49‘‘ and E8º21‘05‘‘ at 682 m a.s.l. on the southern slope of Laegeren mountain, approximately 15 km northwest of Zurich.
The south slope of the Laegeren marks the boundary of the Swiss Plateau, which is bordered by the Jura and the Alps. The western part is dominated by broad-leaved trees, mainly beech (*Fagus sylvatica L.*) and ash (*Fraxinus excelsior L.*). In the east beech and Norway spruce (*Picea abies L.*) Karst.) are the dominant species. The forest has a relatively high diversity of species, with varied age and diameter and the ground cover consists of bare soil, boulders, and litter while the existing understory is characterized by dense herb and shrub cover. Average canopy height is 24.9 m, with a maximum of 49 m, and average stem density is 270 per ha. A core site of 300 m by 300 m has been subject to intensive ground measurement campaigns. Since 1986, the Laegeren site has been a permanent station of the Swiss air quality-monitoring network, NABEL with a 45 m tall flux tower providing micrometeorological data at a high temporal resolution. Routine CO^2 and H_2O flux measurements as a contribution to the FLUXNET/CarboEuropeIP network began in April 2004. The intensive field campaigns started in 2010, including single-tree forest inventory, spectror-adiometric measurement and terrestrial laser scanning. In 2012, the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL) established a long-term ecosystem monitoring site (LWF) close to the flux tower, providing field-based yearly updates of all relevant ecosystem parameters. The URPP added a phenocam to the tower instrumentation in 2015. Within the URPP, the Laegeren is being used as a core test site for calibration, validation and prototyping of remote sensing methods, data and products. Remote sensing data acquired includes laser scanning and imaging spectroscopy data, and ranges from 5 cm to 300 m in spatial resolution. The multi-temporal aspect is covered by annual and seasonal APEX surveys. Together with the field data, an excellent experimental setup for cross-, down- and upscaling is provided. A radiative transfer model based toolbox to facilitate such activities is also available. Through its unique setting conveniently close to the Zurich campuses, the Laegeren site joins the activities of a diverse set of research groups and continues to trigger transdisciplinary research with its extensive datasets and modelling tools.

Applying an ecosystem services approach to support environmental policy-making: a case study in the Canton of Zurich.

Ivan Nikitin
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The understanding of how ecosystems function, provide goods and services, and how they change alongside what allows and limits their performance can add to the understanding of ecosystem change and governance in general in an ever more human-dominated world. The ecosystem approach provides an anthropocentric, ecosystem-focused framework describing the ecological and human costs and benefits of our choices about land and aquatic management. Land use/land cover change (changes in the extent and composition of forests, grasslands, wetlands and other ecosystems) has a large impact on the provision of ecosystem services and biodiversity. The history of land use decisions and their impacts in the Canton of Zurich points to the need to manage systems in ways that recognize their natural constraints and vulnerabilities, as well as the need to create future economies that foster sustainable use of ecosystem services along with the promotion of human well-being. This research bridges the knowledge gap between land use, land cover change and the provision of ecosystem services in the Canton of Zurich and schemes for environmental protection, urban governance and planning. The overall purpose is to improve the understanding of links between human actions, their impact on ecosystems and the services they provide and, ultimately, any consequences for human well-being. The 'Integrated Management of Environmental Assets' (IMEA) suggested by Voora and Venema (2008) shapes the main conceptual reference and defines the phases of the research:
(1) Analysis of the past land use and land cover change and the related drivers. (2) Mapping, assessment and valuation of the ecosystem services provided in the Canton of Zurich and exploration of their impact on human well-being. (3) Identification of bio-physical drivers for environmental policy-making. (4) Analysis of future land use/cover change scenarios (WSL study) and its impact on the provision of ES and human well-being. (5) Identification of socio-political drivers and their impact on environmental policy-making. (6) Formulation of options for sustainable environmental policy-making.
This research contributes to sustainable land-use practices dependent on the consideration, and protection of ecosystems and their services. The results will help to maintain the resilience of ecosystems in the Canton of Zurich, and could be a basis for the upcoming formulation of options for environmental policy-making. Although there is limited empirical research on how biodiversity and ecosystem functioning in urban areas (like the Canton of Zurich) relate to the production of ecosystem services, biodiversity is generally considered fundamental to their generation. In this sense this research contributes to the protection and conservation of biodiversity as an essential component of efforts to maintain ecosystem services.

Biodiversity-productivity relationships in a subtropical forest: the BEF-China experimental platform.

Pascal A. Niklaus[1], Martin Baruffol[1], Nadia Castro, Yuanyuan Huang, Bernhard Schmid[1]
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A Sino-German-Swiss research consortium investigates effects of tree species diversity on ecosystem functioning in a Chinese subtropical forest. The BEF-China research platform was established in 2008 and consists of two main experiments that complement each other. First, effects of tree species richness are assessed in permanent comparative study plots (CSP) established in a subtropical forest located in a nature reserve. The local forest is highly diverse, with a reported 1462 seed plant species belonging to 684 genera and 149 families, and over 250 tree species present. In these plots, both stem basal area and growth were found to increase with tree species numbers. Second, effects of tree species diversity are studied in experimental plots in which tree species composition was manipulated systematically in a total of 566 plots each with 400 trees. These plots cover a species richness gradient from 1 to 24 tree species that simulate a range of extinction scenarios. The data available to date indicate progressively increasing effects of tree species richness on tree biomass and growth, supporting the hypothesis that these effects are at least in part mediated by negative, density-dependent effects of insects and foliar pathogens.

The role of diversity in real-world ecosystem functioning: insights from investigations at the landscape scale.

Jacqueline Oehri, Gabriela Schaepman-Strub, Pascal Niklaus
URPP GCB, University of Zurich; Zurich, Switzerland.

Biodiversity-ecosystem functioning (B-EF) research has been dominated by studies at relatively small spatial and short temporal scales, and by experiments in artificially established plant or animal communities. However, real-world ecosystem functioning is also driven by processes at larger spatial scales (e.g. landscape) and it remains unclear to what extent these large-scale mechanisms modify B-EF-relationships. To fill this knowledge gap, we tested the effects of species and landscape-element diversity on ecosystem functioning at the landscape scale using a comparative study design across Switzerland (Central Europe). Species diversity measures were derived from a national biodiversity monitoring program that provided species inventories for vascular plants, butterflies and breeding birds for 520 plots 1-km² in size. Landscape-element diversity measures were derived from land cover point data provided by the Federal Statistical Office. Ecosystem functioning indices were derived from remote-sensing data (MODIS EVI) and included vegetation activity and land surface phenology, including growing season length. All data cover at least a decade, and we were therefore able to test for effects on the stability of these indices.

Our results show that the diversity of landscape elements (including Shannon's diversity, patch richness and edge density of land cover) is positively related to total and individual species diversity of plants, butterflies and birds in Swiss landscapes. The effect of plants and birds was stronger than that of butterflies, which seem to be related to altitude effects. Furthermore, landscape-scale diversity appears to be a significant driver of land surface phenology. Landscape-element, as well as plant species diversity, appeared to significantly prolong the vegetation growing season length, mainly by a delaying the end of season but also to some extent by promoting an earlier start to the season. Furthermore, average vegetation activity (approximated by average integrated EVI during the growing season) and the stability of vegetation activity (expressed as 1/CV over the 2000-2015 period) was significantly enhanced by both landscape-element and plant species diversity whereas the results for resistance of vegetation activity to drought conditions in the years 2003, 2004, 2014 and 2015 were mixed.

Overall, our results demonstrate that diversity effects on real-world ecosystem functioning and stability at the landscape scale are significant and stress the crucial role of landscape-element diversity as an important factor of species diversity and ecosystem functioning.

Extinction rates in an experimental microbial aquatic community.

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We present a highly replicated microcosm experiment involving a 17-species community of protists. Extinction times were measured for each species during 8 weeks with two different environmental treatments: nutrient concentration and temperature. We developed a modelling framework enabling us to detect correlations between extinctions of different species together with the effects of environmental factors on the distribution of extinction times. We found that the topology of trophic and competitive interactions, together with abiotic factors such as temperature, plays a key role in determining extinction trajectories.

Integration of feedbacks among global change drivers, biodiversity and ecosystem variables through meta-analysis.

Maria Alejandra Parreño
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Global change drivers are phenomena such as climate change, habitat change, pollution and over-exploitation, that affect the Earth system and its capacity to sustain life. Biodiversity plays an important role in the maintenance and resilience of ecosystems to global change. While there are numerous studies reporting the effects of these drivers in changes in biodiversity levels and disruption of ecosystem functions, data is reported in heterogeneous ways and remains largely scattered. Moreover, there are synergistic effects of global change drivers for which is necessary to also look at feedbacks and interactions at different scales, as opposed to studying them in isolation.
In this meta-analysis, I show the results of a preliminary study of the feedbacks within 3 variables: land use/land cover change, species richness and net primary productivity. I integrate data on the effects among these variables between the years 2000-2016 in order to report a net effect of one variable in the other, conjointly. Furthermore, I quantify the proportion of the heterogeneity of data available that can be explain with different moderators, most importantly type of ecosystem where the effect was reported and intensity of the effect variables. In all, I highlight global patterns that may be hard to appreciate with non-quantitative, non-integrative reviews.

Predicting effects of temperature on species interactions and community dynamics.

Frank Pennekamp
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Temperature is one of the most influential factors influencing life on earth, affecting organism numbers and traits through space and time. Despite this importance, predicting how increased temperatures will affect the dynamics of populations and communities is still an open challenge in ecology. This is in contrast with the urgent need to inform policy makers how climate change will impact ecological systems. The ecological forecast horizon (EFH) was recently proposed as a tool to study predictability across dimensions such as time and space, but also abiotic conditions such as temperature, or biotic conditions such as trait similarity. The EFH relates the predictive skill of a model (mechanistic or purely data-driven) to a distance, for instance how many years into the future, or how many degrees from the baseline temperature we can predict. We used the EFH to study how population and community dynamics are affected by temperature using a large-scale microcosm experiment. We collected time-series data on the abundance and trait dynamics of six ciliate species over a two-month period. We then fitted generalized additive models to the population dynamics of competing ciliate communities and compared their predictions with dynamics at higher or lower temperatures and with different competitors. Our results give insight how predictability changes across temperature and ecological complexity, and about the transferability of data-driven models in the context of climate change.

Is ecology predictable? Advancing ecological predictability research with experiments and models.

Owen Petchey
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Forecasts of ecological dynamics in changing environments are increasingly important, and are available for a plethora of variables, such as species abundance and distribution, community structure, and ecosystem processes. There is, however, disagreement about whether ecological dynamics are predictable, and therefore whether researching ecological forecasting is worthwhile. Combining of models and experimentation can play a key role in resolving this debate. Initial results suggest a resolution based on recognizing and understanding scaling of ecological predictability, for example with organismal features such as body size, and with level of ecological organization.

Land Degradation Neutrality, the emerging UN-backed paradigm for responsible investments in natural capital.

Simone Quatrini
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Land Degradation Neutrality (LDN) – a concept long advocated by the United Nations Convention to Combat Desertification (UNCCD) – became a priority of the international community last year with its inclusion in the Sustainable Development Goals (SDG) agenda as a specific target to be achieved by 2030.

LDN can be defined as "a state whereby the amount and quality of land resources necessary to support ecosystem functions and services remains stable or increases within specified temporal and spatial scales". In other words, LDN implies that economic development can be decoupled from natural capital depletion. LDN was conceived to encourage a dual-pronged approach to avoid or minimize degradation of land, combined with measures to restore degraded land, such that losses are balanced by gains.

Is LDN achievable? According to the UNCCD, the annual land footprint of the global economy is estimated at 12 million hectares of land. This adds to an accumulated stock of approx. 2 billion hectares of land already degraded. Achieving LDN will require an optimal mix of interventions designed to sustain and improve the stocks of land-based natural capital and the associated flows of ecosystem services.

The transition to LDN will require huge investments. With estimates of land restoration costs ranging from as little as US$ 33 per hectare to as much as several thousand US dollars per hectare, depending on the specific biome and land degradation severity, it is likely that investments will have to reach several billion US dollars each year.

Where will these additional resources come from? With Official Development Assistance (ODA) for combating desertification projected to remain relatively stable, investments by the private sector will be necessary. While this is in line with what the UN Addis Ababa Action Agenda for financing sustainable development calls for, whether or not LDN will succeed in this endeavor remains to be seen.

Recent market analyses suggest that LDN could bring about a real paradigm shift in the mobilization of private capital for sustainable development, provided that sufficient enabling conditions are put in place in the months and years ahead. It is for this reason that the UNCCD is spearheading the creation of an independent LDN Fund, designed as a public-private partnership for blended finance.

The ambition of the LDN Fund is to leverage, after an initial ramp up phase, more than 50% of capital from private responsible/impact investors. This, thanks to a portfolio that will consist of "triple bottom line" projects that will ensure sufficient financial returns, while generating multiple social and environmental benefits, e.g. food security, environmental protection and sustainable use of natural resources.

Global distribution of Pyrogenic Carbon.

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Pyrogenic Carbon (PyC) is ubiquitous in the environment and represents presumably one of the most stable compounds of the total organic carbon. Due to its persistence in the soil, it might play an important role in the global carbon cycle. In order to model future CO2 emissions from soils it is therefore crucial to know where and how much of PyC exists on a global scale.
Until now only rough estimates for global PyC stocks in soils could be made, and little is known about the distribution of such stocks across ecosystems. We propose here a literature analysis of the current data on worldwide PyC concentrations and stocks.
From the literature we extracted PyC values in soils (n = 600) and analyzed the percentage of PyC in the soil organic carbon (SOC) as a function of climate (temperature, precipitation), soil parameters (pH, clay content), fire characteristics (fire frequency and fire regime) and land use. Overall, the average contribution of PyC to SOC was 13 %, ranging from 0.1 % up to 60 %. We observed that the PyC content was significantly higher in soils with high clay content, higher pH, and in cultivated land as compared to forest and grassland. We did not observe any relationships between fire activity, frequency or intensity and PyC % at a global scale. When the on-site fire regime was monitored (in only 12 % of the data we collected), we observed higher PyC concentrations with higher fire frequencies.
We hypothesize that the resolution of global fire datasets is neither temporally nor spatially high enough to explain the soil samples local fire history.
Data points were not homogeneously distributed across the globe but rather aggregated in places such as Central Europe, the Russian Steppe or North America. A global interpolation is therefore not possible.
In summary, we modelled PyC concentrations, based on the five most significant parameters, clay content, pH, mean annual temperature and precipitation and land use. We predicted worldwide PyC using existing global datasets for these five variables. We present a global map of PyC concentrations and stocks. In arid ecosystems, where SOC is generally low, stocks of PyC are also low, even though concentrations may be high. In contrast, stocks are mostly large in temperate and boreal ecosystems, even when concentrations are low because total SOC stocks are high in such ecosystems. Integrating the modelled data, we found a total global stock of about 230 Pg PyC, corresponding to about 10% of the total soil organic carbon stock. This value lies in the range of current estimates of previous studies.

Modeling the effects of optimal foraging herbivores on the maintenance of trichome dimorphism in a wild Arabidopsis population.

Yasuhiro Sato[1,2] and Koichi Ito[3]
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Diverse species of plants and animals possess genetic variation in their defense traits against natural enemies. It is widely recognized that prey species/genotype diversity can be maintained through adaptive foraging by predators, but such a stabilizing role remains insufficiently understood in the field. Based on statistical modeling, here we aimed to test whether optimal foraging by the Brassica leaf beetle, *Phaedon brassicae*, facilitates the maintenance of the trichome-producing (hairy) and glabrous plants of *Arabidopsis halleri* subsp. *gemmifera* (Brassicaceae). We modeled the effects of optimal foraging by herbivores and defense-growth tradeoff for plants on meta-patch dynamics of the two plant morphs, and then evaluated model likelihood to optimize its own parameters to experimental and field data. With the parameters estimated, we analyzed our model to find a mechanism capable of maintaining the trichome dimorphism. By doing so, our study also intended to show a wide applicability of the statistical approach in untangling species interaction under complex field conditions.

Cross-scale quantification of vegetation-atmosphere interactions and biodiversity change.

Gabriela Schaepman-Strub[1], Pascal Niklaus[1], Maitane Iturrate-Garcia[1], Inge Juszak[1], Jacqueline Oehri[1], Paul Haverkamp[1], Marvin Buergi, Annabelle Constance, Rachel Simeon
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The prediction of consequences of global change requires detailed knowledge about interactions and feedbacks of global change drivers and biodiversity. Through Project 1, we aim to increase the understanding of the influence of biodiversity and global change on carbon and energy budget components of the Earth system, from plot to landscape scale. We therefore include biodiversity as a potential driver of global change. We study the effects of these drivers on ecosystem functions through a combination of observational, experimental, and 3D modelling approaches, with a focus on shortwave radiation interaction in high latitudes and temperate ecosystems.
The research questions addressed by Project 1, illustrated on separate posters, include the following:
1. Is there a relation between biodiversity and stability of vegetation activity, as well as shortwave radiation, from plot to landscape scale?
2. What is the species diversity at the tundra site and how is it related to edaphic variables and soil carbon?
3. How do shrub traits change with soil warming and increased nutrient availability in the Arctic? How might these changes affect shortwave radiation fluxes?
4. Do tundra species diversity and community type influence shortwave radiation fluxes relevant to the surface energy budget, permafrost thaw, and carbon cycle?
During phase II of the URPP GCB program we will extend our activities from mainly observational towards increased experimental biodiversity research. We will manipulate plant functional type richness, in combination with global change drivers in the Arctic tundra. To increase our understanding of the effect of biodiversity on the water and energy cycle, we will add sensible and latent heat fluxes in the plot to landscape scale analysis in forest ecosystems and grasslands.
This poster provides an overview of the research questions addressed in Project 1, and how they are linked. Furthermore, it introduces researchers involved in the project, from MSc to PhD students and PIs, and collaborations with other projects.

Kytalyk – a unique test site in the Siberian Arctic to study interactions and feedbacks of global change, biodiversity, and ecosystem functioning.

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The year 2015 was the warmest on record, with pronounced amplification of climate warming in the Arctic. Climate warming, but also other global change drivers, are expected to alter species, structural, and functional diversity in the tundra ecosystem, with related feedbacks to the permafrost and atmospheric warming.
One of the URPP GCB test sites is located in the Kytalyk nature reserve (70.82N, 147.47E), in the Indigirka river's lowlands, NE Siberia, Russia. This research site is unique as it is practically the only one representing vast lowland tundra ecosystems in NE Siberia, as well as through its vegetation heterogeneity. Within a distance of 50km, four tundra vegetation types and the tundra-taiga boundary are occurring according to the Circumpolar Arctic Vegetation Map (CAVM). Over the last 4 years, the URPP GCB has made substantial investments in this site to provide its researchers with a suitable infrastructure to perform research on the tundra ecosystem under current and future conditions.
This poster provides an overview of the characteristics of the research site, the vegetation composition and species richness at the landscape and plot scale, as assessed in Project 1. Furthermore, we present recent improvements to the research and housing infrastructure, including a phenological camera, high-resolution orthomosaics obtained from a UAV, permanent biodiversity monitoring plots, a solar panel system, and an Arctic tent.
The aim of the poster is to open the discussion for future projects on the soil, plant, and water systems of the site, and attract additional teams to the Kytalyk site during phase II of the URPP GCB.

Remotely sensing functional richness of a temperate forest using airborne laser scanning and imaging spectroscopy.

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Functional richness of forests is an important aspect of biodiversity. It is determined by the spatial distribution of functional traits, which is driven by community assembly processes and structure. Measuring functional traits in forests in a continuous and consistent way is particularly difficult due to the complexity of in-situ measurements and geo-referencing. Using remote sensing, we can overcome these limitations for certain traits. Airborne laser scanning (ALS) and airborne imaging spectroscopy (AIS) proved suitable to derive morphological and physiological forest traits in various environments, from boreal to temperate and tropical forest ecosystems.
In a temperate mixed forest, we derived morphological traits - namely canopy height, density and layering - using ALS and physiological traits - namely chlorophyll, carotenoid and leaf water content - using AIS methods. Based on the spatial distribution of traits, we calculated functional richness at a range of scales and analyzed richness patterns as well as richness-area relationships.
We found higher functional richness on southern slopes of the forest. This is mainly driven by the occurrence of disturbance areas and the mixture of deciduous broadleaf and evergreen coniferous trees. On northern slopes, the dominance of beech trees and the absence of disturbance lead to lower morphological as well as physiological richness. Richness-area relationships show that underdispersion due to environmental filtering is the main process driving community assembly. These findings indicate that changing environmental conditions could alter the distribution of species and traits, potentially leading to increased functional richness under certain disturbance events.

Functional genetic variation in populations of the wild tobacco *Nicotiana attenuata* alters neighbor phenotypes and determines ecological community structure.

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The wild tobacco *Nicotiana attenuata* has been developed as an ecological model organism, providing a window onto plant-environment interactions in a semi-arid desert habitat. *N. attenuata* seeds germinate in near-monocultures in post-fire and disturbed areas and chase a seasonally sinking water table, conditions which are in many ways similar to those in agricultural fields or projected to occur in these environments under climate change scenarios. Post-fire *N. attenuata* populations are genetically and phenotypically highly diverse. The Department of Molecular Ecology has developed a set of hundreds of transgenic lines of *N. attenuata* each modified in the expression of one or a few functional genes, and is currently developing recombinant inbred line (RIL) populations for forward genetics. These transgenic and recombinant lines can be used to quantify the extent, and ecological consequences of, intraspecific natural diversity in this pioneering post-fire plant. The iDiv project group uses this natural model system and its tools to investigate emergent properties of variation in plant traits controlled by single functional genes. We hypothesize that variation within plant populations in traits controlled by single genes can result in emergent properties feeding back on plant productivity and reproductive success, by altering interactions with plants' abiotic and biotic environment in a manner dependent on trait frequency. We are investigating whether single-gene functional diversity might result in higher productivity or greater resilience for species monocultures under different environmental conditions, thus delivering some of the ecosystem services known to be supported by species-level biodiversity.

Genomic and transcriptomic studies reveal that drought is a key environmental factor for diversification and flowering in a tropical tree family, Dipterocarpaceae.

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The Intergovernmental Panel on Climate Change (IPCC) 2010 projected that the frequency of drought in tropical regions will increase in the future. These regions are expected to experience warmer and drier conditions. However, the role of drought on tropical resources still remains to be elucidated. In this project, we studied the importance of drought on the tropical tree family Dipterocarpaceae using genomic and transcriptomic approaches.
We previously conducted RNA-seq analysis of *Shorea beccariana* and showed that general flowering in 2009 was preceded by the upregulation of drought response genes. To further understand the genetic basis of dipterocarp ecology, we assembled the genome of *Shorea leprosula*, which is one of the most widely distributed dipterocarp species in Southeast Asia (Malay Peninsula, Borneo Island and Sumatra). We achieved a high quality assembly (scaffold N50 > 2 MB) enough for resequencing and synteny analysis by sequencing 3 paired-end and 11 mate-pair libraries. The genome showed the signatures of ancient genome duplication. Importantly, gene ontology enrichment analysis showed that duplicated genes relevant for drought responses were preferentially retained, suggesting adaptive significance of drought response.
Although the amount of rainfall is relatively high in Southeast Asian tropical forests, compared to other regions in the world, our data suggest that drought can be an important environmental factor for plants' survival and reproduction. Because the frequency of drought is projected to increase in the tropical regions (IPCC 2010), higher rate of mortality on trees and changes in flowering patterns might be expected. By integrating our findings, we hope to achieve a better understanding on the effects of drought for dipterocarps in the Southeast Asian tropical rainforests.

Epigenetic and genetic factors drive rapid evolution in grassland communities.

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In grassland biodiversity experiments the positive biodiversity–ecosystem functioning relationship generally increases over time. The mechanisms underlying this observation however are unclear. Recent research has shown that within one species, differential selection in monoculture and mixed-species communities can lead to the rapid emergence of monoculture and mixture types. We hypothesize that in large biodiversity experiments pre-adapted genotypes or epigenetic variants could be selected from the standing genetic or epigenetic variation by a sorting-out process.
We used nine plant species selected for 12 years in such a biodiversity experiment to test whether selection for monoculture and mixture types was at an epigenetic and/or genetic level. In a glasshouse experiment we assessed the ability for increased complementarity between and within species grown in mixtures of mixture types and monoculture types. We further tested for genetic and epigenetic variation between monoculture and mixture type of the same species using a novel reference-free reduced representation bisulfite sequencing technique (epiGBS). With epiGBS it is possible to conduct a comparative analysis of DNA methylation and genetic variation in a large number of samples de novo.
We found that selection for monoculture and mixture types occurred in the 12 years of community history. In newly assembled mixed communities, plants with a selection history in mixtures performed better than plants with a monoculture selection history. Furthermore, we could show that plants without a common community history produced the lowest above-ground biomass in both mixed communities and monocultures.
Using epiGBS we were able to classify plants within a species as either monoculture or mixture selection history based on their methylation pattern and single nucleotide polymorphisms in a representative part of the genome. Our results indicate in perennial grassland species it may be both epigenetic and genetic signals driving the rapid emergence of monoculture and mixture types. These novel findings indicate possible mechanisms that explain the rapid evolution of adapted subtypes within a species in grasslands. Uncovering these mechanisms contributes to our understanding of the biodiversity–ecosystem functioning relationship, which has the potential to influence modern day agricultural practice.

Flowering phenology and the environmental factors in the tropical tree genus *Macaranga* (Euphorbiaceae).

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Environmental triggers for flowering has been a central question in Southeast Asian forests because of the lack of clear seasonality in day length, temperature and rainfall in this region. So far many scientists have especially focused on the characteristic irregular flowering event termed "general flowering", in which diverse plant groups flower synchronously, and various environmental factors, such as drought, temperature drop and sunlight, have been advocated to be important as triggers for general flowering. However, while significant number of plant species do not flower in the periods of general flowering, little is known on which environmental factors they use for synchronous flowering within a species. In this study, we focus on the flowering phenology of three pioneer tree species of the genus *Macaranga* (Euphorbiaceae) in Lambir Hills National Park, Borneo, Malaysia. Our 20 months phenology observation by human eyes and interval cameras confirmed that these species exhibit different flowering phenology patterns depending on species: *M. conifera* did not show any flowers within this period, *M. bancana* flowered episodically 3 times synchronously within the population, and every *M. winkleri* individual was flowering almost continuously over the whole period. We examined the environmental triggers of the flowering of *M. bancana* by time-series analysis using phenology observation and meteorological data. This analysis indicated that drought condition around the past one month is the most likely trigger for flowering of *M. bancana*. Previous studies have shown that relatively severe and prolonged drought is important as a trigger of general flowering in the study site. *M. bancana* may use more moderate drought as an environmental trigger of flowering. We will also evaluate the significance of drought for flowering of *M. bancana* by time-series transcriptomic analysis integrating high-throughput sequencing, flowering phenology and meteorological data.

Borneo test site.

Eri Yamasaki and Kentaro Shimizu
URPP GCB, University of Zurich; Zurich, Switzerland.

Borneo is an island of Southeast Asia. It is the third biggest island in the world and divided among three countries: Malaysia, Indonesia and Brunei. It is classified into tropical rainforest climate according to Köppen-Geiger climate classification, and various types of tropical rainforests are stretching over the island. It is hot (average temperature is ca. 30 ˚C) and humid (average annual precipitation is ca. 3000 mm) all year round and there is no clear seasonality. The most spectacular event among the island is called "general flowering", in which phylogenetically diverse tree species come into flower synchronously at irregular intervals (less than one year–10 years) at community level. It is one of the hotspots of biodiversity in the world and there are many unique organisms, such as orangutans, Borneo elephants, many endemic pitcher plants and Rafflesias, etc. While ca. 60 indigenous tribes have lived together with the rainforests and benefitted from the forests, most of the primary forests have been changed into plantations of oil palms, acacias, etc.
URPP-GCB has two test sites in Malaysian Borneo: Lambir and Danum Valley. Both of them consist of lowland mixed dipterocarp forests with extremely high biodiversity. The canopies are located about 50 m above the ground and emergent trees sometimes achieve a height of 70 m. Lambir is one of the National Parks in Sarawak State and its features are the canopy crane system and the canopy walkways, which enable us to access to the canopy. These facilities are used for leaf optical measurements, monitoring of the gene expression related to flowering, and so on. Danum Valley is located inland of Sabah State. Here, a large-scale biodiversity experiment has been established to understand the effect of tree biodiversity on the ecosystem functioning. URPP-GCB members are working on genetic diversity of dipterocarp trees and the functional traits and genes related to drought tolerance.

When a lake stops deep-mixing: dramatic consequences for the food web cascade.

Yana Yankova
URPP GCB, University of Zurich; Zurich, Switzerland.

Climate warming can have crucial impact on food webs in deep lakes. Reduced surface water cooling during winter as a consequence of increasing air temperatures prevents vernal deep lake mixing. Hence, the epilimnetic replenishment with hypolimnetic dissolved phosphorus (DP), essentially important for autotrophic growth, is disrupted, potentially diminishing the cascade of biomass and exudates fluxes to other trophic levels.
Based on long-term (40 years) data for Lake Zurich we found a dramatic decrease in spring epilimnetic DP content, significantly related to a pronounced decrease in diatoms and cryptophytes abundances in spring. In order to test the causal nature of these statistical relationships we designed a simple experiment. Full lake turn-over was simulated by mixing epi- with hypolimnetic water from Lake Zurich during spring in two consecutive years. Notably in these years Lake Zurich was characterized by strongly reduced natural mixing depths. The experimentally induced 'mixis treatments' were compared to controls with untreated surface water. The role of DP was investigated in an additional set up consisting of surface water with added P.
The results for both years showed a significant increase of diatoms and cryptophytes related chlorophyll a concentrations, as well as strong bacterial growth in the treatments with hypolimnetic and P enriched water. In contrast, no significant changes in algal and bacterial growth dynamics were detected in the control treatments. Growth of cyanobacteria (*Planktothrix rubescens*) was not significantly promoted in any of the treatments. These results clearly confirm our thesis generated based on the long-term data. Furthermore, they indicate that another cold winter mediated deep-mixing could result in a reappearance of pronounced phytoplankton blooms.

Lake of Zurich.

Yana Yankova and Jakob Pernthaler
URPP GCB, University of Zurich; Zurich, Switzerland.

Lake Zurich (also referred to as Lower Lake Zurich) is a large (65 km2, 30 km length), deep (136 m), stratifying, pre-alpine lake located on the Swiss Plateau. It is well separated from the fairly smaller Upper Lake Zurich by a sill (natural glacial moraine), allowing for the inflow of only the upper 3 m of surface water, which is nevertheless the major inflow of Lake Zurich. The thermal regime of the lake can be classified as generally monomictic with a water turn-over in early spring. The lake undergoes holomixis after cold winters, whereas partial mixing (80-100 m) occurs after mild winters. In late autumn, thermal stratification of the upper water body gets eroded, which leads to a turbulent mixed zone between 0-30 m. Lake Zurich has been intensively monitored. Different limnological parameters, such as water temperature, oxygen, chlorophyll concentration etc. are measured on a biweekly base since the late 1970's near the deepest point of Lake Zurich by the Limnological Station of the University of Zurich. Data regarding biotic and abiotic factors have also been collected monthly by the City of Zurich Water Supply Company since 1972.
Since the 1900's the lake underwent distinct transitions. Anthropogenic induced eutrophication of the lake led to strong reduction of water quality parameters even until the 1970's. Thereafter, advances in sewage treatment resulted in a re-oligotrophication process. Nevertheless, a significant warming of the water column due to increasing air temperatures happened during the past decades. These processes strongly impact food web compositions in the lake such as a distinct shift from mostly eukaryotic to cyanobacterial primary production. The dominant filamentous cyanobacterium *Planktothrix rubescens* represents a potential hazard for humans and animals due to the highly toxic secondary metabolites (e.g. microcystins). Studying the development of these processes is, therefore, crucial, as Lake Zurich represents an important freshwater reservoir for over 1 million people.

LiDAR-derived vegetation structure predicts beta diversity across taxa and land uses.

Florian Zellweger
Swiss Federal Research Institute WSL; Birmensdorf, Switzerland.

Understanding the mechanisms that control the variation of species composition among sites (i.e., beta diversity) is key to better assess the impacts of global change on biodiversity. While niche-based community assembly processes and their effects on beta diversity are increasingly investigated, little is known about how beta diversity is affected by biotic environmental filters, such as the three-dimensional structure of habitats. Here, we focused on using airborne Light Detection and Ranging (LiDAR) to investigate the independent and shared effects of habitat and climate filters on beta diversity of plants, butterflies and birds, which were sampled across an environmentally heterogeneous region, i.e. Switzerland. While all taxa were strongly affected by climatic filters, we also found a large independent share of explained variance by vegetation structure for all taxa, particularly for birds. Bird community filtering effects mediated by vegetation structure and associated vertical niche partitioning and habitat preferences were confirmed in a smaller, environmentally homogeneous subregion, where vegetation structure emerged as a principal beta diversity driver across different land use types. Making use of costly large area LiDAR data for high-fidelity vegetation structure mapping thus constitutes an important step forward to quantify and monitor beta diversity, a primary determinant of the total species diversity present in a landscape. The growing spatial and temporal availability of LiDAR data offers novel opportunities to improve the understanding and monitoring of the effects of changes in vegetation structure on biodiversity.

FISHBOWL DISCUSSIONS

Grand challenges in global change and biodiversity science.

Chair: Michael W.I. Schmidt
Lead: Samuel Abiven
URPP GCB, University of Zurich; Zurich, Switzerland.

Global change and biodiversity sciences represent a vast field of research, linking together disciplines that do not overlap often. Topics like remote sensing, biogeochemistry, ecology, genomics or political and human geography are present in the University of Zurich Research Priority Programme (URPP) "Global change and biodiversity". In the frame of our programme, we are discussing emerging questions of our individual fields and confronting them to the other disciplines. From these discussions, we are identifying different challenges, overarching the individual disciplines.
This fishbowl discussion aims at confronting these challenges to the opinion of experts in individual fields. These challenges are collected by confronting different time and spatial scales and considering larger perspectives from a back and forth between our different disciplines. We are exploring the different axes of the disciplines: the essential biodiversity variables, the earth system processes, the ecosystem services and the resource frontiers. For each of the axes, we identified several challenges, either related to the exploration of new processes, the application of new technologies to other disciplines, or the questioning of classical discourse in a new perspective.
In this discussion, we will present these different challenges and confront them to the panel's opinion. We would like to address the following questions:

- What are the challenges in integrating the time and spatial scales in biodiversity and global change?
- What are the emerging links between these different individual research field perspectives?
- What are the gaps on the literature preventing from a larger inter-disciplinarity?

Frontiers: expansion and containment.

Chair: Norman Backhaus
Lead: Benedikt Korf
URPP GCB, University of Zurich; Zurich, Switzerland.

Resource frontiers are sites where we witness a dramatic loss in biodiversity. Resource frontiers experience rapid transformations from low intensity to high intensity land use practices, e.g. from slash-and-burn shifting agriculture to plantation economy, or from pastoral to more sedentary forms of land use. These transformations are often combined with an increasing integration into the global market economy. Resource frontiers are therefore also frontiers of production. These social, political and economic transformations substantially alter the landscape and have dramatic consequences in terms of biodiversity loss. Protected areas, in contrast, regarded as a reaction to these changes and a means to prevent further biodiversity loss. In this fishbowl discussion, we will identify key conceptual concerns of the frontier debate and discuss the potential feasibility of case studies on frontier expansion in the Tibet site of the URPP GBC.

Impact of global change on ecological functioning and future effects on ecosystem services.

Chair: Ilse Geijzendorffer[1]
Lead: Astrid van Teeffelen[2]
[1]*Tour du Valat ; Le Sambu, Arles, France.*
[2]*VU University Amsterdam; Amsterdam, Nertherlands.*

Global change impacts ecosystem and their biodiversity in many different ways and often much quicker than our long-term models predicted. In a recent Science paper Newbold et al. (2016) estimate that 48.4% of the terrestrial surface suffers from a degradation of biodiversity intactness, which exceeds the planetary safety boundary for ecological functioning. Although the link between biodiversity, ecological functioning and ecosystem services has been the topic of many studies (e.g. Balvanera et al., 2006), concepts and models that are able to link these and that allow for the development of future projections are rare. At the same time, there is societal and political support to counteract the identified trends, stimulating sustainable development or through off-setting if necessary. Whereas assessment reports for IPBES focus on available information on ecosystem services trends in the past, this might not be sufficient to design the futures that we would like to have. In this fishbowl, we will focus on identifying a prioritization of the information we should focus on to get first, to get the first estimates on how ecological functioning will change under the influence of global change and how this will affect ecosystem services supply towards the future. This information could be in the form of essential information (e.g. the development of Essential Ecosystem Services Variables), most easily obtained information (e.g. indicators based on remote sensing), theoretical predictions of impacts towards the future (e.g. modeling different scenarios of biodiversity loss and subsequent loss of functioning), building of positive storylines based on experiences in place-based research (e.g. explore positive examples how socio-ecological systems have been adapted their changing context) or still other forms of information. The fishbowl will be in the form of an open interactive discussion with participants of the conference with contributions of the speakers of the ecosystem services session.

What is the role of experts in biodiversity and ecosystem services decision making?

Chair: Bernhard Schmid[1]
Lead: Rik Leemans[2]
[1]*URPP GCB, University of Zurich; Zurich, Switzerland.*
[2]*Environmental Systems Analysis; Wageningen University, Wageningen, Netherlands.*

Distributive justice and genetic resources, integrating a global biodiversity fund into the framework of the CBD.

Chair: Peter Schaber
Lead: Anna Deplazes Zemp
URPP GCB, University of Zurich; Zurich, Switzerland.

In this Fishbowl discussion we will discuss a manuscript on distributive justice in the context of genetic resources. This paper will address questions of resource rights and territoriality. The content can be summarized as follows:
The CBD (Convention on Biological Diversity) treats genetic resources as a type of biological resources over which states have national sovereignty. With its access and benefit-sharing scheme the CBD provides a model of how benefits from genetic resources should be shared. This manuscript challenges the model by examining distributive justice in the context of genetic resources against the background of territorial and cosmopolitan theories of global justice. Genetic resources are one subtype of biological resources. A comparison with other types of natural resources shows that genetic resources are particular in terms of their immaterial nature, the strong intellectual contribution to resource value, and the environmental context, in which they have been discussed.
It will be argued that a just distribution of benefits from genetic resources should consider everybody, not only utilizers and providers. Drawing from Thomas Pogge's Global Resource Dividend (GRD) the model for a global biodiversity fund will be suggested. Beneficiaries from genetic resources should pay into this fund. Such a contribution would be modest for academic projects and more substantial if direct financial benefits are involved. In contrast to the CBD, this model not only applies to imported genetic resources but also to those from collections or the environment of the country, in which they have been utilized. This is compatible with territorial rights of biodiversity-rich countries to control access to the genetic resources on their territory. Moreover, it will be argued that the model supports the involvement of indigenous and local communities for instance by requesting free prior informed consent (FPIC).
Finally, the model of a global biodiversity fund can give particular consideration to the environmental context of genetic resources. It will be suggested that the global biodiversity fund should be used to support projects for the protection of biodiversity. This makes it possible to connect rights to benefits from genetic resources directly to the responsibility of protecting biodiversity. Since conservation of biodiversity is considered to be important for everybody, such an allocation of the fund would be in the general interest. Moreover, it could help to reallocate some of the financial burdens and opportunity costs accruing to biodiversity rich states from conservation of biological diversity and sustainable development.

Biodiversity upscaling.

Chair: Gabriela Schaepman-Strub
Lead: Gian Marco Palamara
URPP GCB, University of Zurich; Zurich, Switzerland.

Biodiversity is an abstract concept, ranging from genetic, to species, functional, and structural diversity. Typically, aspects of diversity are measured at specific spatial and temporal scales and scaling the related measures is nontrivial. Describing the processes that characterize the distribution of biodiversity at different scales in space and time remains a challenge. Given the current biodiversity crisis, it is becoming even more urgent to build a robust theoretical framework to describe biodiversity and its role on providing ecosystem services at different scales.
We present the concept of scaling from a statistical perspective to estimate or predict biodiversity and its components. Classic ecological theory has developed a set of modelling tools to describe species abundance at different scales. The species area relationship (SAR) is a simple tool to understand scaling and its properties related to biodiversity. Starting from the SAR we explore the scaling properties of biodiversity measures extending the concept of scaling to time. We investigate the aggregate measures of biodiversity that can be gathered together with the way they can be scaled. In fact, from biodiversity metrics and together with measures of abiotic factors it is possible to quantify ecosystem functions and services and to scale them up as well. We review existing methods used to quantify ecosystem services and functions and show how they have been used to gather predictive understanding of ecological processes at different spatial and temporal scales.
The essence of successful scaling is to infer the key patterns from information collected at one scale and use those patterns to make inferences at another scale. Scaling methods can be classified according to both the statistical approach used (e.g. Bayesian or Frequentist, spatial or spatio-temporal) and the ecological questions and dimensions they address. During the discussion we will address both the mathematical challenges and the ecological questions related to scaling biodiversity. Some questions we will address are:
How should models that describe biodiversity at different scales be designed according to the available amount of data (e.g. how model parameters relate to each other at different scales)?
What ecological processes can be described at different scales? How can we relate different statistical methods at different spatial and/or temporal scales?
Furthermore, we will discuss the existing gaps in the literature and potential synergies between disciplines that can be used to address those gaps. We will try to include different perspectives into the discussion, ranging from social and natural sciences to modelling and statistics.

Integrating high-throughput sequencing technique to global changes and biodiversity: on phenology and genetic diversity.

Chair: Kentaro K. Shimizu
Lead: Eri Yamasaki
URPP GCB, University of Zurich; Zurich, Switzerland.

Global change, such as climate change and artificial alteration of environments, brings considerable effects on ecosystems. Especially, phenology and genetic diversity of organisms are highly vulnerable to global change. For example, the URPP studies showed that growing season length measured has changed over the past 30 years (Garonna et al. Glob Chang Biol 2014): Pauls et al. (Mol Ecol 2013) reviewed that anthropogenic pressures like habitat fragmentation have caused loss of genetic diversity. Because the global change is ongoing rapidly, it is urgent to predict how the phenology and genetic diversity change in the future. However, it has been difficult to predict it precisely because of complex and diverse natural environments and uncertainty in the internal mechanisms of the organisms. Rapidly advancing high-throughput sequencing technique in genomic sciences is a powerful tool to dissolve these difficulties. In model species Arabidopsis, rice and their related species, large scale genome-wide data successfully yielded modeling and prediction of phenology and rapid evolution by using time-course genome-wide expression data (e.g. Aikawa et al. PNAS 2010, Nagano et al. Cell 2012, Plessis et al. eLife 2015) and distribution-wide genome-wide polymorphism data, respectively (e.g., Banta et al. Ecol Lett 2012). An emerging challenge is to extend these methods to ecologically relevant species by integrating global change studies and genomics. The URPP Global Change and Biodiversity (URPP GCB) has an ideal interdisciplinary setting and already initiated projects. We will summarize current progress, challenges and future direction, for example, how to support long-term observation of gene expression and which species and regions to focus. The discussion will be summarized in a review paper and will be submitted to Trends in Plant Science or other high-impact journal.

(1) Phenology. The phenology symposium in 2014 united different disciplines and resulted in "terminology brief" on phenology, by highlighting shared and different terminology in three fields (phenology in ecology by Eri Yamasaki, land-surface ecology in remote sensing by Irene Garonna, succession in microbiology by Yana Yankova). Phenocams were setup in URPP test sites, and the flowering study in Borneo (Kobayashi et al. Mol Ecol 2013) was the first to use tree transcriptomes in naturally fluctuating environment.

(2) Genetic diversity and rapid evolution. Although rapid evolution tends not to be integrated in predictions by climatic models, biologists found many episodes of rapid evolution by artificial and natural environmental changes (reviewed by Hoffmann and Sgro, Nature 2011). In the URPP GCB, Zuppinger-Dingley et al. (Nature 2014) showed that rapid evolution takes place in monocultures and mixed species communities within10 years of selection in the Jena Biodiversity Experiment. In the Laegern research site, ongoing project is investigating the pigment and architectural traits with genome-wide polymorphisms. New methods (genome-wide association studies, restriction site-associated sequencing, etc.) to detect genome-wide polymorphisms would enable us to estimate which gene is sensitive to global change.

Measuring biodiversity from space.

Chair: Susan Ustin
Lead: Paul Moorcroft
URPP GCB, University of Zurich; Zurich, Switzerland.

Increasingly the satellite record of data is being used to assess diversity from space. Earth observation from space has traditionally been monitoring plant functional traits of biochemical and structural nature (i.e. canopy chlorophyll, leaf area index, land surface phenology, etc.), but have not yet been widely used to assess changes of functional diversity at global scale. The concept of 'Essential Biodiversity Variables' (EBVs) is currently emerging, assessing which metrics should be used, as well as discussing future observational capacity to coherently assess many variables simultaneously. Despite the emerging availability of key functional traits available from satellites (such as LMA, N, NSC, Chl, Carotenoids, Lignin), still a fundamental data and knowledge gab exists in assessing plant functional diversity from space.
We discuss the need and priorities of global scale EBV's, their use in predictive modeling as well as the dimensionality of traits needed to arriving at such predictions.

SCIENCE CAFÉ

Equal opportunities in science: what can we actively do daily about it?

Samuel Abiven, Jennifer Bartmess, Veruska Muccione, Debra Zuppinger-Dingley
Career and Equal Opportunities Committee (CEOC)
URPP GCB, University of Zurich; Zurich, Switzerland.

Equal opportunities initiatives in science are developing at an increasing number of research institutions; universities and funding agencies to cite a few. Large-scale schemes have been initiated to ensure academic staff are treated equally, without prejudice or unjustified preferences. Hiring procedures, often at professorial level, are targeted in particular as part of such initiatives. However, this represents only one part of the academic activities within a well-defined frame to increase equal opportunities in science. Further actions to increase equal opportunities to be considered include those for early- and mid-career staff.
In the frame of the University of Zurich Research Priority Program, Global Change and Biodiversity (URPP GCB), the career and equal opportunities committee proposed a series of actions available to all the URPP GCB members. For example, we initiated a series of career talks, in which invited speakers described their career steps to early- and mid-career researchers, and a mentoring program, designed such that PhD candidates and post-docs have the opportunity to interact with a more experienced URPP member about diverse aspects of their academic career.
In this science café, we would like to exchange with you the outcome of our committee activities and about other actions you may be involved in that could be organized in the frame of the URPP GCB.

Earth-World Integration?

Benedikt Korf, Norman Backhaus, Samuel Abiven, Michael E. Schaepman
URPP GCB, University of Zurich; Zurich, Switzerland.

Objectives

To discuss first ideas about a paper that tries to synthesize work on global drivers of change by bringing a global environmental change ("earth") and a resource frontier ("world") perspective into a coherent analytical framework. The "earth" perspective analyses large spatio-temporal changes in the biophysical environment and their impacts on human livelihoods (e.g. adaptation to climate change). The "world" perspective studies the political economic drivers of short-term major environmental changes in frontier sites, which experience dramatic landscape alterations (e.g. palm oil plantations). Our argument is that these two perspectives complement each other: they describe different types of processes with different temporalities and spatialities that might overlap in different sites of biodiversity hotspots in specific ways. We hope to get some ideas how to bring this idea forward into a draft paper.

How to foster interdisciplinarity in global change research?

Veruska Muccione, Anna Deplazes-Zemp, Alejandra Parreño
URPP GCB, University of Zurich; Zurich, Switzerland.

Objectives

Interdisciplinarity refers to an approach in research that requires collaboration in the formulation of research questions and in the choice of research methods and interpretation of results, possibly resulting in the generation of integrative knowledge. Interdisciplinarity is needed in global change research since this body of research explores issues in coupled human-environment systems, a task that demands an integration of knowledge across and within natural sciences, social sciences and humanities. In this Science Café we will explore opportunities, challenges and strategies for interdisciplinary research in academic programs similar to the URPP GCB. We will start with an exercise where participants will be asked to define which research topics and methods from the URPP GCB cluster approach are truly interdisciplinary and which are disciplinary. The scope of this exercise is to ultimately come to a common definition of interdisciplinarity. We will then move to a more general discussion on different aspects of interdisciplinarity. Possible guiding questions are:

On the nature of interdisciplinary research

1) Is interdisciplinarity important to your research?
2) What are the advantages and challenges of "doing" interdisciplinary research?

On the research standards

1) How to preserve academic integrity and standards?
2) How to meet disciplinary expectations while keeping an interdisciplinary focus?

On incentives and opportunities

1) What ae the incentives and career perspectives of early career researchers working in "so-called" interdisciplinary research programs?
2) How to overcome the academic bias that currently promotes discipline-based work?
3) Is the peer-review process friendly to interdisciplinarity?

Sustainability within the URPP GCB.

Alejandra Parreño, Carla Guillen Escriba, Katie Horgan
URPP GCB, University of Zurich; Zurich, Switzerland.

Objectives

Discuss within URPP GCB members results from a survey on sustainability issues within the URPP.

Identify key areas in our daily operations in which we have an impact, and with pros and cons of

Recognize areas in which we don't have enough data or need more research.

Raise awareness on sustainability issues and draft individual or collective feasible goals for next year.

During the month of June-July, a survey on sustainability related to 2 key environmental areas (energy use/CO2 emissions and waste management/origin materials used) and 1 key social area (communication and integration) will be circulated within URPP members, to be filled anonymously. During the Science Café, the results of that survey will be presented briefly and put within a framework of sustainability in three pillars: economical, social and environmental. The participants will be asked for their opinion and we will foster discussions towards answering 5 basic questions:

1) Was there anything missing in this survey that you think worth analyzing? **(recognize current data and information limitations)**
2) What are the key areas in which we should improve towards a sustainable research group, and in which we are already doing a good job? **(identify strengths and weaknesses)**
3) How can we include in our analysis the positive outcomes of our research? **(debate how to include non-quantitative impacts)**
4) How can we improve those areas in which we need progress? **(set feasible, concrete goals individually or collective as guidelines for next year)**
5) Who are the stakeholders of our operations, the people /organisms affected by our research for which we have to be accountable for our actions? **(stakeholder analysis, awareness of external impacts of the research operations)**

URPP GCB sites – networking internally and externally.

Gabriela Schaepman, Bernhard Schmid, Felix Morsdorf, Jakob Pernthaler, Dennis Hansen, Kentaro Shimizu
URPP GCB, University of Zurich; Zurich, Switzerland.

Objectives

The URPP GCB supports 6 test sites across a latitudinal gradient, with differing global change drivers and magnitudes. Over the past 4 years, research projects have revealed a wealth of information on biodiversity, global change, and related processes at the URPP sites. This science café is aiming at increasing the internal networking across sites through synthesizing first results, as well as increasing the visibility of the sites in international research efforts.

The presenters will provide a summary of the sites (location, biodiversity, global change drivers, main research questions addressed within the URPP) during the poster session, serving as a basis for the discussion.

Participants will brainstorm, together with the presenters, on the following topics:

1) What research questions, experimental, observational, and modelling opportunities are there to increase internal networking across sites? What research questions currently addressed at one site would be interesting to expand to other sites?

2) Towards which international activities and networks can we contribute? Are standardized measurements needed that can easily be put in place?

What is biodiversity? How to define biodiversity, biodiversity measurement?

Debra Zuppinger-Dingley, Terhi Hahl, Sofia van Moorsel, Bernhard Schmid
URPP GCB, University of Zurich; Zurich, Switzerland.

Objectives
Terminology briefs provide short summaries on the definition and common understanding of terms, which are of key importance to the University Research Priority Program Global Change and Biodiversity.
Formal definition:
Biodiversity is the diversity of biological organisms. The term biodiversity is used to include the number of species, their relative abundance and composition in an ecosystem and how the species within an ecosystem interact with each other. A more general definition includes the diversity of ecological systems including not purely biological processes among and within them, but for practical reasons this more general definition is rarely used in biodiversity research.
We study the forms and patterns of biodiversity, examine the values and importance of biodiversity and determine the processes maintaining biodiversity.

1) How does biodiversity influence the functioning and stability of ecosystems and the natural services that they provide which are essential to human wellbeing?
2) How do we analyze biodiversity as both a response variable affected by global change drivers and a factor modifying ecosystem processes and services?

In this Science Café we will discuss the definition of biodiversity as both a response variable and a factor modifying ecosystem processes and services. We will review, compare and classify different measures of biodiversity. The goal of this café is to write a terminology brief including the views of the URPP GCB on biodiversity and a summary of key terms.