Global Change and Biodiversity: Integrating the impact of earth and world drivers across scales

URPP
Global Change
and Biodiversity

Conference
Monte Verità; Ascona, Switzerland.
30 June - 4 July 2019
Program and Abstract Book

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PROGRAM

Global environmental changes, e.g. increasing CO_2 levels or habitat transformation, are driven by biophysical, chemical and structural changes in the earth system as well as socio-economic and political changes in the human system. The drivers are linked and act simultaneously. The conference examines the impacts on biodiversity and ecosystem processes and how this affects human societies at local, regional and global levels.

Fishbowl Discussions: The goal of the fishbowl discussions is for participants to exchange ideas, discuss concepts, potentially advance manuscripts guided by an expert panel on a predetermined topic.

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. Participant groups contribute to solving problems, discuss. 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 30 June	
Arrival **Registration**	
from 15:15	Shuttle bus transports guest from main station
16:00 – 17:30	Registration
17:30 – 18:30	Welcome drink (Terrace/Balint)
Welcome Session	Chair: Annabelle Constance
18:30 – 18:45	**Welcome Address: Owen Petchey** *'Global Change and Biodiversity'* (Auditorium)
18:45 – 19:30	**Opening Speaker: Jessica Hellman** *'Frontiers in biodiversity science, from predictive modeling, human intervention in ecosystems, and being explicit about our biodiversity goals'* (Auditorium)
19:30 – 20:30	Dinner
20:30 onwards	Science Pub and Quiz (Open Bar on the Terrace/Dining room)

Monday 1 July	
07:00 – 08:00	Breakfast
Session 1	Chair Auditorium: Fernando Pedraza Perez
08:15 – 08:30	**Welcome Address by the CSF and the FMV** (Auditorium)
08:30 – 09:10	**Key Note: Kai M.A. Chan** *' Relational Policy Mixes for Sustainability: Integrating Incentives, Certification, Regulations and Place-based Approaches'* (Auditorium)
09:15 – 09:45	**Speed Science** (Terrace/Dining room)
09:45 – 10:15	Coffee Break
Session 2	Chair Auditorium: Daniel Kükenbrink
10:15 – 11:15	**Science Café:** (Balint) *'How can we rigorously detect meaningful but minor signals in noisy and complex data'* *'Do we need to fly so much in academia?'* *'Raising Awareness with Headline Indicators: What is the 1.5°C target in Biodiversity?'* *'Fearful probable futures and trustful preferred futures?'* *'Career and Social Media'* *'Interdisciplinarity and interdisciplinary research in global change research'* *'Do more species maximize more ecosystem functions?'* *'Should science communication be an integral part of an academic career?'*
11:20 – 12:00	**Key Note: Andrew Hector** *'The Rise and Fall of Rain Forests'* (Auditorium)
12:00 – 13:30	Lunch
Session 3	Chair Auditorium: Sarah Mayor
13:30 – 14:15	**Ignite Session** (Auditorium)
13:30 – 13:45	**Michael J. O'Brien** *'Genotypic filtering under global change at spatial and temporal scales'*
13:45 – 14:00	**Maarten Eppinga** *' Quantifying social-ecological system sensitivity: a multi-disciplinary approach to global change research?'*
14:00 – 14:15	**Sofia van Moorsel** *'Freshwater community stability in stressful times'*
14:15 – 14:30	**Guido Wiesenberg** *'Improved understanding of ecosystem functioning as a response to climate and biodiversity change by the use of lipid biomarkers'*

14:30 – 15:00	Coffee Break
Session 4	
15:00 – 16:20	**Fishbowl Discussions** Topic: **Integrating food web concepts into biodiversity research** *Aleksandra Lewandowska* (Auditorium) Chair: Fernando Pedraza Perez Lead: Aleksandra Lewandowska Topic: **Biodiversity and climate change** *Cornelia Krug and Michael Schaepman* (Balint) Chair: Cornelia Krug Lead: Michael Schaepman Topic: **Opportunities and Landscape for a new Interdisciplinary Environmental Institute/Center in Switzerland** *Mollie Chapman, Hanneke Van t' Veen, Debra Zuppinger-Dingley* (Eranos) Chair: Hanneke Van t' Veen Lead: Mollie Chapman Topic: **Why pure richness effects are still the only general result of 25 years biodiversity–ecosystem functioning research** *Bernhard Schmid* (Pioda) Chair: Maarten Eppinga Lead: Bernhard Schmid
Session 5	Chair Auditorium: Alizée Le Moigne Chair Balint: Anubhav Gupta
16:30 – 17:15	**Key Note: Kirsten Thonicke** *'Influence of environmental and competitive filtering on functional diversity of European Forests'* (Auditorium)
17:15 – 17:45	**John O'Neill** *'What is lost through no net loss'* (Auditorium) **Michel Loreau** *'Long-term dynamics and sustainability of human-nature interactions'* (Balint)
17:50 – 18:20	**Geeking Session** with: **Kai M.A. Chan** (Spazio Roccia) **Andrew Hector** (Terrace) **Jessica Hellman** (von der Heydt Room) **Kirsten Thonicke** (Mandala Room) **John O'Neill** (Auditorium) **Michel Loreau** (Terrace)
18:30 – 19:30	Poster Session and Apéro (Balint)
19:30 – 21:00	Dinner

Tuesday 2 July	
07:00 – 08:00	Breakfast
Session 6	Chair Auditorium: Fanny Petibon Chair Balint: Martin Oliver Reader
08:15 – 08:55	**Key Note: Eric Lambin** *'Scaling up interventions for nature conservation'* (Auditorium)
09:00 – 09:30	**Barbara Muraca** *'Relational Values and biocultural diversity: integrating earth and world'* (Auditorium)
	Jonathan Hutton *'Biodiversity Revisited: Sparking a new approach to research for the biosphere'* (Balint)
09:30 – 10:00	**Ralf Seppelt** *'Deciphering the biodiversity-production mutualism in the global food security debate'* (Auditorium)
	Sophie Cauvy-Fraunie *'A global synthesis of biodiversity responses to glacier retreat'* (Balint)
10:00 – 10:30	Coffee Break
Session 7	Chair Auditorium: Elena Plekhanova Chair Balint: Nicholas Ofiti
10:30 – 11:00	**George Holmes** *'Conservation, capitalism and colonialism: exploring the values and beliefs of the global conservation community'* (Auditorium)
	Yvonne Oelmann *'Role reversal of actors tightening the P cycle in experimental and real-world grasslands'* (Balint)
11:10 – 11:40	**Geeking Session** with: **Eric Lambin** (Terrace) **Barbara Muraca** (von der Heydt Room) **Jonathan Hutton** (Terrace) **Ralf Seppelt** (Mandala Room) **Sophie Cauvy-Fraunie** (Spazio Roccia) **George Holmes** (Auditorium) **Yvonne Oelmann** (Balint)
12:00 – 13:30	Lunch and Group Photo

Session 8	Chair Auditorium: Ewa Czyz Chair Balint: Konchok Gelek
13:30 – 14:10	**Key Note: Henrique Pereira** *'A multimodel analysis of historical trends and future scenarios for biodiversity'* (Auditorium)
14:10 – 14:40	**Xiaojuan Feng** *'Molecular alteration to soil organic matter under global changes'* (Auditorium) **David Schimel** *'Flux towers in the sky: biodiversity and ecosystem function from space'* (Balint)
14:40 – 15:10	**Forest Isbell** *'How valuable is biodiversity?'* (Auditorium) **Jeannine Cavender-Bares** *'Integrating methods to detect biodiversity and ecosystem function to enhance monitoring and management for sustainability'* (Balint)
15:10 – 15:40	**Geeking Session** with: **Henrique Pereira** (Mandala Room) **Xiaojuan Feng** (Terrace) **David Schimel** (von der Heydt Room) **Forest Isbell** (Auditorium) **Jeannine Cavender-Bares** (Balint Room)
15:40 – 16:10	Coffee Break

Session 9

16:10 – 17:30 **Fishbowl Discussions**

Topic: **Revisiting Biodiversity – How do we identify and frame the key questions?**
Jonathan Hutton

(Auditorium)
Chair: Jasper Montana Lead: Jonathan Hutton

Topic: **Imagining the scope, elements, and aims of "diversity science"**
Owen Petchey

(Balint)
Chair: Alejandra Parreño Lead: Owen Petchey

Topic: **Data ownership and data sharing: perspectives from the biodiversity and ecosystem service community**
Meredith Schuman, Anna Deplazes-Zemp, Debra Zuppinger-Dingley and Veruska Muccione

(Eranos)
Chair: Maarten Eppinga Lead: Meredith Schuman

Topic: **The grammar of relational values**
Mollie Chapman and Anna Deplazes Zemp

(Pioda)
Chair: Anna Deplazes Zemp Lead: Mollie Chapman

18:00 – 19:00 Poster Session and Apéro (Balint)

19:30 – 21:00 Dinner

Wednesday 3 July	
07:00 – 08:30	Breakfast
Session 10	Chair Auditorium: Hanneke Van t' Veen Chair Balint: Daniel Kükenbrink
08:30 – 09:00	**Christopher Trisos** *'The projected timing of ecological disruption from climate change'* (Auditorium)
	Sarah Cornell *'What does a planetary social-ecological perspective add to our understandings of biodiversity losses and climate change?'* (Balint)
09:00 – 09:45	**Ignite Session** (Auditorium)
09:00 – 09:15	**Alejandra Parreño** *'How do life experiences shape our perception of and attitudes towards biodiversity? An opinion and a quest for more shared, positive experiences on biodiversity'*
09:15 – 09:30	**Felix Morsdorf** *'Close-range laser scanning and vegetation structure - can we have too much information?'*
09:30 – 09:45	**Kentaro Shimizu** *'Genomics for global change studies'*
09:45 – 10:15	Coffee Break
Session 11	Chair Auditorium: Leila Schuh Chair Balint: Cheng Li
10:15 – 10:45	**Lindsay Turnbull** *'The Aldabra Clean Up Project'* (Auditorium)
	Jes Hines *'28 Years of Biodiversity and Ecosystem Function Research: Food webs connect core and integrative research domains'* (Balint)
10:45 – 11:30	**Ignite Session** (Auditorium)
10:45 – 11:00	**Frank Pennekamp** *'Temperature effects on ecological stability across scales'*
11:00 – 11:15	**Gian Marco Palamara** *'Metacommunities in Dynamic Landscapes'*
11:20 – 12:00	**Key Note: Aletta Bonn** *'Ecosystem Services - for Whom?'* (Auditorium)

12:00 – 13:30	Lunch
Session 12	Chair Auditorium: Chongmeng Xu Chair Balint: Rémi Willemin
13:30 – 14:00	**María Vallejos** *'The GEO BON`s challenge of monitoring Ecosystem Services'* (Auditorium)
	Aleksandra Lewandowska *'Scale-dependent biodiversity patterns in marine foraminifera time series'* (Balint)
14:00 – 14:30	**Geeking Session** with: **Christopher Trisos** (Terrace) **Sarah Cornell** (Terrace) **Lindsay Turnbull** (von der Heydt Room) **Jes Hines** (Spazio Roccia) **Aletta Bonn** (Mandala Room) **María Vallejos** (Auditorium) **Aleksandra Lewandowska** (Balint)
14:30 – 14:45	Gather for excursion
	Excursion: See final list for - *Brissago Islands and visit to botanical garden* Take a boat trip on Lago Maggiore, and explore the Brissago Islands, home to a unique Botanical Garden. The Garden was founded by the Russian Baroness Antoinette de Saint Léger in the late 1900s, and is home to 1 500 plant species. Walk to Ascona to the harbour, boat trip across the lake, about 1 hour visit of the botanical garden. Return to Monte Verità by bus or on foot. 60 participants. *Chestnut Groves* Explore a unique forest type of Southern Switzerland, the Chestnut Forest. Learn about its history and ecology, as well as the socio-cultural changes the region has undergone. The excursion is guided by Dr. Marco Conedera, WSL Cadenazzo. Bus tour to Chestnut grove, 1,5 - 2 hour walk, return to Monte Verità by bus. 20 participants *Culinary Forest Walk* A walk through the forest with renowned cook Meret Bissegger. Explore the edible treasures of the forest, try and taste them, and find out how to use them in your daily cooking. Bus tour to forest, 1,5 – 2 hour walk, return to Monte Verità by bus. 20 participants
19:30	**Dinner at Monte Verità**

Thursday 4 July	
07:00 – 08:00	Breakfast
Session 13	Chair Auditorium: Alejandra Parreño Chair Balint: Christian Rossi
08:00 – 08:40	**Key Note: Mary O'Connor** *'Biodiversity, ecosystem function and feedbacks with human well-being: a case study with seafood, and an agenda for research'* (Auditorium)
08:45 – 09:15	**Thomas Knoke** *'Modelling the influence of ecosystem services (functions) on land-use decisions'* (Auditorium)
	Marcel Holyoak *'The effects of climate change on the spatial dynamics and movement of species'* (Balint)
09:15 – 09:45	**Esther Turnhout** *'Inclusive concepts for biodiversity governance: democratic legitimacy and pluralism at the science-policy-society interface'* (Auditorium)
09:45 – 10:10	Coffee Break
Session 14	Chair Auditorium: Cyrill Zosso Chair Balint: Zhaoju Zheng
10:10 – 10:50	**Key Note: Eva Knop** *'Causes and consequences of artificial light at night for biodiversity and ecosystem functioning'* (Auditorium)
10:50 – 11:20	**Tuyeni Mwampamba** *'Introducing the Essential Ecosystem Services Variables for monitoring sustainability* (Auditorium)
	Michio Kondoh *'Does ecological complexity stabilize the community against external disturbances? - an empirical test based on a data-driven approach'* (Balint)
11:20 – 11:50	**Geeking Session** with: **Esther Turnhout** (Spazio Roccia) **Thomas Knoke** (Terrace) **Michio Kondoh** (Balint) **Mary O'Connor** (von der Heydt Room) **Tuyeni Mwampamba** (Auditorium) **Eva Knop** (Mandala Room) **Marcel Holyoak** (Terrace)
11:50 – 12:00	**CSF Early Career Researcher Presentation Award** (Auditorium)
12:00 – 12:20	**Closing Address: Michael Schaepman** *'Biodiversity beyond World and Earth drivers: Pathways to biodiverse futures'* (Auditorium)
12:20	Packed lunch and make our way home

ABSTRACTS

KEY NOTE SPEAKERS

Ecosystem Services - for Whom?

Aletta Bonn
German Centre for Integrative Biodiversity Research (iDiv), Halle-Jena-Leipzig; Leipzig, Germany
UFZ – Helmholtz Centre for Environmental Research, Department of Ecosystem Services, Leipzig, Germany
Friedrich-Schiller-University Jena, Faculty of Biological Sciences, Jena, Germany

Demand for different ecosystem services will differ between recipients, and preferences may differ between local users and beneficiaries from or in distant locations. As such, there is often a spatial disconnect between the place where ecosystem services are provided and associated change in biodiversity, and the place where ecosystem services are consumed and where people may trigger changes in land use affecting biodiversity. Direct and indirect drivers for ecosystem service provision therefore often do not operate in closed systems but may be determined by non-local processes and institutions. Interregional ecosystem services flows are often linked to national and supranational economies, trade and cultural preferences, and as such remote responsibilities as well as dependencies emerge that may affect issues of national security and global equity. Despite a growing number of national-scale ecosystem service assessments, interregional ecosystem services flows are rarely considered and their effects on global sustainability is little known. We developed a conceptual framework and guidelines for assessing telecoupled services and guidelines and tested these for different flow types. Moving towards understanding the distributive effects of biodiversity use and ecosystem service consumption patterns will inform modes of governance for sustainable global ecosystem supply.

Relational Policy Mixes for Sustainability: Integrating Incentives, Certification, Regulations and Place-based Approaches

Kai M.A. Chan
Institute for Resources, Environment and Sustainability, University of British Columbia; Vancouver, Canada

In the face of pressing global sustainability challenges, key moments of opportunity pass by while prevailing responses draw piecemeal from a basket of well-worn tools, with little consideration of larger systemic effects. Accordingly, well-intended efforts at 'incentive' programs, certification systems, regulations and place-based planning and integrated management work at cross purposes and alienate many mainstream audiences. Environmental protection thus remains a David-and-Goliath struggle, where a small cadre of die-hard environmentalists continue to deepen the divide between themselves and the mainstream—despite the reality that values of environmental responsibility are shared broadly across many populations. This paper/talk examines all four categories of sustainability solutions for their strengths and limitations from the perspective of structural and societal changes needed for sustainability. We then explore the idea that smart mixes of tools and approaches could be re-designed in concert to unleash and normalize existing relational values of responsibility in all sectors and steps of supply chains. Such relational values—preferences, principles and virtues about human relationships involving the environment—are strongly and widely shared, but often latent due to a lack in enabling conditions. Crucially, such 'smart mixes' could be initiated from the bottom up in the many contexts where governments are not yet onside with or empowered to take strong environmental action. One bottom-up possibility is a system of genuine biodiversity and ecosystem service offsets for consumers and retailers, to provide the conditions that enable the easy but socially conspicuous expression of responsibility, and its leverage up and down supply chains. Although difficult, such relational policy mixes could help achieve broadly agreed-upon sustainability goals without disaster or draconian measures, preventing and addressing present and future injustices, including by maintaining critical natural capital and heritage.

What does a planetary social-ecological perspective add to our understandings of biodiversity losses and climate change?

Sarah Cornell
Historical Landscapes, Stockholm University, Stockholm Resilience Centre; Stockholm, Sweden

The world's ecosystems are being simplified and degraded – because of people's activities. The world's climate is changing rapidly – because of people's activities. Our scientific understandings of these processes and the consequences of moving into unprecedented conditions are still constrained by discipline divides, despite important advances in action-oriented sustainability sciences. And the main policies that are intended to influence people's activities are plagued by implementation gaps and challenges of integration and incoherences.
In this presentation, I discuss how we can expand the predominantly biophysical understandings of global change processes with a planetary social-ecological perspective. This will entail much closer attention to the ways we deal with the "problematic human" (with my thanks to Lesley Head for this term!) in global-scale conceptualizations of our environmental system and its dynamics. It also drives us to look at the micro aspects too: diversity plays a critical role in the possibilities for adaptive change, in both social and ecological domains. When we do this, we see new challenges and new risks – but we may also expand our methodological and practical action toolkits for responding to them.

The Rise and Fall of Rain Forests

Andrew Hector
Department of Plant Sciences, University of Oxford; Oxford, UK

The widespread degradation and loss of tropical forests is having negative impacts on biodiversity and ecosystem functioning. My talk will synthesize results from the Human Modified Tropical Forests programme (UK NERC) that examined this topic in Sabah, Malaysian Borneo. The HMTF consortium examined the response of a wide range of diversity and functions measured across a disturbance gradient comparing increasing intensities of logging and eventual conversion to an agricultural land use (oil palm plantation). I will also summarize results to date from a long-term study of tropical forest restoration – The Sabah Biodiversity Experiment. Taken together these studies should help us to better understand how human activities are impacting tropical forest ecosystems and how we can best restore them.

Frontiers in biodiversity science, from predictive modeling, human intervention in ecosystems, and being explicit about our biodiversity goals

Jessica Hellmann
Institute on the Environment, University of Minnesota; Saint Paul, Minnesota, USA

As I see it, there are three great challenges in biodiversity science today, and this talk will explore technical issues and social-ethical realities that we must confront to meet them. Ours is not a field of only scientific interest and natural observation but social striving and ethical dilemmas. First, I'll talk about the need for—and technical challenges of creating—predictive models that increasingly incorporate biological realities (e.g., local adaptation, species interactions), so that stakeholders can explore future realities with reasonable confidence. Second, I'll discuss the need to empirically and socio-politically test different strategies for human intervention in ecosystems, given shifting baselines from climate change and other stressors. And, third, I'll ask what we are all striving for and what the goal of biodiversity conservation can—and should—be in an era of climate change. Each of these asks scientists to show ambition, cross boundaries, and explore diverse possibilities for the future.

Causes and consequences of artificial light at night for biodiversity and ecosystem functioning

Eva Knop[1,2,3]
[1] *URPP Global Change and Biodiversity, University of Zurich*
[2] *Agroscope, Swiss centre of excellence for agricultural research*
[3] *Institute of Ecology and Evolution, University of Bern*

Artificial light at night (ALAN) is a rapidly increasing perturbation at night, and considered as a major global change driver of the 21st century. It can cause alterations in physiology and behavior of organisms, thereby increasing mortality, reducing reproduction as well as altering species abundances and community composition. Yet, its consequences for biodiversity, species interactions and ecosystem functioning are largely unknown. At the same time, the worldwide decline of pollinators has raised concerns of a parallel decline of the essential pollination service they provide to both crops and wild plants. Global change drivers of diurnal pollinator decline, such as agricultural intensification, the spread of pathogens, or climate change have received considerable attention. However, nocturnal pollinators, their pollination service, and the threat posed by ALAN have so far largely been neglected. We quantified for the first-time nocturnal plant-pollinator interactions in the field using a community approach. Furthermore, using commercial LED-street lamps, we set-up a large landscape experiment to quantify the effect of artificial lighting on nocturnal plant-pollinator interactions and the pollination service nocturnal pollinators provide. We show that ALAN has strong disruptive effects on nocturnal plant-pollinator communities with negative consequences for plant reproductive success. Further, by merging diurnal and nocturnal pollination sub-networks we show that the structure of these combined networks tends to facilitate the spread of negative consequences of ALAN from nocturnal to daytime pollinator communities. The results presented demonstrate that ALAN is a new threat to pollination and that negative effects of ALAN on nocturnal pollinators are predicted to propagate from the nocturnal to the diurnal community.

Scaling up interventions for nature conservation

Eric F. Lambin[1, 2]
[1] *School of Earth, Energy & Environment Sciences and Woods Institute for the Environment, Stanford University, Stanford, USA.*
[2] *Georges Lemaître Earth and Climate Research Centre, Earth and Life Institute, University of Louvain, Louvain-la-Neuve, Belgium.*

Given multiple interacting causes of environmental change, designing effective interventions to reverse degradation trends is challenging. A number of policy instruments have shown to be effective at the local scale, in specific contexts. A major challenge is the scaling up of policy interventions that are specific to a region, commodity or land use, to lead to systemic transformations of land use. New partnerships between governments, private companies and non-governmental organizations are reshaping land use governance. In particular, there has been a rise of voluntary sustainability standards in an attempt to manage social and environmental impacts of global supply chains. This has led to a policy ecosystem characterized by a proliferation of standards that complement, substitute or compete against each other, with coordination mechanisms beginning to arise. I will show that multiple interventions can have synergistic effects and reinforce each other to lead to more sustainable land use. The amplification mechanisms that create tipping points of adoption of new land use practices include public policies that support voluntary sustainability standards or make them mandatory, and commitments by dominant private companies that impose sustainability standards across their value chains. I will provide examples of policy mixes to reduce tropical deforestation by combining command-and-control and voluntary approaches, area-based and supply chain initiatives, and sanctions and incentives. Better understanding how new regulations interact with the pre-existing policy ecosystem will help designing more effective interventions.

Biodiversity, ecosystem function and feedbacks with human well-being: a case study with seafood, and an agenda for research

Mary I. O'Connor
University of British Columbia, Vancouver, Canada

Predicting the consequences of global change for biodiversity, ecosystem services and ultimately for human well-being is one of the greatest challenges society faces. Biodiversity – ecosystem functioning science has demonstrated how diversity and the processes that maintain it can enhance ecosystem functions. I will present new research that links biodiversity in seafood to measures of human well-being in terms of meeting dietary nutritional targets. Diversity in nutritional traits enhances human nutritional intake in seafood, and this effect persists whether seafood is selected from local or global species pools. Following this example that links biodiversity with the ecosystem service of nutritional provisioning, I will then make a broader argument for research priorities for the next 50 years of biodiversity research in the context of biodiversity – ecosystem function – ecosystem service projects. This agenda is developed collaboratively by leading biodiversity researchers, and identifies 6 grand challenges in biodiversity research to be prioritized in the coming decades that specifically target biodiversity, function and human activity feedbacks. Our 'Agenda 2049' aims to fill gaps between biodiversity science and ecosystem function and services science that persist even in the highest levels of biodiversity science, policy and management.

A multimodel analysis of historical trends and future scenarios for biodiversity

Henrique Pereira
German Centre for Integrative Biodiversity Research (iDiv), Halle-Jena-Leipzig, Germany.

Over the last two decades many scenarios exercises about the future of biodiversity have been carried out. However, they often use a single model and when different models are compared, they often use different driver projections. Here we present the first multi-model comparison with a set of harmonized land-use and climate change scenarios. We brought together ten biodiversity models and six ecosystem function and ecosystem services models to assess impacts of land-use and climate change scenarios in coming decades (up to 2050) and to hindcast changes to the last century (to 1900). We used harmonized scenarios from the Shared Socio-Economic Pathways – Relative Concentration Pathways (SSP-RCP). Biodiversity loss from land-use change is projected to keep up with historical rates or reduce slightly, but when combined with climate change it is projected to accelerate. During the 20th century there were increases in provisioning services at the cost of declines in regulating services. The same overall trend is projected to happen in coming decades, although with variation across scenarios. Renewed efforts are needed by governments if the 2050 vision for the Convention of Biological Diversity is to be met. Identifying policy pathways for such positive vision is at the core of on-going work by IPBES on developing Nature Futures Scenarios. I will conclude with a brief discussion on how multi-model projections are a key component of the development of Essential Biodiversity Variables in GEO BON.

Influence of environmental and competitive filtering on functional diversity of European Forests

Kirsten Thonicke
Earth System Analysis, Potsdam-Institute for Climate Impact Research (PIK); Potsdam, Germany

Environmental and competitive filtering determine which plant strategies occur in natural forests. Further, coexistence of functionally different plant strategies is influenced by leaf and stem-economics spectra, tree demography and disturbance impact. Trade-offs between plant traits result in different growth efficiency, and thus competitive strength of tree individuals. When combining these into the flexible-trait model LPJmL-FIT and with additionally replacing bioclimatic limits co-existence of PFTs and biogeographic plausible distribution emerge. Functional diversity can be computed from simulated distribution of plant traits in the niche space. Functional richness depends on the type of plant traits used and the dimensionality. Functional divergence reflects competitive exclusion and functional evenness resource efficiency in the niche space. Spatial gradients of those functional diversity indices reflect the influence of environmental and competitive filtering. Generalisations of functional diversity indices across spatial scales and plant traits used need to be discussed.

PLENARY SPEAKERS

A global synthesis of biodiversity responses to glacier retreat

Sophie Cauvy-Fraunie
National Research Institute of Science and Technology for Environment and Agriculture, Antony, France.

At the interface between the cryosphere, hydrosphere, pedosphere, glacier-influenced ecosystems are particularly sensitive to the impacts of climate change. Global warming has hastened both the rate and extent of glacial melting, which foreshadows global-scale modification in biodiversity patterns and functions and make these ecosystems critically endangered. Usually, these glacier-fed systems are referred as hostile environments characterized by low diversity and productivity. However, glacial influence also creates specific habitats sheltering unique ecosystems. Although our understanding of the ecological consequences of glacier retreat has improved significantly in the past decade, we still lack a comprehensive framework that can predict biodiversity responses to glacier retreat globally. To address these gaps, we conduct a meta-analysis of biodiversity change across glacial influence using 2100 observations from more than 200 published studies in the three major glacier-influenced systems: tidewater glacier-fed fjords, glacier-fed freshwaters, and terrestrial glacier forefields. We show that on average glacial influence has a negative effect on taxa abundance and richness, thereby forecasting a general increase in local diversity as glaciers retreat (winners). However, we also observe a significant heterogeneity among community and population responses to glacial influence, with 6-11% of studied populations threatened by the glacier retreat (losers). Most losers are specialised taxa, adapted to glacial conditions while winners are generalist taxa colonizing from downstream. Our analysis further identifies key geographical variables (glacier cover, isolation and melting rates but not latitude nor altitude) and species traits (body size and trophic position) that would modulate taxa sensitivity to glacial retreat.

Integrating methods to detect biodiversity and ecosystem function to enhance monitoring and management for sustainability

Jeannine Cavender-Bares
Department of Ecology, Evolution and Behavior, University of Minnesota; Minnesota, USA

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services has highlighted global trends in species extinction, habitat degradation and population declines. While many of the headlines were already known to the scientific community, the multiple IPBES assessments have also highlighted the gaps in knowledge and lack of information at regional scales on trends in biodiversity. Lessons learned from studies of global environmental risk management emphasize the importance of credible monitoring to implement and enforce intergovernmental commitments to reverse harmful trends. Consequently, expanding efforts to combine remote sensing approaches with the full range of ongoing biodiversity monitoring efforts to enhance their coverage and long-term continuity is of great interest. As part of these efforts, the need to embrace our comprehension of biodiversity in its many dimensions beyond species richness— including genetic, phylogenetic, functional and spectral diversity—across a range of spatial and temporal scales and to consider its contributions to myriad ecosystem functions—including belowground processes—will contribute to innovation in how we monitor biodiversity. A critical requirement for using remote sensing to monitor biodiversity is to constrain the problem. Combining both direct detection of community composition and predictive models of species pools using species distribution modeling approaches is one way to increase feasibility. Such approaches also lend themselves to forecasting in relation to global change and options assessment by examining trade-offs and synergies between biodiversity and ecosystem services. Enabling these efforts will further humanity's capacity to manage Planet Earth for sustainability.

Molecular alteration to soil organic matter under global changes

Xiaojuan Feng[a,b],* Juan Jia[a], Yiyun Wang[a,b], Jin-Sheng He[c]
[a] *State Key Laboratory of Vegetation and Environmental Change, Institute of Botany, Chinese Academy of Sciences, Beijing, China.*
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Alterations to soil organic carbon (SOC) cycling under global changes constitute a critical feedback of terrestrial ecosystems to climate change. However, due to the complex composition of SOC and counteracting responses of various carbon pools, it is challenging to detect subtle variations in SOC storage in a relatively short timeframe. Here we show several case studies where molecular-level investigations may reveal "early-sign" shifts in SOC sourcing and dynamics under global changes that have important implications to SOC storage in the long term. For instance, we utilize a long-term warming experiment on the Qinghai-Tibetan Plateau and demonstrate that warming induced substantial changes in carbon dynamics for the subsoil but not topsoil in an alpine grassland. Driven by elevated root distribution at depth, newly synthesized carbon accumulated in the silt-clay fraction of subsoils under warming, accompanied by increased concentrations of lipids, sugars and water-soluble peptides of both microbial and plant origins. However, lignin degradation increased in the subsoil (especially in macroaggregates) with shortening of soil freezing period and labile carbon-fueled microbial co-metabolism. These findings suggest that the warming response of topsoil may not reflect shifting soil carbon processes at depth. More importantly, as warming is accompanied by deepening roots in a wide range of ecosystems, root-driven priming of native SOC versus new carbon accrual needs to be evaluated beyond alpine systems to determine the future patterns and magnitude of soil carbon stock changes in a warmer world. Overall, our molecular approach delivers a mechanistic understanding for the high sensitivity of subsoil carbon dynamics to warming, which has significant implications for improving soil carbon models and predictions.

28 Years of Biodiversity and Ecosystem Function Research: Food webs connect core and integrative research domain

Jes Hines
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Over the last several decades, an academic conversation about biodiversity and ecosystem functioning (BEF) has emerged. I will present a network analysis that uses keyword co-occurrences to characterize and review almost three decades of research focused on these terms. The rapidly growing literature has developed in four core research domains that reflect dominant foci of biodiversity research published in the past 28 years. The analysis shows that food webs in aquatic and agricultural landscapes serve as integrative domains that connect divisions in scientific discussion surrounding BEF experiments and science policy. The divisions are defined by three main differences, namely 1) baselines upon which changes in diversity patterns are compared, 2) scale of inference, and 3) currency of measurements. Recognizing divisions and connections among core and integrative topics will contribute to stronger international and interdisciplinary cooperation. Such cooperation is essential for maintenance of biodiversity and ecosystem functioning across the globe.

Conservation, capitalism and colonialism: exploring the values and beliefs of the global conservation community

George Holmes
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There has long been a vibrant debate about the future of conservation, on what biodiversity conservation is and how it should be done. There has been a debate about the merits of competing ideas, as well as on whether certain demographic groups are imposing their ideas on a diverse movement. Here we present the results of the first global survey of conservationists. It shows that there is considerable agreement but also important areas of disagreement within conservation. Furthermore, there is considerable variation in how different demographic groups respond, including by gender, continent of origin, seniority, disciplinary background, age, and other factors. We also analyse the data in the context of where conservationists work compared to their country of origin, and debates about contemporary and historical colonialism within conservation.

The effects of climate change on the spatial dynamics and movement of species

Marcel Holyoak
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An age-old challenge in ecology, and one that is renewed in thinking about the ecological effects of climate change is to understand how spatial and temporal patterns of population dynamics and distributions are linked. Many kinds of species are likely to be affected by shifts in climatic regimes. Increasingly, studies have investigated aspects of spatial dynamics in relation to climate, such as range shifts viewed through metapopulation dynamics, shifts in predator-prey cycles of Arctic mammals, or the timing of seasonal migrations. I concentrate on aspects of the spatial dynamics and movement of single species, drawing on empirical knowledge and conceptual thinking to elucidate what kinds of changes in spatial dynamics are likely to occur and how changing patterns of organismal movement relate to these dynamics. Weather-induced changes can produce shifts from population sources to sinks, which seem quite frequent and could become more common with ongoing climatic change. The limitation to localized spatial scales where movement is sufficient to balance negative local population growth rates means that these kinds of dynamics may be seen particularly on advancing or receding edges of species ranges. Phenological and season-length changes are expected to produce more mixed effects on spatial dynamics. At a larger scale than source-sink dynamics, changed migration patterns are likely to mean that some seasonal visitors become residents, and in other habitats certain types of species are likely to be forced into becoming seasonal migrants if they are to persist in local communities. Increasing evidence of extreme weather events also creates more non-equilibrium local communities, such as through local extinctions within metapopulations or vacant niches and resource pulses for species that are either resident (e.g. propagule banks) or can rapidly invade. An overarching question that emerges from the review is whether climate change leads spatial dynamics becoming more frequent as species expand or contract, with patchy distributions or declining metapopulations, or whether the opportunities that arise from non-equilibrium conditions favor highly mobile species that may be more likely to show spatial dynamics. A synthetic view adds new understanding to our views of spatial dynamics and movement ecology.

Biodiversity Revisited: Sparking a new approach to research for the biosphere

Jonathan Hutton
Luc Hoffmann Institute, Gland, Switzerland

The biosphere ¬– the thin film of life that envelops our planet and sustains humanity – is being severely degraded by human action. The manifestations of this include a deterioration in land, air and water quality, continuing loss of natural ecosystems, extinctions and widespread declines in populations of wild species. A significant portion of this degradation, particularly of habitats and species, is generally described as biodiversity loss.

Biodiversity was coined to replace notions such as 'nature' and 'natural heritage' in the 1980s. It refers to the variety and variability within living organisms which is believed to contribute to the stability and resilience of living systems, offering insurance against predictable and unpredictable future environmental change. It also directly supports human livelihoods and welfare, especially of the rural poor. As with climate change, there have been some responses to the deterioration of biodiversity, but unlike climate change, these have been piecemeal and ineffective. There are a number of reasons why this may be the case. The concept is vague and the systems involved are complex. There is still only a rudimentary understanding of what constitutes a dangerous degree of biodiversity loss. It is therefore not surprising that concern about biodiversity degradation is not widely shared within society. It also explains why governments and businesses are able to ignore the issue.

A significant community of researchers, NGOs and others are deeply concerned about the lack of traction that biodiversity has in policy and mainstream economic activity. Some share this concern, but are also worried that, even more significantly, that a biodiversity framing may have taken us down the wrong path in terms of the issues to which society ought to be paying attention. The concept and narrative of biodiversity may have made it more difficult for a holistic framing where biodiversity is more tightly coupled with climate, land degradation and sustainable development. What would such a framing look like and what would its new science encompass?

How valuable is biodiversity?

Forest Isbell
College of Biological Sciences, University of Minnesota; Saint Paul, USA.

Biodiversity enhances many of nature's benefits to people, including the regulation of climate and the production of wood in forests and livestock forage in grasslands. Yet people are now driving the sixth mass extinction event in Earth's history. Halting biodiversity loss is listed among the United Nations Sustainable Development Goals. Biodiversity loss could substantially diminish the benefits people derive from nature by decreasing ecosystem functioning and stability. It remains difficult, however, to quantify and predict the cascading effects of human activities on biodiversity, ecosystem functioning, and ecosystem services, especially within remaining fragments of nature at the larger spatial and temporal scales that are most relevant to policy and conservation. New multiscale knowledge is beginning to link these relationships, revealing strong dependence of several ecosystem services on biodiversity. Global species extinctions (gamma diversity losses) reduce ecosystem functioning both through loss of local (alpha) diversity and through spatial homogenization of biota (loss of beta diversity). The gradual loss of biodiversity from remaining fragments of nature will likely result in social costs that greatly exceed current global conservation expenditures. Thus, it can be economically efficient to invest not only in preventing habitat loss, but also in conserving biodiversity and preventing the emergence of extinction debts within remaining fragments of nature.

Modelling the influence of ecosystem services (functions) on land-use decisions

Thomas Knoke
Institute of Forest Management, TUM School of Life Sciences Weihenstephan, Technical University of Munich, Germany.

A range of important ecosystem services or functions, uncertainties and mathematical optimisation approaches are usually underrepresented in land-use modelling. This presentation shows how a variety of ecosystem services or functions and their variability can inform the modelling of land-use decisions. A continuous but static optimisation approach is presented to consider multiple normalized indicators and to address their uncertainties, when simulating the allocation of land to land-use types. Information for indicators may come from many sources. Based on an example for Central Chilean forestry it is shown how expert opinions and their variability can be used to optimise the long-term composition of future forests to be established on previously burned forest lands. The rehabilitation of abandoned agricultural lands in Ecuador is used as a second example. Here, indicators are based on field experiments, models and household surveys. The results show that no single rehabilitation option dominates the desirable future composition of the currently abandoned lands. Rather forest and agricultural land-use types in combination with succession areas are needed to provide stable and high levels of multiple ecosystem service indicators. The consideration of uncertainty hardly changes these results. It is finally discussed how this model approach can be developed further towards a dynamic approach to model land-use scenarios.

Scale-dependent biodiversity patterns in marine foraminifera time series

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Planktonic foraminifera communities offer a rare opportunity for analyzing the dynamics of marine biodiversity over different temporal scales from millions of years to decades. We analysed data on community composition of planktonic foraminifera over eight million years at multiple time scales, combining measures of standing diversity (richness and the effective number of species) with measures of temporal community turnover (presence-absence-based, dominance-based). We found that richness decreased over time and the effective number of species peaked during the transition from cold to warm periods in the Earth history. Strongest community turnover was found at the longest time scales, but modern data show rapid decadal variation in the foraminifera dominance structure, which is of comparable magnitude as over eight million years. Here, we would like to reinforce the role of historical baselines of biodiversity change in interpretations of current dynamics and reveal that restructuring of communities occurs at all times and can reach similar magnitudes despite different drivers.

Does ecological complexity stabilize the community against external disturbances? - an empirical test based on a data-driven approach

Michio Kondoh
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Theory suggests that the ecological complexity may stabilize community dynamics and therefore potentially plays the critical role in shaping the ecosystem's response to external disturbances. However, not many empirical studies have succeeded in testing the hypothesis, partially due to difficulties in detecting interspecific interactions, measuring community complexity and identifying its hypothesized effect to community dynamics. In this talk, using a data-driven approach based on non-linear dynamical theory and long-term monitoring data, I show that in a marine fish community the fluctuating biodiversity is actually causing the seasonal fluctuations in community stability. Some conservation implications of the finding will be discussed.

Long-term dynamics and sustainability of human-nature interactions

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Human societies have major impacts on biodiversity and ecosystems, from local to global scales. In turn, they depend on biodiversity and ecosystems through a wide range of ecosystem services at multiple scales. This generates an important if poorly understood feedback loop between humans and nature. We build novel models that include this feedback loop together with changes in human behaviour and spatial ecological dynamics to investigate the stability of coupled social-ecological systems and their ability to keep providing ecosystem services to a growing human population. Our integrative dynamical approach provides important new insights into the long-term sustainability of human societies and of their interactions with biodiversity. In particular, it shows that modern human-nature interactions have an inherent propensity to generate societal collapse, and that preventing societal collapse requires foresight and strong collective action.

Relational Values and biocultural diversity: integrating earth and world

Barbara Muraca
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In the relational value approach, the importance of the natural environment for humans is framed in terms of reciprocal, constitutive relations, in which earth and world are inseparably entangled and interdependent. By drawing on decolonial thought and environmental justice studies, the presentation shows how this relational approach can help articulating struggles for the conservation of 'biocultural diversity' and offer a basis for fruitful alliances between Western-based science and other systems of knowledge.

Introducing the Essential Ecosystem Services Variables for monitoring sustainability

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The absence of a global harmonized system for jointly monitoring key ecological and social variables that can inform on important changes occurring in Earth's socioecological systems is a major impediment for designing adequate policies and informing decision-making for sustainability. The development of Essential Variables facilitates a coherent and systematic collection of data to inform progress towards policy objectives such as the Sustainable Development Goals (SDGs) or the Aichi Targets. While existing Essential Variables such as those for climate, biodiversity and oceans capture the biophysical components of the Earth System, they provide little to no information on human-nature interdependencies including nature's contribution to human wellbeing and the intricate sociopolitical and technological structures that exist to manipulate the flow of services from ecosystems to people. We propose a first set of **Essential Ecosystem Services Variables (ESSV) that can be considered as the minimum set of critical information needed to characterize** key dimensions of ecosystem services for policy and decision making. Divided into two main classes of essential variables, the ESSVs help describe the flow, demand and use of ecosystem services on the one hand, and highlight the values associated with the services. Each ESSV is **a value or measurement that captures one or more dimensions** of ecosystem services. An Essential Ecosystem Services Variable can be used alone, or it can be combined with other variables to create indicators of ecosystem service trends. We envision our EESV framework to be a starting point for monitoring efforts, not a fixed and final list.

Role reversal of actors tightening the P cycle in experimental and real-world grasslands

Yvonne Oelmann
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together with the Jena Experiment and Biodiversity Exploratory consortia

Biodiversity is an important driver of nutrient cycles, as demonstrated by experimental diversity manipulation. Particularly, higher plant diversity enhances complementary nitrogen (N) use and reduces N loading of groundwater. High and regionally even increasing N deposition will, however, shift many currently N-limited ecosystems towards phosphorus (P) limitation in the near future. Consequently, the biodiversity - P cycle relationship is increasingly important for ecosystem functioning. Our aims were to disentangle mechanisms underlying potential plant diversity effects on the P cycle in a plant diversity experiment and test whether these play out under real-world conditions in temperate, semi-natural grasslands.

In the experimental grassland, increased P availability in soil at high plant diversity originated from increased organic matter stocks which were used by heterotrophic microbes. Subsequently turnover of microbes released P into soil and increasingly so under favourable conditions (microclimate, microbial activity) at high plant diversity. Even though P availability was higher under diverse as compared to less diverse mixtures, P resources in soil were used more efficiently by plants as indicated by higher plant P exploitation. This might be related to complementary P-mobilizing plant traits and a tight link to the rhizobiome. However, more than a decade after establishment of the experiment soil organic matter (SOM) stocks in the experimental grasslands did not reach levels typical for real-world grasslands. The fact that SOM stocks were independent of plant diversity and of management in real-world grasslands suggests that SOM stocks at quasi steady-state conditions in the experimental grassland will not depend on plant diversity – though these likely will be reached at a diversity-dependent pace. Therefore, plant diversity effects on environmental factors might be less pronounced once steady-state conditions of soil organic matter stocks will have been reached in the experimental grassland.

In a wide range of semi-natural grasslands, plant diversity was largely determined by nutrient availability linked to management. We statistically accounted for the influence of management, yet mechanisms described above for the experimental grassland could not be detected in real-world grasslands. This discrepancy was related to the central role of plant-diversity dependent SOM accumulation in the experimental grassland which was not observed under real-world conditions. Nevertheless, plant diversity fed back positively on microbial P resource use and strongly reduced P availability in soil of real-world grasslands. Strikingly, actors responsible for a tight P cycle differed between experimental (plants) and real-world grasslands (soil microorganisms) because of a shift in the competitive success of acquiring P resources mediated by mycorrhizal fungi.

Together, our results clearly demonstrate that higher plant diversity leads to tightened P cycling. Because P losses can be reduced by increasing plant diversity in either case, grassland management should promote and maintain higher plant species richness particularly in view of finite rock reserves of P fertilizer.

What is lost through no net loss

John O'Neill
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No net loss approaches to environmental policy claim that such policy should aim to maintain aggregate levels of natural capital. Substitutability between different natural assets allows losses in some assets to be compensated for by gains in others while maintaining overall levels of natural capital. The paper argues that major goods that matter to people and their well-being will be lost through a policy of no net loss. The argument is developed through a criticism of the claim that environmental goods should be characterised in terms of natural capital and the ecosystem services they provide which underpins the no net loss approach to environmental policy. The concepts of natural capital and ecosystem services assume de dicto valuations of environmental goods that cannot capture all the dimensions of value that matter to human well-being.

Flux towers in the sky: biodiversity and ecosystem function from space

David Schimel
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Today, global ecology is enabled by vegetation indices (greenness) from operational space-based imagery but new sensor capabilities greatly expand the scientific possibilities for ecologists. New observations from spacecraft on orbit allow estimation of gross carbon fluxes, photosynthesis, biomass burning, evapotranspiration and biomass, to create virtual flux towers in the sky. New technology, on orbit now or soon to be launched will reveal dimensions of the diversity of life itself through canopy and ecosystem structure, plant functional traits and habitat models for other taxa. These observations will improve our understanding of the global productivity and diversity-productivity relationships. Advances in remote sensing challenge ecologists to relate information organized by biome and species to new data arrayed by pixels and develop theory to address previously unobserved scales. Crucially, space-based observations will provide a global baseline, and the ability to detect change and prioritize field effort to obtain taxonomically-based data. The flood of data from space both enables and challenges the biodiversity research community.

Deciphering the biodiversity-production mutualism in the global food security debate

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Current conservation efforts notwithstanding, significant biodiversity losses are continuing across the planet. Much of this is driven by food production – particularly the expansion of pasture and cropland. While major achievements have been made to boost agricultural production, we can show that production increases slow down: we reached peak rate years of renewable resource production. These higher yield are typically accompanied by intensified production techniques, which come with negative consequences for biodiversity. Yet biodiversity in agricultural landscapes is critically important to maintain agricultural yields for proving basic ecosystem function such as pollination or biocontrol. While this mutual dependency of biodiversity and agricultural production is undisputed, empirical implementations of these relationships are lacking. The knowledge needed to gain a quantitative understanding of the biodiversity-production relationship under land-use intensification is available but fragmented. Synthesis and new modeling approaches require a new conceptual framing which must transcend disciplinary boundaries. This paper finally suggest a framework for conceptualizing integrated models of the biodiversity–production mutualism and discusses how these models can be used to support more comprehensive assessments of the planet's productivity.

The projected timing of ecological disruption from climate change

Christopher Trisos
National Socio-Environmental Synthesis Center; Annapolis, Maryland, USA.

Anthropogenic climate change is becoming a major driver of biodiversity loss, disrupting ecological assemblages, but the nature of this disruption—gradual or abrupt—and the consequences for people depend critically on the timing of individual species impacts. I will present projections of future ecological disruption due to climate warming throughout the 21st century, suggesting abrupt disruption beginning before 2030 in tropical oceans, spreading to higher latitudes by 2050, and having a global mean in the 2070s under a 'business-as-usual' scenario. Beyond the internationally agreed limit of 2°C warming, the risk of abrupt ecological disruption accelerates. These findings highlight the impending risk of sudden biodiversity declines from climate warming, with consequences for forecasting disruption to ecosystem services, natural climate solutions and ecosystem-based adaptation to climate change.

The Aldabra Clean Up Project

Lindsay Turnbull
Department of Plant Sciences, Queens College, University of Oxford; Oxford, UK

Aldabra Atoll is a UNESCO world heritage site, and one of only two raised coral atolls left in the world that has not been heavily impacted by human activity. However, despite protection from the Seychelles Government, it is increasingly a victim of an exploitative global business model that treats natural resources as disposable commodities. In 2018, we began fundraising to remove tonnes of plastic debris that had accumulated along its coastline and in March 2019 a group of multi-national volunteers spent five weeks cleaning up. I present the shocking findings of this expedition and discuss where we go next in trying to safeguard Aldabra's future.

Inclusive concepts for biodiversity governance: democratic legitimacy and pluralism at the science-policy-society interface

Esther Turnhout
Forest and Nature Conservation Policy Group, Wageningen University, The Netherlands.

The relation between science, society and policy is in flux with science being pulled in different directions. Calls for so-called evidence-based policy making suggest that the need for reliable scientific knowledge is greater than ever, but at the same time, the authority of science is increasingly questioned in public knowledge controversies. In this context, there is a need for institutions of biodiversity expertise to rethink their identity and role as well as their place in democratic societies. One crucial question is how to make sure that expertise is not just credible and relevant, but also inclusive of diverse stake- and knowledge holders. In this talk, I will use examples from the domain of biodiversity policy to illustrate the various tensions and challenges that inevitably emerge at the interface between science, policy and society. Drawing on our recent book[1], I will use these examples to sketch out different options for making and justifying ethical choices in knowledge production and ensuring the democratic legitimacy of environmental expertise. In developing this argument, I will pay particular attention to the importance of accommodating pluralism in ways of knowing and valuing biodiversity as a condition for the democratic legitimacy of expertise.

[1]Turnhout, Tuinstra and Halffman, 2019. Environmental expertise: connecting science, policy and society, Cambridge University Press. https://www.cambridge.org/nl/academic/subjects/earth-and-environmental-science/environmental-science/environmental-expertise-connecting-science-policy-and-society?format=PB

The GEO BON`s challenge of monitoring Ecosystem Services

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The Ecosystem Services concept continues to evolve from its beginnings. The concept now includes multiple conceptualizations of values, and the incorporation of multiple trade-offs and scales into decisions concerning nature conservation and sustainable development. Despite this progress, there are still many challenges ahead, requiring a broad interdisciplinary team of scientists to jointly address them. The Group on Earth Observations Biodiversity Observation Network (GEO BON) is an initiative aimed at improving our understanding and the availability of data on changes in biodiversity and related ecosystem services so that better informed policy decisions can be taken. The Ecosystem Services Working Group (ESWG) of GEO BON contributes to the international research community in three ways: (1) the development of monitoring concepts related to ecosystem services, (2) the development of ecosystem services measures and indicators which are spatially and temporally scalable, (3) promoting the implementation of ecosystem services in policy contexts. The first area aims to advance our conceptual representation of ecosystem services, including further elaboration of new and expanding ways of approaching ecosystem services. The second area explores how these concepts can be established into entities that can be measured and monitored where applicable, and how to develop propositions of monitoring methods and measurements to track changes in ecosystem services and their benefits across spaces and time. The third area brings the information from the first two areas into policy and other practical uses of particular interest for ecosystem managers, decision makers and their policy conventions. I will present the framework used in the working group and some examples of ongoing work and future directions.

IGNITE PRESENTATIONS

Quantifying social-ecological system sensitivity: A multi-disciplinary approach to global change research?

Maarten B. Eppinga and Maria J. Santos
URPP GCB University of Zurich; Zurich, Switzerland

Global Circulation Models (GCMs) provide the scientific basis for the IPCC Assessment Reports. An important goal of GCMs is to quantify climate sensitivity. In this context, climate sensitivity describes how internal system feedbacks modify the system's initial response to the perturbation of the Earth's radiation balance, as driven by anthropogenic greenhouse gas emissions. In this ignite talk, we will explore to what extent this concept of sensitivity can be used to quantify and catalogue social-ecological system responses to changing environmental conditions. First, we will present a detailed example of how ecosystem sensitivity can be quantified in the study of biodiversity responses to habitat fragmentation. We will show how these responses need to integrate system responses in time (e.g. secondary extinctions) and space (e.g. cascading regime shifts). Second, we will address some of the outstanding challenges involved in broadening the concept and developing generic metrics to quantify social-ecological system sensitivity.

Close-range laser scanning and vegetation structure: Can we have too much information?

Felix Morsdorf
URPP GCB, University of Zurich; Zurich, Switzerland

Laser scanning's unique measurement capability has the potential to revolutionize the way we assess and quantify three-dimensional vegetation structure. Modern laser systems used at close range, be it on terrestrial, mobile or unmanned aerial platforms, provide dense and accurate three-dimensional data whose information just waits to be harvested. However, the transformation of unorganized 3d point-cloud data to information is not as straightforward as for airborne and space-borne approaches, where typically empirical models are built using ground truth of target variables. Simpler variables, such as diameter at breast height, can be readily derived and validated. More complex variables, e.g. leaf area index, need a thorough understanding and consideration of the physical particularities of the measurement process and semantic labelling of the point cloud. The physical information of the laser scanning process is still underused and we show how it could play a vital role in conjunction with three-dimensional radiative transfer models to shape the information retrieval methods of the future. Using recent examples, this ignite talk will highlight the potential of laser scanning data and aims at triggering a discussion of how much non-redundant data could possibly be needed in ecological applications and if there could be such a thing as too much information.

Genotypic filtering under global change at spatial and temporal scales

Michael J. O'Brien
URPP GCB University of Zurich; Zurich, Switzerland

Global change drivers such as land-use and climate change cause biodiversity declines in forests on nearly every continent. The effects of these variables on species composition and abundance have been well studied. However, the role of these global change drivers on altering genotypic diversity at local, landscape and regional scales is a persistent knowledge gap, especially in species-rich systems such as tropical rainforests. Genotypic diversity and its response to global change drivers has implications for assessing environment and organismal feedback loops, understanding species and community resilience, predicting future species distributions and informing mitigation/restoration practices. I will briefly summarize potential impacts on, and responses of, genotypic diversity on these drivers with a focus on tropical forests, which are simultaneously facing conversion to agriculture, resource overexploitation and climate change. I intend to mediate a discussion around developing a conceptual model to synthesize the effect of these interacting drivers on genotypic diversity. The goal of the model would be to create a foundation for formulating research approaches to empirically test the effect of these global change drivers at the level of within species while extending those impacts to larger spatial and temporal scales.

Metacommunities in Dynamic Landscapes

Gian Marco Palamara[1,2], Charles Novaes de Santana[2,3,4], Alejandro Rozenfeld[2,5], Carlos Melián[2]
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Habitat change, due to both human and non-human factors, is one of the main drivers of biodiversity changes at different spatiotemporal scales. Experiments, theory and field data have shown how landscape connectivity, measured as the maximum distance among connected sites in a static landscape, affects local (alpha) and regional (gamma) diversity. Whether species richness increases or decreases with the connectivity of a static landscape, the effect of landscape dynamics on biodiversity remains poorly explored and yet, a unified theoretical framework to describe such dynamical changes is lacking. In this talk, I will show how to extend metacommunity theory, classically used to describe biodiversity in static landscapes, to include dynamical changes in landscape connectivity. I will show how including periodic fluctuations in landscape connectivity allow alternate processes of migration and speciation driving patterns of biodiversity that consistently differ from the patterns predicted by metacommunity theory in static landscapes. This novel theoretical framework improves our mechanistic understanding of biodiversity dynamics and provides new testable predictions about species diversity in rapidly changing landscapes.

How do life experiences shape our perception of and attitudes towards biodiversity? A quest for more shared, positive experiences on biodiversity

Alejandra Parreño, Owen Petchey, et al.
URPP GCB, University of Zurich, Switzerland

What common biodiversity experiences do all humans on Earth have? For complex concepts such as biodiversity, it is not likely that we have a common experience, such as, for example, temperature. In addition to reaching an agreement on valid and useful measurements, perception of what is diverse, and why diversity may be valuable in a system may differ according to a person's background, their interests and their situation. In this context, we asked ourselves:
In this ignite talk, we will delve into some of the shared experiences that may be consciously, or subconsciously, shaping our perception of biodiversity, and consequently its management. We will discuss two almost-universal human life experiences: games and food. Playing games is one of the first ways we are introduced to many concepts in life, society and the nature that surrounds us. Through such experiences we develop our cognitive skills, a sense of our role in the world, and our opinions about good and bad. Food, in contrast, is unequivocally one of the primal relationships we have with nature throughout our life. There is a rich corpus of research on the influences and consequences of the biodiversity we consume. The combination of different elements in recipes is by itself an exercise in understanding the non-additive value of diversity.
We propose that avoiding accidentally biased experiences and creating more nuanced and shared experiences of diversity would lead to more unified attitudes towards an understanding of biodiversity. Such a unified approach would have an impact on the decisions made regarding biodiversity. What do you think? Please join us to debate these ideas and broaden our point of view during the discussion following this ignite talk.

Temperature effects on ecological stability across scales

Frank Pennekamp
URPP GCB, University of Zurich, Switzerland

Global temperatures continue to rise due to the effects of man-made climate change. Despite temperature being one of the most prominent drivers of biological systems, we are still unable to accurately predict the effects of temperature on the stability across scales of ecological organization for any given ecosystem. I will present three experiments designed to understand the effect of increasing temperature on the stability of simple ecological communities -- a predator-prey pair, a simple food web, and competitive communities of protists -- and contrast our results with available theory. Despite temperature generally leading to destabilization, I will illustrate the different pathways leading to lower stability and how community complexity and additional stressors interact with temperature.
With this talk, I want to stimulate discussion about how to better integrate temperature effects on stability across scales, how to connect empirical and theoretical work on ecological stability and how to provide a more integrative approach to the multifaceted nature of ecological stability in the face of environmental change.

Genomics for global change studies

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

In the face of global change, it is important to understand and predict phenology, the study of recurring plant and animal life cycle stages, especially their timing and relationships with weather and climate (an interdisciplinary discussion resulting in a URPP GCB terminology brief). My group proposed that time-course gene expression data will improve the accuracy of the prediction of phenology (Yamasaki et al. 2017, a review paper in collaboration with the URPP GCB). Here I would like to discuss the potential of machine learning in analyzing large data sets such as gene expression together with meteorological and remote sensing data.

Freshwater community stability in stressful times

Sofia J. van Moorsel[1,2], Owen L. Petchey[2], Justin Marleau[1], Charles Bazerghi[1], Jorge Negrin Dastis[1] and Andrew Gonzalez[1]
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We tested the interactive effects of two environmental stressors, acidification and heat, on the stability of aquatic freshwater communities. To this aim, we measured dissolved oxygen (DO) in freshwater mesocosms as a proxy for whole community functioning over five months in a set of mesocosms at the Gault Nature Reserve in Mont-St-Hilaire, Quebec, Canada. We used data from 12 sensor loggers deployed in mesocosms that differed in their water pH, which measured DO every 20 minutes.
Initial results show that the two co-occurring stressors interacted and reduced community stability; however, the effect on community stability depended on the time scale. A (temporary) crash in diurnal variation in response to stress can be viewed as lower stability, whereas a lack of monthly variation means greater stability. It is thus important to consider stability at different time scales when assessing how environmental changes impact community stability.

Improved understanding of ecosystem functioning as a response to climate and biodiversity change by the use of lipid biomarkers

Guido L.B. Wiesenberg, Carrie L. Thomas
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Climate and environmental changes and anthropogenic activities have diverse and strong impacts on the quality and cycling of organic matter at the ecosystem level. Whereas changes in plant biodiversity can be traced, e.g., by field surveys or remote sensing, qualitative changes of plant and microbial organic matter are not so obvious but may have a strong impact on the resilience of ecosystems, the food chain, and the fate of organic matter and nutrients. Some biomarkers which can be used to distinguish different types of biomass, enable the deciphering of organic matter sources, and trace past and present environmental changes in plant biomass, peat, soils and sediments are included in the lipid compound class. Bound lipids, such as phospholipid fatty acids, intact polar glycerol dialkyl glycerol tetraethers, and suberin- and cutin-derived biomarkers, can be used to qualitatively and quantitatively describe different functional groups of biomarkers and root- versus leaf-derived organic matter, respectively. Free extractable lipids like alkanes, fatty acids, alkanols, sterols and many others enable improved identification of organic matter sources and assessment of their fate in different ecosystems, especially if they are combined with compound-specific isotopes such as $\delta^{2}H$, $\delta^{13}C$ and $\Delta^{14}C$. As information across different biomarkers and biomarker classes can be fragmented and might not show uniform results, we started improving the VERHIB model (Vegetation Reconstruction with the Help of Inverse modeling and Biomarkers) to improve our knowledge with respect to the significance of environmental changes and the fate of organic matter by simultaneous analysis of multiple biomarkers. This approach might be extremely valuable for a better understanding of ecosystem functioning and responses to global change.

SESSION FIVE POSTERS

Ecosystem services trade-offs arising from non-native tree plantation expansion in southern Chile (Poster 7)

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Helmholtz Centre for Environmental Research; Leipzig, Germany

Non-native tree plantations (NNTP) are an increasingly relevant global source of timber. Their expansion may lead to tradeoffs with important local ecosystem services (ES) that need to be evaluated for a sound and sustainable landscape planning. For a mountain area in southern Chile, we assessed the effects of NNTP expansion and potential NNTP timber-ES tradeoffs through a spatial tradeoff typology based on ES supply variations. We evaluated changes in prioritized ES (native timber supply, forage supply, water regulation, and recreation opportunities) and NNTP timber supply based on a probabilistic projection of NNTP expansion at two administrative levels (the municipality and small, medium and large farm properties). Results show that NNTP expansion triggered an increase of 361% in NNTP timber supply at the expense of decreases in provision of selected ES, such as forage supply (16.3%), native timber supply (9.4%), water regulation (0.4%) and recreation opportunities (66.8%). Tradeoffs were restricted to small geographic areas but were considerably high in terms of the magnitude of ES supply losses. Tradeoffs were highest in medium farms as compared to small and large properties. Results corroborate that tradeoffs arise from the interplay of several factors, such as ES type and ES productivity, and they are site-specific and scale dependent. If NNTP continue to expand at the current rate (yearly 9.6%) and under the current management (large scale monocultures), significant ES supply changes are inevitable. These results can inform landowners, landscape planners and governments to better anticipate and mitigate tradeoffs arising from afforestation.

Mangrove ecology on an undisturbed atoll: Diversity, changes in extent over 30 years, and structure on Aldabra, Seychelles (Poster 3)

Annabelle Constance[1], Michael Schaepman[1], Owen Petchey[1], Nancy Bunbury[2], Dennis Hansen[3], and Gabriela Schaepman-Strub[1]
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Islands and their endemic biodiversity are challenged by the loss of suitable habitat as a result of sea level rise. In this research project, we assess the persistence of ecosystems on low-lying atolls of the Indian Ocean in the face of global change drivers. Specifically, we evaluate mangrove diversity, changes in extent, and forest structure in relation to their environment on Aldabra Atoll—Seychelles' largest area of mangrove forest (1720 ha)—to understand the response of this protected habitat to a moderately increasing sea level in the Indian Ocean.
Plot-based diversity was surveyed in a large mangrove stand on the atoll in 39 plots of 25m^2. On an atoll-wide scale, a post-classification change detection method (the overlay of two independently classified images to derive extent change) was applied on several Landsat surface reflectance images from 1985 to 2015. An extensive field campaign is planned in fall 2019 to improve understanding of the mechanisms underlying patterns in mangrove forest structure and observed extent changes.
Three mangrove species were encountered in the survey: the most important (considering frequency, density and dominance) was *Rhizophora mucronata*, followed by *Ceriops tagal* and *Avicennia marina*. The tallest mangrove tree recorded was 8.1 m and the largest had a stem diameter of 47.4 cm (*A. marina*). The seedling density in the stand was 12.3 stems/ha, indicating a high rate of regeneration and recruitment.
Results of the change detection reveal a net gain of 174 ha in mangrove area on Aldabra during the study period. The increasing trend is related to the dynamic mangrove vegetation, which expands especially at its landward margins, suggesting that mangroves on Aldabra are resilient and persistent in colonizing new suitable areas over time. Loss of established mangrove forests at their seaward margin was observed only on the northern, most exposed part of the coastal lagoon, highlighting the importance of continued habitat monitoring.
This work serves as a valuable baseline for understanding the ecology of pioneer mangroves on islands and their response to climate change drivers in the absence of local human effects.

Evolution in a community context alters species response to environmental change
(Poster 12)

Lynn Govaert, Luis J. Gilarranz, Florian Altermatt
URPP GCB, University of Zurich; Zurich, Switzerland

Attempts to bridge evolutionary biology and community ecology have been mainly conceptual. Hence, experiments often still lack such an integration: evolutionary experiments often ignore the community context, while community ecological experiments ignore the possibility of evolution to occur. We present an experiment that takes both aspects into account. Specifically, we evaluate the evolutionary response of two competing protist species – *Paramecium aurelia* and *Spirostomum teres* – to an increased salinity gradient when the species occur in monoculture, or when they co-occur across five different salinity concentrations during three months. At the end of the selection experiment, we performed a common garden experiment to evaluate the response of the evolved protist populations and communities to each of the five salinity concentrations. We found that evolution in the community context not only results in different trait values, but also alters the species response to the salinity gradient. Next, we used a recent developed method, the reaction norm approach, to calculate contributions of plasticity, mean trait evolution and evolution of plasticity to observed changes in population mean trait values, but also in higher moments of their trait distribution. This approach allows connecting plasticity responses with adaptation to novel environments.

Urban administrative promotion enhances governance capacity (Poster 10)

Gengqiu Gelai (Konchok Gelek)
URPP GCB University of Zurich; Zurich, Switzerland

This PhD project studies urbanization on the Tibetan plateau that affects the political economy of agricultural land in the urban fringe against the background theme of an unprecedented urbanization process throughout China. We aim to understand planning and practice of the administrative system of the newly created city of Yushu, which was reconstructed out of the county town of Jyekundo that was devastated by an earthquake. This urban administrative promotion was designed to enhance governance capacity through administrative structural changes, the creation of new apparatus such as UGMM, conversions of collectively owned agricultural land to urban land, the property relationship, demarcations of urban space, and requirements of residential registration.

This project aims to show the effects of this urban administrative promotion in terms of state capacity in the urban fringes. These effects are studied combining different sources of data, from narrative accounts of residents, farmers, government officials and traders, to field observation, mapping, government documents and literature reviews.

Through this data, I will show how urban administrative promotion leads to an expansion of the state apparatus and increases control of the state over citizens in the urban margins. I identify three mechanisms through which the state's capacities are expanded:

(i) Upgrading administration increases governance capacity to implement plans and policy and to monitor temporal migrants and permanent residents.

(ii) Re-classification of political entities provides easy access to administrative services but it strengthens state control of citizens.

(iii) City health standards are propagated by the government as a key instrument to develop Yushu city as a "civilized", patriotic and eco-friendly city. Standards serve to discipline inhabitants at the urban fringes into "modern citizens".

Inference of species interactions and prediction in changing environments (Poster 4)

Anubhav Gupta, Owen Petchey, Florian Altermatt, Jordi Bascompte, Catherine Graham, Jakob Pernthaler
URPP GCB, University of Zurich; Zurich, Switzerland

Knowing the food web structure is crucial in understanding its dynamics and response to environmental changes. Various sources of information have been used for food web prediction. We would like to address the following questions: A. How can diverse sources of information such as gut contents, stable isotope composition of tissues and direct observations be used simultaneously to infer the structure of an ecological network (food web)? B. What increase in the precision and accuracy of network inference is gained from using multiple sources of information? C. Which sources of information are valuable, and which are redundant? D. What are the implications for predicting network responses (e.g. structure and stability) to changing environments across spatial and temporal scales? To answer Question A, we will use network model selection and parameterization via approximate Bayesian computation (ABC). We have implemented the rejection algorithm in ABC to parameterize a food web model which is Allometric Diet Breadth Model (ADBM). Along with the model parameters, ABC also quantifies the underlying uncertainties. Questions B and C will be addressed *in silico* by simulating networks (food webs) so that true parameter values are known. Inferred parameter values will be compared to true ones, and inferred network structure will be compared to true network structure. Variation in the types of information used for inference will be compared to variation in accuracy and precision of the parameter estimates and network structure. Question D will be addressed *in silico* by making predictions of changing network structure that include parameter uncertainty with appropriate propagation of uncertainty. Prediction of changing network structure will be useful depending on the size of the effect of environmental change relative to the uncertainty in that effect size. An important goal of the project is that the questions are addressed in case studies of real ecological communities and not just *in silico*. Such collaborative case studies within the URPP GCB focus on networks observed at test sites and we could transfer this expertise to other research projects and individuals within the URPP GCB.

GlobDiversity: RS-enabled EBVs contribute to the observation of key biodiversity characteristics using satellites (Poster 9)

Isabelle Helfenstein[1], Claudia Roeoesli[1], Vladimir R. Wingate[1], Gabriela Schaepman-Strub[1], Paul Haverkamp[1], David Small[2], Michael E. Schaepman[1]
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GlobDiversity is a European Space Agency (ESA)-funded project aimed at defining and developing a means to assess biodiversity on a global scale using satellite remote sensing (RS). Remote sensing-enabled essential biodiversity variables (RS-enabled EBV) are metrics that are relevant for biodiversity monitoring retrieved from RS. Best practice approaches were developed for three RS-enabled EBVs as part of this project, including Land Surface Phenology (LSP), Ecosystem Fragmentation, and Canopy Chlorophyll Concentration. These RS-enabled EBVs are being developed on ten pilot sites located across six terrestrial biomes. As part of GlobDiversity, we developed a novel RS-enabled EBV based approach on characterizing LSP at a high spatial resolution and large spatial scale. LSP characterizes recurrent biological events in the annual profile of vegetated land surfaces at ecosystem scales, as observed by RS. RS has been widely used as a measure of the response of terrestrial ecosystems to changes in climate and environmental conditions or for characterizing species composition and ecosystem biodiversity. The LSP algorithm was developed at a high spatial and temporal resolution by merging Sentinel-2 and Landsat-8 satellite time series. Currently, the algorithm prototyping, implementation, testing and upscaling is taking place. Here, the objective is to enable the production of the RS-enabled EBVs across biomes by implementing the RS-enabled EBV algorithms into an operational cloud computing processing system. Their effectiveness at monitoring biodiversity and their usefulness for conservation applications are currently being demonstrated in four use-case studies. In Kytalyk, Siberia, we are currently investigating the biodiversity monitoring and conservation applications of RS-enabled EBVs, particularly LSP. Here, the focus is on demonstrating how these can be used to model the nesting habitat and breeding success of the Siberian White crane (*Grus leucogeranus*), as well as the lesser sandhill crane (*Grus canadensis*).

ARES: Airborne Research Facility for the Earth System (Poster 14)

Andreas Hueni, Felix Morsdorf, Michael E. Schaepman
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The Airborne Research Facility for the Earth System (ARES) is an integrated research infrastructure for measuring terrestrial processes of the Earth system at a regional scale. Data from complementary remote sensing instruments are assimilated in models within a dedicated computing infrastructure. The objective of this project is to design and implement the ARES infrastructure, which comprises airborne sensors, processing and storage segments for the payloads, and Earth system models parameterized by ARES sensor data.
ARES is currently being designed and implemented. The first payload component is the Compact Wide Swath Imaging Spectrometer (CWIS-II), expected to enter operations in 2021 – 2022. CWIS-II exists as a prototype at NASA/Jet Propulsion Laboratory (JPL), and JPL and UZH are developing CWIS-II in collaboration. Meanwhile, NASA and UZH have entered a 5-year agreement to fly NASA airborne spectrometers in Europe. This will bridge any possible data availability gap between the current APEX sensor and CWIS-II and prepare both the calibration and the product scientists for the data from CWIS-II.
APEX, the current airborne imaging spectrometer used within URPP GCB, and AVIRIS-ng, the current top-notch imaging spectrometer of NASA, were already flown in tandem in a European flight campaign in 2018. A further AVIRIS-ng campaign in Europe is planned for 2020, once more targeting URPP GCB-relevant sites.

Qinghai-Tibetan Plateau Test Site (Poster 23)

Benedikt Korf, Bernhard Schmid
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The Qinghai-Tibetan Plateau site (37.48N, 101.21E) is described as alpine meadow, dominated by *Kobresia humilis* and various grasses and forbs along the valley floor. Shrubs (*Potentilla fruticosa*) are located on the northern slopes and the marsh vegetation consists primarily of *Kobresia tibetica* and *Pedicularis longiflora*. The overall land-use patterns in the higher regions are summer grazing lands. Valley floor meadows are grazed in winter because over 80% of the precipitation in the region occurs during summer (Zhao & Zhou, 1999). 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 this field site. Current research funded by the URPP GCB studies the transformation of peri-urban landscapes at the fringe of Yushu City, a growing urban settlement. The project, conducted by PhD student Konchok Gelek, studies the political dynamics of urban expansion and how these dynamics change land use patterns in the peri-urban fringes and the rural vicinities. Previous research conducted global-change experiments to study biodiversity effects at high altitudes (Bernhard Schmid), and a new collaboration is under way, led by Bernhard Schmid and Michael Schmidt, to study deep-soil warming.

Lake Zurich Test Site (Poster 21)

Alizée Le Moigne, Jakob Pernthaler
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Lake Zurich (also referred to as Lower Lake Zurich) is a peri-alpine lake located on the Swiss Plateau. It provides key ecosystem services, most importantly the drinking water and a recreational hotspot for roughly a million residents in the adjacent settlement area. It is the only exclusively aquatic test site within the framework of the URPP GCB. The lake has been intensely studied for the past 4 decades by members of the Limnological Station of the UZH situated at the lake shore in the village of Kilchberg. Based on the available long-term data series, Lake Zurich also acts as a sentinel of global change. Specifically, the lake has undergone a distinctive warming of the water column during that period, resulting in profound changes of seasonal mixing processes and the functioning of the planktonic communities. The focus of the preceding phase of the URPP GCB has been on changing macroscale physical processes and their effects on a dominant primary producer, *Planktothrix rubescens*, directly leading to a follow-up project within a larger international framework (EU INTERREG). Our current investigations link experimental work on the assembly processes and carbon use efficiency of aquatic microbial assemblages from Lake Zurich with observational data collected at the Siberian test site.

Scaling diversity-productivity relationships from experimental field plots to real-world landscapes (Poster 17)

Sarah Mayor, Florian Altermatt, Michael Schaepman, Bernhard Schmid, Pascal Niklaus
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Biodiversity loss is now ranked among the top global stressors affecting species and ecosystems. However, empirical evidence for impacts of biodiversity loss on ecosystem functioning largely rests on plot-level studies and thus is restricted to the organizational scale of species and the spatial scale of typically small plots. To date, it thus remains unclear whether and to which extent these experimental results can be extrapolated to real-world landscapes that are characterized by meta-ecosystems with a more complex hierarchical structure.
Here, we address this topic by adopting quasi-experimental study designs that combine species inventory data and land cover information with satellite-remote sensed time series of terrestrial productivity. Specifically, we posit that the additional scales of ecological and spatial complexity in natural landscapes may lead to diversity-functioning relationships different from the ones found at the small scale of traditional experiments. Using Switzerland as a study region, we demonstrated that landscape-scale productivity and its temporal stability increase with the diversity of plants and other taxa with effects sizes comparable to plot-scale biodiversity studies. We further showed that growing season length increased progressively over the observation period and that this shift was accelerated in more species-rich landscapes, suggesting that biodiversity facilitates adaptation to climate change (Oehri et al. 2017 PNAS 114 10160-10165). In a second study, we tested whether diversity effects also occur with respect to the diversity of larger organizational units, namely entire ecosystems. This hypothesis was motivated by the reasoning that a multitude of functionally relevant spatial connections exist among ecosystems and that these could support novel, emergent, interactions in real-world landscapes that could sum up to relevant diversity effects at the landscape scale. Analyzing data from more than 4,000 landscapes, we were able to demonstrate that landscapes composed of multiple ecosystem types indeed had higher levels of functioning and that this functioning was temporally more stable (Oehri et al. 2019 Nat. Comm., rev. submitted). We are currently in the process of extending and developing these analyses by (1) considering larger regions in a number of different biomes to enable tests of environment-dependencies of diversity-functioning relationships; and (2) integrating effects across scales by linking species and ecosystem-type level diversity and productivity data.
Our research bridges concepts and methods from remote sensing, community ecology and biogeography and provides a framework in which diversity effects can be evaluated across scales and biomes. It links plot-scale studies with the landscape dimension, which currently is largely uncharted terrain in ecological biodiversity and ecosystem functioning research. This appears critical given that this link ultimately is important for modeling and forecasting. Within the URPP GCB, our project fosters research interactions and collaborations between groups and clusters. It further integrates the URPP GCB with external initiatives such as the “Global Forest Biodiversity Initiative”, in which some of the project leaders participate, and the “Swiss Biodiversity Monitoring Program”.

Laegern test site (Poster 20)

Felix Morsdorf, Samuel Abiven, Daniel Kükenbrink, Michael Schmidt, Michael Schaepman
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The Laegern site is located at an elevation of 682 meters on the south slope of the Laegern mountain, approximately 15 km northwest of Zurich. The south slope of Laegern marks the boundary of the Swiss Plateau, which is bordered by the Jura Mountains and the Alps. The mean annual temperature is 8º C, the mean annual precipitation is 1200 mm and the vegetation period is 170-190 days. The western part is dominated by broad-leaved trees, mainly beech (*Fagus sylvatica L.*) and ash (*Fraxinus excelsior L.*). In the eastern part, beech and Norway spruce (*Picea abies* (L.) Karst.) are dominant. The site has a relatively high diversity of tree species, ages, and diameters, and the ground cover consists of bare soil, boulders, and litter. Existing understory is characterized by dense herb and shrub coverage. The average canopy height is 24.9 m, with a maximum of 49 m and stem density of 270 stems/ha. A core site comprising a flux-tower (ETH/WSL) has been subject to intensive ground and airborne measurement campaigns. This site is also used to investigate the carbon cycle and serves as a demo site for students in biogeoscience. The Laegern site infrastructure consists of field, remote and in-situ observations. Some of the measurements are obtained through installed hardware either on or around the flux-tower; other measurements are done using observational systems brought into the forest for short periods of time. Single-tree forest inventory (~1300 trees) and UAV-based maps of crown polygons were used for linkage of field with EO data and to facilitate tree-based EO approaches. In addition, we gathered leaf-optical properties, phylogenetic tree and genetic structure sampling using micro-satellites. Since 2010, Laegern is being used as a core test-site for calibrating, validating and prototyping remote sensing methods, data and products. Remote sensing data acquired includes laser scanning (ALS) and imaging spectroscopy (IS) and ranges from 5 mm to 300 m in spatial resolution (d). The multi-temporal aspect is covered by annual (2009-2016) and seasonal (4 different months within the growing period) APEX surveys. Next to the tower, a series of long-term field incubation setups are installed, where highly labelled root and fire-derived organic matter was added to the soil in 2009 and 2013. A radiative transfer model (DART)-based toolbox, parameterized using the measurements mentioned above to facilitate up-, cross- and downscaling of remote sensing data and products, is also available.

Identification, comparison, and analysis of hypotheses in systematic review (Poster 1)

Alejandra Parreño, Bernhard Schmid, Owen Petchey
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For any given system of variables, such as those relating biodiversity, environment, and ecosystem processes, alternative hypotheses about the effects observed in nature and in experiments may be proposed. Identifying comparable hypotheses in the literature is often difficult for complex ecological systems. In this study, we propose a method to identify, compare and analyze hypotheses for a complex system, using tools from quantitative review and statistics.
Our method consists of four steps: a systematic literature search for study selection, the identification of hypotheses through "backwards inference" from the original statistical analyses, the elimination of additional variables where experimental designs allow for it without altering the relation between remaining variables, and classification of compatible hypotheses into groups suitable for quantitative analysis. To describe our method, we provide a detailed case study of a system with relationships between biodiversity, productivity, light and nutrients.
In our case study, we identified 760 initial papers, of which 74 (123 independent studies) met our selection criteria. From these, we identified 34 different hypotheses, which were reduced to 15 when we eliminated additional variables. Only five hypotheses have been considered in more than one study. We found substantial differences between proposed hypotheses in terms of causality, with more intricate hypotheses that would presumably better represent the higher complexity of the natural system tested only a handful of times. Additionally, we recorded features that would be of relevance for a quantitative analysis (e.g., reported effect and study sizes, data availability, ecosystem type, etc.). Our method allows for an accurate depiction of the number of times that compatible hypotheses are tested. This is particularly valuable for evaluating whether it is possible or not to proceed with a rigorous quantitative review that produces unbiased and robust statistical results. Moreover, our method facilitates the identification of knowledge gaps and mismatches between hypotheses, study designs and statistical tests in a given area of research.

What are the hallmarks of integrative research and can its added value be demonstrated? (Poster 15)

Owen L Petchey, Michael Schaepman, Bernhard Schmid
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One source of creativity is the combination of previously disconnected ideas and knowledge. Integrating ideas and knowledge is also necessary for addressing many complex challenges, such as some Sustainable Development Goals. Thus, many programs aim to nurture integrative research and for this to have added-value outcomes. In some first steps to assess integration and added-value, we focused on analyses of research published by the URPP GCB. A densely linked co-author network shows that many URPP GCB researchers share co-authorship on many publications, with on average 30% more co-authors than in a reference corpus. Furthermore, publications of the URPP GCB have been cited around 70% more frequently than those of the reference corpus. We suggest that this bibliometric analysis has captured a shadow of URPP GCB integrative research and its added value. Bibliometrics are not a panacea for measuring research dissemination, however, and will provide more limited data as one aims to integrate across domains with different dissemination cultures. Complementary and alternative methods of quality and added-value assessment, and perhaps even alternate methods for achieving the aims of assessment, should be considered.

Feedbacks between biodiversity and climate: How diversity of plant community traits influences light absorption (Poster 6)

Elena Plekhanova, Pascal A. Niklaus, Michael Schaepman, Owen Petchey, Gabriela Schaepman-Strub
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The interaction of shortwave radiation with vegetation drives basic processes of the biosphere, such as primary productivity, species interactions through light competition, and energy fluxes between the atmosphere, vegetation and soil. We study how the effect of plant trait diversity influences the shortwave radiation budget of the plant community (i.e. albedo and fraction of absorbed photosynthetically active radiation). We hypothesize that an increase in structural diversity, and hence structural complexity, within a plant community decreases the albedo. To test this hypothesis, we employ a 3D radiative transfer model, which allows us to simulate different trait diversity levels and track radiation-vegetation interactions. We simulate monocultures to diverse mixtures following classical biodiversity experimental designs by varying the following traits: (a) plant structure (e.g. plant height and leaf angle distribution) and (b) optical properties of the single scattering components (e.g. reflectance, transmittance, and absorptance of leaves and branches).
Our first results indicate a significant redistribution of light absorbed within canopies in mixtures compared to monocultures, as well as an overall decrease of albedo with increasing trait diversity. The results of this study shed light on mechanisms governing the effect of biodiversity of a plant canopy, specifically structural diversity, on absorbed photosynthetically active radiation as a proxy for productivity. They will further inform the parameterization and quantification of radiative feedbacks of biodiversity changes with climate.

From local to regional: Functional diversity in differently managed alpine grasslands
(Poster 5)

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Ecosystem functions in grasslands are essential for the survival of plant and animal species and vital for sustaining human life. Increasing evidence suggests that ecosystem functions are strongly linked to different plant traits and their variations. This relationship between trait diversity, called plant functional diversity, and ecosystem functions is likely to be scale-dependent and vary within the phenological cycle. Further, trait diversity estimation on large spatial scales might add crucial information related to resilience of an ecosystem. A faster recovery of disturbed areas depending on the availability of surrounding ecosystem functions is to be expected. However, capturing the trait variations at distinct spatial scales and temporal stages and in differently managed grassland remains a cost- and time-efficiency nightmare. Modern remote sensing systems have the potential to close the knowledge gap produced by the limited availability of trait measurements. In particular, satellite datasets provide a complete landscape picture with high revisit time. Based on Sentinel-2 optical data, we quantified plant traits in grasslands in the Swiss National Park and the agricultural landscape in the surrounding area. To quantify traits, we used radiative transfer modelling and vegetation indices that measure the unique molecular absorption profiles of leaves in canopies. Different aspects of functional diversity were quantified in space and time. It was possible, therefore, to distinguish the impact of different fertilization and grazing intensities on plant traits and functional diversity on a regional scale and in time in our study area. Furthermore, we demonstrated the importance of quantifying large-scale functional diversity from space by comparing this to locally measured diversity. Functional diversity on a local scale is affected by nutrient availability, grazing and mowing intensities. On a regional scale, control parcel size and the uniformity of agricultural practices and policies over large areas diversity. Variance of functional diversity in time is characterized by emergence, senescence and mowing events. Overall, plant trait diversity retrieved from Sentinel-2 datasets produces evidence for the evaluation of protective and agricultural measurements on extended spatial scales, which are important for conservation and restoration decision-making. Furthermore, due to the high revisit time of Sentinel-2, this method is suitable for incorporation into monitoring schemes.

Feedbacks of plant identity and diversity to the diversity and community composition of rhizosphere microbiomes from a long-term biodiversity experiment (Poster 13)

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Soil microbes are known to be key drivers of several essential ecosystem processes such as nutrient cycling, plant productivity and the maintenance of plant species diversity. However, how plant species diversity and identity affect soil microbial diversity and community composition in the rhizosphere is largely unknown. We tested whether, over the course of 11 years, distinct soil bacterial communities developed under plant monocultures and mixtures, and if the bacterial communities with which plants with a monoculture or mixture history associated changed over this timeframe. For eight species, we grew offspring of plants that had been grown for 11 years in the same field monocultures or mixtures (plant history in monoculture vs. mixture) in pots inoculated with microbes extracted from the field monoculture and mixture soils attached to the roots of the host plants (soil legacy). After 5 months of growth in the glasshouse, we collected rhizosphere soil from each plant and used 16S rRNA gene sequencing to determine the community composition and diversity of the bacterial communities. Bacterial community structure in the plant rhizosphere was primarily determined by soil legacy and by plant species identity, but not by plant history. In seven of the eight plant species, the number of individual operational taxonomic units with increased abundance was larger when inoculated with microbes from mixture soil. We conclude that plant species richness can affect below-ground community composition and diversity, feeding back to the assemblage of rhizosphere bacterial communities in newly establishing plants via the legacy in soil.

Advancing Methods to Model Landscape Heterogeneity (Poster 11)

Leila Schuh, Rogier de Jong, Maria J. Santos, Michael E. Schaepman, Reinhard Furrer
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Landscape heterogeneity is a promising concept for the study of ecosystem alterations such as the migration of biome boundaries. Shifting climatic zones result in spatial reconfiguration of potential biome ranges, with the northern high latitudes experiencing some of the most rapid changes globally. As a result, current transition zones between ecosystems are expected to respond strongly to novel bioclimatic conditions. Furthermore, landscape heterogeneity can be exploited to assess ecosystem changes on smaller scales, for instance variation in species diversity and habitat fragmentation.
In this study, we extend pixel-wise trend analyses with different heterogeneity measures to investigate spatio-temporal dynamics. Moving beyond the most prominent quantification methods, including the Shannon Diversity Index and first-order texture metrics (i.e., average, standard deviation, coefficient of variation or evenness), we apply second-order metrics such as homogeneity, contrast, dissimilarity and entropy. We advance available methods by increasing their ability to be dynamically adjusted to various neighborhoods, scales and research settings. Utilizing the probability of pixel relations at different angles and orientations, these metrics help to quantify both within (intra-) and between (inter-) ecosystem heterogeneity.
The Normalized Difference Vegetation Index (NDVI), a proxy for photosynthetic vegetation activity, consists of what may be treated as continuous data in this context, yet it can also be discretized in meaningful ways. We exploit this quality and use the NDVI to analyze spatial heterogeneity at different scales in the northern high latitudes. We consider two different neighborhoods that both enter metric equations, one for the probability of pixel occurrences and one for heterogeneity. Probability matrices are calculated via two approaches: for very large-scale analyses (northern Eurasia), we consider large, relatively static neighborhoods; for smaller scale analyses (ca. 250.000 km^2), we consider dynamic neighborhoods centered around each pixel.
We found contrast and entropy to be the most suitable metrics to detect transition zones between ecosystem types, while homogeneity emphasizes intra-ecosystem heterogeneity. Observed neighborhood sensitivity implies that the application of heterogeneity metrics must involve careful assessment of the inherent scales. We thus explore the capability of scale space multiresolution decompositioning to inform the size of probability and heterogeneity neighborhoods. For further method improvement we aim to develop a hybrid approach to calculate probability matrices, optimizing computational efficiency and the ability to detect local ecosystem change. As the methodology enables the identification of areas characterized by high inter-ecosystem heterogeneity and of vegetation change within one ecosystem type, it provides a promising starting point for further research analyzing the type, direction and velocity of change. Specifically, we aim to advance methods for the investigation of *how* inter- and intra-ecosystem alterations occur over time and space.

Effects of interspecific variation in thermal responses on stability and food web structure. (Poster 2)

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The effect of temperature on population dynamics is reasonably well understood; however, we still lack a clear understanding of how temperature affects complex communities. Bioenergetic models make it possible to explore how scaling relationships for biological rates and feeding interactions are manifested in a network context. These models are based on the fundamental equation of the Metabolic Theory of Ecology, which links the metabolic rate of an organism to its mass and temperature. It has been shown that this dependency equally holds for other vital rates, providing an avenue to model ecological dynamics using simple rules. However, the metabolic theory assumes a universal temperature dependence of biological rates, despite empirical research showing substantial variation in this temperature dependence of biological rates across species.
Here I address how interspecific variation in thermal responses affects the stability, structure and predictability of complex communities. Furthermore, I also explore how the covariation of activation energy of vital rates affects food web stability and structure.
A set of theoretical communities were generated varying in species richness and were exposed to a temperature gradient from 0 to 40° C. Then a subset of these communities was tested for three scenarios of interspecific variation in thermal responses. I found that variation in activation energy substantially changes stability and network structure regardless of the covariation structure among thermal responses. Interspecific variation in thermal responses, on the one hand, decreased persistence. On the other hand, persistence increased with warming contrary to the results from the default model with identical thermal responses across species, where warming decreased persistence. This suggests that interspecific variation in thermal responses in a community might have stabilizing effects and substantially lead to different outcomes. Therefore, understanding diversity in thermal responses among species is crucial for predicting the effects of global warming on species survival.

Community-wide ecological genomics to monitor environmental responses: Drought, phenology and biodiversity effects (Poster 16)

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The goal of this project is to establish community-wide ecological genomics to study the effect of global change on biological networks. We will investigate such changes by integrating high-throughput sequencing data and ecological and meteorological data as we proposed in a joint review paper (Yamasaki et al. 2017).
A major driver of change in the Asian tropics is the change of rainfall patterns. At our Borneo test sites, we found four lines of evidence supporting the ecological importance of rare drought events in the tropical "rain" forests, although there is no annual dry period. First, we studied the trigger of mass flowering in the tropics: it has been much debated as to whether this is due to temperature, rainfall or sunshine. We collected meteorological data and flowering-phenotype data using remote sensing and genome-wide gene-expression data of a pioneer species *Macaranga* for 80 weeks. Machine-learning analysis of the molecular data supported the drought hypothesis of mass flowering. Next, we conducted the genome assembly of dipterocarps, the most dominant tree family in the Asian tropics. We found that the copy number of drought-response genes increased non-randomly, supporting the importance of drought. We analyzed the phenotypic and gene-expression data of the artificial drought experiments of adult dipterocarp trees. We confirmed that flowering and flowering-related genes were induced by the drought treatment, corroborating the drought hypothesis of flowering.
In an associated study using a large grassland biodiversity experiment (the Jena Experiment), we found that seven years of drought selection significantly increased species complementarity after an experimental drought event. Furthermore, diversity selection in the Jena Experiment led to genetically increased between-species complementarity and facilitation and increased community stability.
To study the genetic basis of community ecology, we used the model plant *Arabidopsis thaliana* and its associated insect community. We found that a single gene affecting leaf hairs has a large effect on the insect community. Surprisingly, we found the genotype of neighboring plants has a large effect on the insect community in our genome-wide association studies. *Arabidopsis* genetic diversity related to phenotypes or metabolites enhanced food web stability at different temperature treatments. Our ecological genomic results under different environmental conditions show that diversity is important for adaptation and mitigation of global change.

Freshwater community stability in stressful times (Poster 18)

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Community stability has been a focal subject of research in ecology over the last decades, but we still lack a thorough understanding of stability at the whole-community level, particularly in response to stress. We tested the interactive effects of two environmental stressors, acidification and heat, on the stability of aquatic freshwater communities. To this aim, we measured dissolved oxygen (DO) in freshwater mesocosms as a proxy for whole community functioning during five months in a set of mesocosms at the Gault Nature Reserve in Mont-St-Hilaire, Quebec. This so-called Large Experimental Array of Ponds (LEAP) consists of 107 mesocosms filled with 1000 liters of water from a nearby lake, thus containing natural freshwater communities. We used data from 12 sensor loggers deployed in mesocosms that differed in their water pH; four loggers were in mesocosms at pH 5.5, four loggers were at pH 6.5 and four loggers were at pH 8.5, which was the control-level that corresponded to the pH in the lake. As expected, acidification generally reduced DO. DO responded differently to increased water temperature during a record heat wave depending on the pH treatment. The relationship was more negative for communities at pH 5.5. They were thus more strongly affected by the high temperatures recorded at the field site. Initial results show that the two co-occurring stressors interacted and reduced community stability; however, the effect on community stability depended on the time scale. A (temporary) crash of diurnal variation in response to stress can indicate less stability, whereas a lack of monthly variation means more stability. We show that it is important to consider stability at different time scales when assessing how environmental changes impact community stability.

Modelling feedbacks between livelihood capitals: The case of tropical wood charcoal systems (Poster 8)

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Globally, wood charcoal production contributes to forest degradation and 7% of deforestation, while simultaneously providing socioeconomic benefits to both charcoal producers and consumers. Actors involved in the charcoal value chain interact with tropical forest resources through the conversion of natural capital (plant biomass) into physical capital (charcoal biomass). This interaction between natural and physical capital increases the income and savings (financial capital), which allows them to pay for, for example, their children's education (human capital). Simultaneously, the conversion of natural into physical capital may alter the networks, i.e., the inter-relationships between charcoal producers (social capital) due to, for example, communal (self-) organization or through external influences. We expect that levels of conversion of plant biomass to charcoal, as well as user excludability from use of forest resources (e.g. privatization) alter the availability and accessibility of plant biomass over space and time, and thus affect the connections and feedbacks between the different capitals. In this study, we aim to (i) identify and describe wood charcoal systems worldwide in terms of their production intensity and user excludability, and (ii) build upon a multi-dimensional poverty trap model to conceptualize how livelihood capitals connect and are affected by changes in charcoal production intensity and user excludability. Our review indicates that charcoal systems differ in their production intensity, with intensive production (up to ±75,000 kg per producer per year) in areas with relatively high forest stocks in the vicinity of centers of demand and relatively lower production (from ±6,300 – 11,700 kg per producer per year) in areas distant from centers from demand or in regions with degraded forests. Charcoal systems range from open-access systems exploited by independent users (e.g. Sub-Saharan Africa) and communal systems managed by (self-) organized communities (e.g. Tanzania and Senegal) to private systems (e.g. Brazil). Our initial model output indicates that traditional open-access systems result in a stabilizing feedback between natural capital and physical capital at low charcoal demand with the emergence of alternative stable states with increasing demand. The simulated transition from open-access systems to communal management or private systems results in stabilizing feedback with relatively higher charcoal production rates and larger forest stocks. We show that there are many pathways for charcoal systems, which provides a better understanding of the limits and opportunities of charcoal systems worldwide.

SESSION NINE POSTERS

Biosphere Reserve Engiadina Val Müstair test site (Poster 25)

Norman Backhaus
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The Swiss National Park (SNP), founded 1914, forms the core zone of the Biosphere Reserve Engiadina Val Müstair, which was only established in 2017. The SNP was created as a wilderness area (IUCN category Ia) in order to observe the ecological processes in areas that were previously heavily used as pasture lands and for logging, but also in almost untouched valleys. The park has, therefore, a long history of research and monitoring that is unique in the Alpine region. Moreover, the research is accessible via an integrated database (parcs.ch). In addition to research on undisturbed areas of the park, there are a number of research projects which analyze differences between used and unused areas of the biosphere reserve (including the buffer zones around SNP) and regional economic and social development.
Although the SNP with its surrounding buffer zones was only recently integrated into the URPP GCB as a test site, several URPP GCB research projects have begun in the area. As it is easily accessible, has well-documented long-term research and an excellent network with other research institutions, the biosphere reserve offers a number of opportunities for new research projects.

RiverDNA - uncovering fundamental biodiversity in riverine systems using environmental DNA (Poster 14)

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Current biodiversity monitoring methods are designed to focus on single groups and often rely on site or capture of the target organism. However, to accurately carry out complete biodiversity assessment, we need to integrate such groups. Furthermore, we need to include the species which occur in low densities and are often missed by capture methods, such as rare, elusive or invasive species. Here, we investigate the potential of environmental DNA (eDNA) as a method for complete biodiversity assessments. By using eDNA, we are able to extract the DNA shed by organisms (such as skin cells, faeces, and mucus) and determine the presence of species across all domains of life by collecting water samples throughout a river catchment.

Donkeys, deer, and death around the Swiss National Park: Developing a relational values approach to align environmental values in conservation policy (Poster 11)

Mollie Chapman, Anna Deplazes Zemp, Norman Backhaus
URPP GCB, University of Zurich; Zurich, Switzerland

Environmental conservation efforts are often based on either the intrinsic value of nature or on its instrumental use to humans. Yet neither of these approaches effectively captures a wide range of values that motivate many people to care for land, ecosystems and species. For many people, relationships with nature, and with other people via nature, better characterize how they value and view their biophysical environment. This research project seeks to elaborate a relational values approach to conservation. Interviews with farmers in the vicinity of the Swiss National Park along with philosophical analysis will serve to elaborate an approach to relational values and develop the conceptual foundations of this emerging research area. This poster presents preliminary results from 32 interviews conducted in March 2019 with farmers in Val Müstair and the Lower Engadin.

Aldabra Atoll: A unique living laboratory (Poster 24)

Annabelle Constance, Gabriela Schaepman-Strub
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Aldabra Atoll occupies a unique place among the world's atolls due to the wealth of its biodiversity, its relatively undisturbed status and its designation as a UNESCO World Heritage Site. Aldabra lies in the Western Indian Ocean and is one of the largest raised coral atolls in the world with a landmass of 155.4 km^2. A large expanse of mangrove forests (17.2 km^2) connects the semi-arid, shrub-dominated vegetation to the lagoon environment. The outside rim of the atoll meets the deep ocean comprising a species-rich coral reef ecosystem. The implications of global change drivers on Aldabra are especially high given the low elevation of the atoll (maximum height of < 8 m), increasing drought frequency, and the strong interdependency of its ecosystems. Aldabra Atoll was added to the URPP GCB test sites during Phase I of the program. Research activities of core and affiliated projects on the atoll have focused on multiple ecosystems and include the understanding of the impact of El Niño on community composition of coral reef benthos; the spatial availability of terrestrial habitat types and their usage by Aldabra giant tortoises; and the spatial structure, species diversity, and drivers of recorded mangrove habitat extent. An extensive field campaign is under planning for fall 2019 to assess the relative role of hydrological and soil variables in structuring mangrove forest structure and diversity on Aldabra. Twelve water-level sensors will be installed, and repeated measures of soil salinity and other relevant parameters will occur in 54 plots of 25m^2 each, according to standard methods. The sampling location is spread out across two of the largest mangrove areas on the atoll. A phenocam was set up in 2015 on a remote part of the atoll for continued vegetation monitoring in light of increasing drought. A Memorandum of Understanding has been signed in the current phase II between the URPP GCB and the Seychelles Islands Foundation, the organization responsible for the management of Aldabra, as a framework for future project collaborations. All research projects of the URPP GCB are aimed at enhancing the understanding of integrated ecological systems, their biodiversity and interactions with global change drivers.

Enabling scalable biodiversity-ecosystem functioning relationships using hyperspectral imagery (Poster 10)

Jane Cowles
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Unmanned aerial vehicles (UAVs), in combination with modern sensor technologies such as lightweight hyperspectral cameras, are a critical tool for understanding how to scale our knowledge of the importance of biodiversity for sustainable ecosystem functioning to the larger scales and varying conditions necessary to inform management and global policy. To this end, we conducted a drone survey over the BioCON experiment (Minnesota, USA), a multifaceted global change experiment, containing 2 x 2 m plots planted with herbaceous plant species communities of differing richness and composition and experiencing a range of global change simulations, including nitrogen deposition, CO2 enrichment, warming, and drought. We can compare the remotely sensed hyperspectral data, capable of assessing species richness, identity, and productivity, with hand measured species-level biomass data and soil properties in order to test the efficacy of the UAV survey measurements. Additionally, this framework provides vastly more information about the plots than is feasible with classic hand-collected data, including spatially explicit measurements (to the sub-decimeter scale) that can help us understand how the biodiversity-function relationship changes across spatial scales and temporally repeated flights, allowing an estimate of within season biodiversity effect strengths and complementarity. In addition, I outline a novel R package, created as an open-source, command line alternative to proprietary software, in order to orthorectify and process hyperspectral drone imagery, increasing the reach of these novel technologies to impact our understanding of the globe.

Merging facets of biodiversity: Spectral-trait niches across phylogenetic groups derived from airborne imaging spectroscopy time series (Poster 6)

Ewa Czyż[1], Ryan Pavlick[2], Kerry Cawse-Nicholson[2], Carla Guillén Escriba[1], Fabian Schneider[2], Meredith Schuman[1], David Schimel[2], Michael Schaepman[1].
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Inter- and intraspecific trait variation are both recognized as important factors driving ecosystem functioning, productivity and structure. Additionally, the magnitude of the variation is related to the fitness of populations and may be associated with evolutionary processes. Thus, assessing the state of and tracking changes in trait variation are essential for understanding ecological processes. We used imaging spectroscopy to investigate phenotypic variation across phylogenetic groups in a temperate forest system located in the Swiss midlands (Laegern, 47°28′N, 8°21′E). The dataset includes spectral information derived from the APEX (Airborne Prism Experiment) imaging spectrometer with a 2-meter spatial resolution and 284 spectral bands. Imaging spectrometer data represent 11 tree species and were obtained for three seasons in 2016. We used the Harsanyi–Farrand–Chang (HFC) method, based on eigen-decomposition, to calculate the dimensionality of the spectral signal. By evaluating the basis functions of the signal subspace, we are able to evaluate the importance of each of the wavelengths in generating the variance in spectra that reflects trait variation in the studied tree canopies.
This method allows us to separate enhanced detectability from noisy data: a common challenge in working with a hyperspectral signal acquired under natural conditions. Based on eigenvectors influencing the dimensionality across the visible to shortwave electromagnetic spectrum, we determined the signal regions that vary across and among different phylogenetic groups. We found that the magnitude of spectral variation between 0.6 – 0.8 µm as well as 1.6 – 1.8 µm is specific to each of the 11 species investigated and highly related to the phylogenetic clade. By resolving the spectral traits with biochemical and morphological traits, we can connect the spectral variation with inter- and intraspecific phenotypic variation. This study demonstrates how imaging spectroscopy can access information about trait variation in tree populations over large areas and in a continuous manner, which is relevant for investigating ecological and evolutionary processes.

Geostatistical models for stream ecologists - reconciling statistical requirements and end user needs (Poster 18)

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Spatial autocorrelation is ubiquitous in ecological data as many ecological processes have a strong spatial component. Data from stream networks present a unique challenge in this context, because their spatial structure is inherently complex: relevant distances are typically hydrological distances and flow direction plays a major role in shaping spatial dependencies.
Peterson and Ver Hoef (2010) proposed a mixed-model moving-average approach for geostatistical modeling in stream networks.
While this approach has been successfully applied to predict chemical or physical stream characteristics, it has been less used for biodiversity data.
Using simulated data in Swiss river networks, we test the sensitivity of the model for different covariance functions and discuss practical aspects of the application of the model for stream ecologists.

bioDISCOVERY: Advancing and integrating science to better observe and predict biodiversity and ecosystem change (Poster 3)

Cornelia Krug
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bioDISCOVERY is a global research network that supports decision making and policies that ensure the conservation and sustainable use of biodiversity worldwide. The activities of bioDISCOVERY promote and advance interdisciplinary collaborative research on feedbacks between global change drivers and the biodiversity, functioning and services of natural ecosystems. Synthesis and catalyzing work forms the backbone of bioDISCOVERY's activities, which are centered around three focal areas: (1) Monitoring & Observation, (2) Scenarios & Models, and (3) Supporting Assessment Bodies. Activities are geared towards achieving synthesis of existing science, leading to, e.g., development of new indicators or scenarios; and catalysis of new knowledge, leading to the development of new approaches and methodologies and adding value to existing research.
At the URPP on *Global Change and Biodiversity*, bioDISCOVERY acts at the science-policy interface, linking the program to other research networks—internationally to GEO BON, IPBES, and the Convention on Biological Diversity and nationally to the Swiss Future Earth Committee and the Forum Biodiversität—by e.g. representing the URPP GCB at meetings of these organizations and bodies. In 2018, bioDISCOVERY (co-)organized workshops, symposia and summer schools that were open to researchers and students of the URPP GCB.

Spatio-temporal modelling of light extinction in a temperate and tropical forest
(Poster 5)

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The complex three-dimensional (3D) structure of forests greatly influences the light distribution inside the canopy. Understanding light availability inside forest canopies is critical for assessing species coexistence, competition and diversity. However, measuring the 3D light distribution in the canopy is not a trivial task.
In this contribution, we introduce an approach to parameterize the DART radiative transfer model for the simulation of high resolution (25 cm voxel size) 3D light extinction fields in the photosynthetically active radiation (PAR) regime for a tropical rainforest in Borneo, Malaysia and a temperate mixed deciduous forest in Switzerland. The 3D structure of the two 60x60 m^2-large study areas were derived from terrestrial laser scanning measurements (TLS) from the ground, complemented by UAV laser scanning and crane-based TLS, minimizing occlusion within the upper canopy layer. The vegetation density distribution inside the forest canopy was derived using the AMAPVox software toolbox. To model tree trunks as opaque objects within DART, a voxel stem model (5 cm voxel size) was extracted from the laser point cloud by separating the points of wood from those of leaves with a reflection and voxel grid filter.
Based on the dense TLS scan pattern, a high-resolution 3D point cloud with minimal occlusion, we are able to parameterize the DART model with a high level of detail. This allows us to analyze differences in 3D light distribution due to differing canopy structures found in the two contrasting forests, further providing important insights into light-related mechanisms driving species coexistence, competition and diversity.

Arctic tundra energy budget under global change (Poster 17)

Raleigh Grysko, Jacqueline Oehri, Gabriela Schaepman-Strub
URPP GCB, University of Zurich; Zurich, Switzerland

The Arctic is undergoing amplified climate warming, and temperature and precipitation are predicted to increase even more in the future. Increased climate warming is indicative of changes in the surface energy budget, which lies at the heart of the carbon and water budget. The surface energy budget is an important driver of many earth system processes, and yet has received little attention in the past.
The aim of this project affiliated with the URPP GCB is to investigate the relative importance of biotic and abiotic drivers, such as vegetation type, soil moisture, and permafrost, for the partitioning of surface energy fluxes in the Arctic. We will address this goal with two approaches:

1. By integrating knowledge from literature, experts, and a systematic analysis of observational data and by summarizing results in a review paper. In a further step, we will predict the partitioning of surface energy fluxes under current and future conditions at the pan-Arctic scale.
2. By testing the effect of changing summer precipitation on the surface energy budget experimentally by simulating precipitation extremes – extreme drought and extreme precipitation totals. Extreme drought/precipitation will be simulated by removing/adding a predetermined amount of ambient precipitation from/to the test plots. Control plots, where ambient precipitation is not modified, will also be used as a baseline in this study. The experiment will be established at the URPP GCB Siberia test site. It is a shared experiment with the URPP GCB project that will investigate plant compositional and trait changes under extreme summer precipitation conditions (conducted by Elena Plekhanova). Plot selection, soil sampling, and installation of below-ground sensors were performed during the past two summers, while shelters and water-addition installations are being installed at this very moment.

The shared aim of the projects is to improve the understanding of the state and development of the surface energy budget under current and future conditions in a rapidly changing region that impacts the earth system on a local, and potentially global, scale. With our results on energy fluxes under changing summer precipitation regimes, we expect to inform mechanistic and statistical modelling of species distributions, ecosystem functions, and feedback with climate in the Arctic tundra.

Stochasticity in bacterial community assembly: Impact on community functioning
(Poster 1)

Alizée Le Moigne, Anubhav Gupta, Samuel Abiven, Owen Petchey, Gabriela Schaepman-Strub, Jakob Pernthaler
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The high biodiversity of bacteria confers a plethora of metabolic activities that allow microbial communities to play a fundamental role in many biogeochemical cycles. Yet, the link between the structure of a particular community and its functioning remains unclear. Such understanding is nonetheless needed in the context of global change, necessitating the study of bacterial community assembly processes. Both deterministic (niche-based) and stochastic (neutral) processes play a role in shaping bacterial community structure, but it is challenging to disentangle them.
The goal of this research project is to understand the importance of stochasticity in shaping the community structure of aquatic bacterial communities. It also aims to assess the impact of this stochasticity on functional properties of these communities, notably carbon remineralization.
Parallel microcosms that harbour spontaneously assembling bacterial communities are powerful experimental tools for addressing this question, since the influence of deterministic factors such as environmental selection can be controlled, and communities can be maintained under identical abiotic conditions. However, they lack the complexity of natural environments. Therefore, our laboratory-based research is complemented by an observational approach. Numerous thermokarst ponds characterized by a short seasonal ice-free period are found at the URPP GCB Siberian site, Kytalyk. Understanding carbon cycling as mediated by bacteria in this region is important due to the expected warming and the expected carbon release from the permafrost.
First lab-based experiments show that stochastic processes can lead to drastic variation in the community structure of bacterial consortia at identical growth conditions. These communities, moreover, differ in growth features and carbon utilization. The planned modelling of such communities will further assist in understanding the relative importance of individual aspects of the assembly processes. Subsequent experiments will involve the setup of more complex cultivation systems to study the propagation of stochastic effects and community stability. Moreover, the mixing of microcosms with diverse functional properties will help to clarify the links between community structure and function. The analysis of the Siberian ponds is currently in progress; a second field campaign is planned to relate the carbon budget of these systems to their local bacterial communities.

Coevolution in spatial ecological networks (Poster 9)

Fernando Pedraza Pérez, Jordi Bascompte
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Ecological networks have been largely studied as static systems. However, networks are made up of evolving organisms embedded in a spatial landscape with particular ecological dynamics. It thus follows that the architecture of interaction networks—and its consequences on biological processes—will be shaped over time by both the evolution of member species and the spatial processes connecting networks. This project aims to disentangle the interplay between network structure and spatial dynamics to understand how species coevolve in networks. This task will be addressed by developing a suite of analytical and simulation tools to study: i) how coevolution is driven by network structure, ii) how species coevolve in spatially connected networks of contrasting architectures and iii) how coevolution operates in increasingly connected networks of networks. Here we present the general framework for the project and outline the questions that will be addressed. Ultimately, our findings will provide insights on how habitat fragmentation affects species evolution and on the way network architecture determines how selective pressures ripple across the web of life.

Relationship between reflectance, morphological, and physiological properties in beech leaves *(Fagus sylvatica)* (Poster 8)

Fanny Petibon, Guido L.B. Wiesenberg, Giulia Ghielmetti, Mathias Kneubühler, Michael E. Schaepman, Michael W.I. Schmidt
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Functional traits retrieved from remotely sensed data allow for monitoring diversity at a variety of spatial and temporal scales. Most retrievals depend on specific light absorption mainly driven by pigment composition, leaf structure and water content across the solar reflective spectrum. Understanding the seasonal dynamics of leaf biochemical properties is thus of utmost importance to validate measurements and identify associated uncertainties. In this study, we evaluate the potential of recent analytical advances in liquid chromatography techniques to describe variations in pigment composition over the growing season.
We sampled sun exposed and shaded leaves of a mature beech tree *(Fagus sylvatica)* located on the University of Zurich campus on a weekly basis at different tree heights from 3 to 10 meters between May and November 2018. To investigate pigment content and composition, we selected three approaches based on spectral indices derived from: (i) leaf optical properties measured in–situ using a SPAD Chlorophyll Meter and a contact probe coupled with a spectroradiometer, (ii) optical properties of bulk extract, and (iii) individual pigments measured with both standard and newly developed high pressure liquid chromatography (HPLC) methods. Complementary traits including leaf per mass area, moisture, carbon and nitrogen content and stable carbon and nitrogen isotope composition were also measured with standard laboratory methods at leaf level.
Based on SPAD values, we first estimated variations in leaf chlorophyll and nitrogen contents within an individual tree. Both appear to depend on sun exposure, with higher chlorophyll content and lower nitrogen content, respectively, with increasing irradiance. However, no effect of sampling height was observed. Nevertheless, higher stable carbon isotope ratios on the top of the tree in comparison to the bottom suggest photosynthetic effects on isotope discrimination and thus metabolic processes depending on tree height. A more exhaustive description of pigment content and composition obtained with our HPLC method will allow us to better understand these processes. Preliminary results highlight that analytical methods and calibration strategy impact plant traits retrieval. We will test if our method can improve the calibration and the sensitivity of spectral-band based devices as a tool for assessing functional traits in forest ecosystems.

Siberian test site (Poster 19)

Elena Plekhanova, Jacqueline Oehri, Raleigh Grysko, Alizée Le Moigne, Gabriela Schaepman-Strub
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The Siberian tundra test site complements the latitudinal approach of the URPP GCB with its low diversity in high latitudes, strong global change drivers (temperature and precipitation increase, potentially invasive species) and major threats to the livelihood of local people through resource decline (fish) and environmental change (flooding, weather extremes), with potentially global feedback effects through the carbon and energy cycle. The main ongoing projects in the Kytalyk test site along the soil to the atmosphere continuum include:

- A soil carbon decomposition and stabilization experiment using in situ mesocosms
- Microbial diversity and community assembly processes in thermokarst ponds and their effects on the carbon cycle
- Plant species diversity, composition and abundance assessment and monitoring, and contribution to the Arctic Vegetation Archive, an international, pan-arctic data set of plot-based species abundance relevées under development
- A precipitation experiment studying the effect of extreme precipitation regimes on soil heat flux and permafrost thaw, below- and aboveground plant traits, species diversity, community composition, and related feedbacks on energy fluxes between the surface and the atmosphere
- A pan-arctic review of drivers of Arctic surface energy budget: assessment and analysis of relative contribution
- Remote sensing data collection and analysis of greening/browning trends, and contribution to the international High Latitudes Drone Ecology Network (HiLDEN) to inform analyses on pan-arctic vegetation response to climate change.

The Kytalyk nature reserve enables us to study the influence of global change drivers on Arctic ecosystems with the aim of supporting mechanistic models through quantification and process understanding.

Ecosystem service changes with global delta modification (Poster 12)

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Ecosystem services (ES) are critical to short-term human wellbeing and the long-term maintenance of Earth's life support system. It is generally hypothesized that humans have intensified provisioning services, for example, agricultural production, with the trade-off of reduced regulating and supporting services which maintain ecosystem functions and processes. Biodiversity is increasingly linked to the supply and range of ES. It is therefore important to establish balances of ES usage that provide sufficient human wellbeing while maintaining biodiversity and the long-term ecosystem functioning it supports.

We test this hypothesis on a set of global deltas, dynamic sedimentary landforms formed around river mouths, which are disproportionately critical to local and global ES given their small area. Deltas were chosen as study systems given their dense population, important food resources and rare habitats, alongside a multitude of other services. However, deltas are under increasing stress from local and global environmental change drivers, these stresses increasing as they are modified from their natural state. Some may already be 'locked-in' to unsustainable, degraded states, while others are at a critical juncture in their development. We ask:

- How do ES supply change with delta modification and which ES are most influenced?
- What are the synergies and trade-offs of ES within deltas?
- Are particular bundles of ES typical at different levels of modification?

Here, we assess the condition of delta ES globally, classifying them along a gradient of modification. 234 larger coastal and inland deltas were identified and mapped using the presence of distributary networks via satellite imagery. Human modification of each delta was measured by its population density, and the proportion of its watershed taken by reservoirs. ES were assessed using multiple indicators from global datasets and the conversion of land cover classifications into ES using lookup tables. We used k-means cluster analysis to identify separable delta states and regression analysis to understand the association between delta development gradient and ES. Structural equation models were used to show which ES most predict modification. We expect to show which deltas are in early, moderate, late and potentially locked-in stages of development; that provisioning services will be found to increase with modification up to a point, but then decline in highly modified deltas; and that other ES will generally decline with modification. This global analysis is the first to illustrate how deltas along a gradient of development may provide similar or dissimilar ES, and their capacity to be resilient to current and future ES demands.

Field GWAS of neighbor effects and its potential application to targeted polycultures in anti-herbivore defense (Poster 15)

Yasuhiro Sato[1], Rie Shimizu-Inatsugi[2], Misako Yamazaki[2], Atsushi J. Nagano[3], Kentaro K. Shimizu[4]
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Herbivory risk to an individual plant depends not only on its own traits but also on those of neighboring plants. Despite the potential importance of plant neighborhood effects in population-level resistance, we still know little about what kinds of plant genes are responsible for neighbor effects and how to design genotype mixtures. Here, we conducted genome-wide association studies (GWAS) of plant neighborhood effects at two field sites (Zurich, Switzerland and Shiga, Japan) over two years. Our newly proposed method, neighbor GWAS, revealed that neighbor effects explained 10-30% of the variation in the leaf damage and insect diversity and detected plausible candidates underlying neighbor effects. We also conducted genome-wide sparse regression to predict herbivore damage on all genotype pairs under polyculture conditions. As a result of lasso and elastic net, it was estimated that a mixed planting of the Bg-2 and Uod-1 accession could reduce herbivory by flea beetles. These results suggest that neighbor effects are an important source of phenotypic variation in field-grown plants, and that machine learning approaches may be useful for selecting a target of polyculture from a vast number of plant genotypes. Towards a next step, we wish to discuss how to predict plant biodiversity effects based upon a GWAS framework.

Disentangling the effects of morphological and physiological diversity on ecosystem functioning by combining remote sensing and ecosystem modeling (Poster 7)

Fabian D Schneider[1,2], Paul Moorcroft[4], Michael E Schaepman[3], Eugenie Paul-Limoges[3], Marcos Longo[1], Felix Morsdorf[3], Bernhard Schmid[3], David S Schimel[1]
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Biodiversity is a key component driving ecosystem stability and productivity under global change. With the recent recognition of the importance of trait-based biodiversity assessments, a way to map, monitor and predict changes in plant functional diversity and functioning is urgently needed. In previous research, we demonstrated how one can measure plant functional diversity by remote sensing in a spatially explicit and continuous way. Now, we show how we can estimate productivity based on remote sensing and ED2 modeling for different sites and in a future step, we can assess the relationship between the two as normally done with ground-based data of productivity and trait diversity. Moreover, the modeling framework allows interchanging structure, composition and soils of the sites, helping to disentangle their contributions to productivity.
We developed a method to map canopy structure and composition as well as corresponding functional diversity at very high spatial resolution using airborne laser scanning and imaging spectroscopy data. We applied this method to a temperate mixed forest in Switzerland (Laegern, CH) to characterize and initialize five forest sites, spanning an elevation gradient with changing canopy structure and composition as well as soil type and depth, in the ecosystem demography model ED2. A comparison with ground-based measurements showed accurate forest structure and composition derived from remote sensing data and the ability to predict monthly carbon (GPP, NEP, R) and water fluxes (ET) with ED2 at the flux tower site. Applying this modeling approach to all five sites for the years 2006 to 2015 will offer the opportunity to simulate different combinations of structure, composition and soils to disentangle their effects on ecosystem functioning over time. This will ultimately allow us to test the hypothesis that functionally more diverse forest communities are more productive over time, and to disentangle whether morphological or physiological diversity or the environment is driving the diversity-productivity relationship at sites within an ecosystem.

Borneo test site (Poster 22)

Yuji Tokumoto[1], Michael O'Brien[1], Kevin Kit Siong Ng[2], Kentaro K. Shimizu[1]
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The Borneo test site includes three sub-sites: Danum Valley (Sabah), Lambir Hills (Sarawak), and the Forest Research Institute Malaysia (FRIM; Peninsula Malaysia). Each test site has unique characteristics or equipment, and researchers are able to use all facilities. Danum Valley, which has a 50-hectare permanent forest plot covered by lowland dipterocarp forest, is maintained by SEARRP (South East Asia Rainforest Research Partnership) and includes accommodation for researchers. In Lambir Hills, researchers are easily able to access the forest canopy layer using an over 70-meter high canopy crane and tree towers constructed in the forest. Three permanent forest plots have been maintained by JRCTS (the Japanese Research Consortium for Tropical Forests in Sarawak) and CTFS (the Center for Tropical Forest Science) since the early 1990s. FRIM, about 20 km north of the center of Kuala Lumpur, includes experimental facilities for molecular biology and other research fields, and a neighboring experimental forest. In this poster, we will introduce the site characteristics, achievements until 2019, how to start new research and possibilities for collaborative studies at the sites.

Humans in nature: An ethical perspective on differences and similarities (Poster 2)

Anna Wienhues, Anna Deplazes Zemp
URPP GCB, University of Zurich; Zurich, Switzerland

Are humans part of nature or not? The characterization of the current epoch as "the Anthropocene" highlights humanity's unnatural effects on the planet. However, environmental sciences indicate how humans depend on the rest of nature, and social sciences describe that many human practices take place in the understanding of humans as part of nature. In the ethical literature, the question of whether humans belong to nature is relevant when it comes to how we value nature, and how we understand our role and rights in nature.

This work, part of the project "People's Place in Nature", is situated in the field of environmental ethics and aims at mediating between the view of humans as opponents to nature and the view that denies any morally relevant differences between humans and nature. The poster presents some preliminary argumentative grounding for this approach, according to which a responsible and respectful attitude towards nature implies both understanding similarities and differences between humans and non-human nature. Starting from a relational nature concept that situates humans within nature but simultaneously also acknowledges their difference from non-human nature, it is argued that:

- Differences need to be emphasized by acknowledging the different roles and capacities of humans and non-human nature and the rejection of views that deny any morally relevant differences. Yet, an emphasis on differences has to be distinguished from creating a human-nature dualism according to which humanity is (not neutrally different but) superior to the rest of nature.
- Similarities need to be highlighted by the denial of exceptionalist rights of humans to control and dominate non-human nature and by emphasizing that all different elements of nature must be considered morally.

In this sense, differences concerning rights to control and dominate nature are being denied, whereas differences in admitting varying roles and capacities are being highlighted. Such a focus on respecting differences leads to an appreciation of the significance of biodiversity. Moreover, respect for these differences and similarities paves the way for a relational contextual account according to which moral responsibilities for nature depend on context, relationships and specific situations.

Waterscapes as hydro-chemo-social? Reflexive photography on unseen water quality
(Poster 13)

Rémi Willemin, Norman Backhaus
URPP GCB, University of Zurich; Zurich, Switzerland

With a focus on visuality, our research project studies the relationships between visual representations shaping environmental imaginations and the practices imagined as leading to sustainable water management. Within this project, the reflexive photography project looks at co-developed perceptions of "practices impacting the water quality". Participants, selected among farmers and beekeepers in a region particularly sensitive to watershed contamination, captured three pictures of waterscapes that best represent their relations to water. On the basis of their photography, we explore how social practices, water, and chemicals interact and co-create each other.
By eliciting their selection of pictures, the participants reveal their inter-/intra-relations to water, aquatic ecosystems and waterscapes. In addition, they quantify the importance of the photographed waterscapes in regards to six dimensions of landscapes proposed by Backhaus, Hammer, and Siegrist (2018, as represented in the four poles models).
Although imaginations of water quality are reflected in some pictures, they extend beyond the perception of the naked eye and wide-angle photographic lenses. These are the results of semi-structured interviews, during which participants narrate histories of practices that they think affect the water quality, such as, for example, the evolution of agricultural, industrial and household activities to using synthetic chemicals, and other products involved in processes of aquatic ecosystem depletion.
Materializing the unseen through oral histories of practices reveals plural geographies of waterscapes in which things sometimes have their own agency. For instance, water exercises agency through, rains and droughts and (for biodynamic farmers) through its capacity to carry substance and energies to heal plants and humans; things, exposed to synthetic chemicals, are interacting in processes of inter-species solidarity mechanisms.
Altogether, material practices impacting water and (oral and visual) discursive practices addressing water quality issues modify our imaginations of terraqueous resource frontiers, from a problematization of water quantity (in terms of scarcity and distribution) to additional qualitative aspects of water.

Individual-tree based functional diversity monitoring in a sub-tropical forest (Poster 16)

Zhaoju Zheng[1], Felix Morsdorf[1], Yuan Zeng[2], Fabian D. Schneider[3], Bernhard Schmid[1], Michael E. Schaepman[1]
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Functional diversity has become one of the commonly used metrics of biodiversity, which can predict ecosystem functioning by accounting for inter- and intraspecific variations as well as functional redundancy. However, the spatial distribution of forest functional traits and functional diversity is difficult to assess due to the complexity and costs of in-situ measurements and access limitations. Airborne laser scanning (ALS) and imaging spectroscopy provide spatially explicit wall-to-wall data, which should allow to map selected forest traits at multiple spatial and temporal scales, even at the individual tree level.
In a Chinese sub-tropical forest, we retrieved morphological traits (95th quantile height, leaf area index and foliage height diversity) and physiological traits (leaf nitrogen, carotenoid and specific leaf area) for each individual tree from ALS and imaging spectroscopy data, respectively. Then we developed a spatially continuous individual tree-based method to map functional diversity (richness, divergence and evenness) at different scales and explored the spatial patterns and the scale dependency of forest functional diversity. We compared our method with field measurements and a pixel-based approach and found reasonable agreement. Finally, we analyzed trait responses and functional diversity variations along environmental gradients to understand how environmental variables affect the patterns of functional traits and diversity.
We found a logarithmic increasing relationship between functional richness and area, whereas divergence and evenness are scale-invariant within our test area, given our data. Higher functional richness is found in forests situated in medium elevations. This is mainly driven by the mixture of evergreen broadleaved, deciduous broadleaved and coniferous trees. In comparison with morphological traits, physiological traits are more strongly influenced by topographic and soil variables. Our method demonstrates the potential of estimating individual plant-trait-based forest functional diversity from remote sensing, providing a pathway to conduct individual tree-based ecology with much larger sample sizes across environmental gradients.

The lower third matters: Microbial and plant biomass responses to deep soil warming
(Poster 4)

Cyrill U. Zosso[1], Nicholas O.E. Ofiti[1], Jennifer L. Soong[2], Emily F. Solly[1], Margaret S. Torn[2], Guido L.B. Wiesenberg[1], and Michael W.I. Schmidt[1]
[1]*URPP GCB, University of Zurich; Zurich, Switzerland*
[2]*Lawrence Berkeley National Laboratory, California, USA*

Soil warming will affect the capacity of soils to store carbon by changing proportions of plant- and microorganism-derived biomass inputs. Warming experiments to date have mostly examined the reaction of microorganisms in the uppermost soil horizons, often observing an increased activity with warming, which increases the CO_2 fluxes from the soils to the atmosphere. However, large uncertainties remain as to how subsoils (below 20 cm) will respond to warming. At depth, the organic C input pathways (roots and dissolved organic carbon) and growth conditions for microorganisms (lower carbon concentrations) are completely different than at the surface of soils.
To resolve some of the open questions, we analyzed soil cores from one of the first long-term whole soil profile warming experiments conducted on an Alfisol in a coniferous temperate forest in the Sierra Nevada, California, USA. The soils have been warmed 4°C to a depth of 1 m for 4.5 years. We analyzed soil samples, above- and below-ground plant biomass for carbon and nitrogen contents, and their stable carbon isotope (^{13}C) compositions. Furthermore, we extracted the free extractable lipid fraction (alkanoic acid) and calculated different molecular proxies to discriminate soil organic matter sources and degradation.
In the warmed plots, the soil organic carbon concentration was 18% lower, with main differences below 20 cm. Also, the fine root (< 2 mm) mass in the top 1 m and the mass of free extractable lipids between 20-90 cm was significantly lower. However, we only observed a difference in d13C values and the molecular proxies between control and warmed plots in the lower third, from 60-90 cm. At these depths, d13C values and the ratio of saturated vs. unsaturated fatty acids were higher in the warmed plots, indicating more degraded organic material. Further, the average chain length was lower in warmed plots, indicating that there is more microorganism-derived soil organic carbon. Using molecular proxies on a deep soil warming experiment for the first time, we observed depth-dependent responses of soil organic carbon pools. We did not observe any effect on the top 20 cm, which might be due to large fresh biomass inputs to the topsoil in this ecosystem. The difference in the molecular proxies is only visible below 60 cm, which might either be due to a concentration effect (a higher soil carbon concentrations above 60 cm overlay effect), but could also indicate that the subsoils respond faster to warming. Interestingly, previous studies at this site found similar temperature sensitivities of the soil respiration at all depths after 27 months of warming. However, as our results indicate more degraded and more microorganism-derived organic material after 4.5 years in the lower third only, temperature sensitivity might decrease earlier in the subsoils, as carbon stocks seem to get depleted faster. It remains to be seen whether accelerated decomposition of soil organic carbon (especially > 60 cm) persists in the future and whether it holds true for other ecosystems.

FISHBOWL DISCUSSIONS

The grammar of relational values.

Mollie Chapman and Anna Deplazes Zemp

Chair: Anna Deplazes Zemp
Lead: Mollie Chapman
URPP GCB, University of Zurich; Zurich, Switzerland.

In this session we will present a conceptual framework that is designed to help dissect the "grammar" of relational values. Just as a linguist would identify the subject, object and verb of a sentence, on hand from our conceptual framework we want to do the same for qualitative empirical data on relational values. We identify the subject and object associated with relational value statements, as well as qualities and characteristics of that relationship. Moreover, we seek to identify attitudes, responsibilities and rights that may be associated with the relational value. In the course of our fishbowl discussion we will use empirical examples of relational value statements to discuss ideas on how the data could be interpreted on hand of the conceptual framework. Based on this discussion we will solicit feedback from the participants on how our conceptual framework could be refined and improved.

Opportunities and Landscape for a new Interdisciplinary Environmental Institute/Center in Switzerland.

Mollie Chapman, Hanneke Van t' Veen, Debra Zuppinger-Dingley

Chair: Hanneke Van t' Veen
Lead: Mollie Chapman
URPP GCB, University of Zurich; Zurich, Switzerland.

As the URPP GCB enters its third stage, we are asking ourselves: what comes next? To begin this process, we'd like to use this fishbowl to start a discussion. We'll draw from experts from various institutions that will share their expertise on what makes a good interdisciplinary environmental institute. We'll also talk with experts from within Switzerland about the research and institutional landscape here. We will discuss questions such as:

- What makes an institute/center truly interdisciplinary? What types of infrastructure, governance, culture, practices, people or other pieces of the puzzle help? What types of practices are key, e.g., joint grant proposals or co-supervised PhD students?
- How can a common vision be created across or among different departments and groups?
- What hurdles should we anticipate and how should we prepare for them?
- What are the institutional gaps or needs within Switzerland, in Europe or globally for interdisciplinary environmental research, teaching or collaboration? (e.g., collaboration across natural science, social science and humanities)
- What would be a useful focal topic/theme for such an institute? Would biodiversity and global change still make sense? What else might be exciting?
- What are the strengths and resources that we bring to the table and would like to continue? (e.g., MoUs at research sites, data sets, relationships and networks)

Revisiting Biodiversity – How do we identify and frame the key questions?

Jonathan Hutton

Chair: Jasper Montana[1]
Lead: Jonathan Hutton[2]
[1]*School of Geography and the Environment at the University of Oxford.*
[2]*Luc Hoffmann Institute, Gland, Switzerland*

"Biodiversity is struggling to gain traction in policy and mainstream economic activity and it is possible that the very concept of biodiversity has made it difficult to achieve a holistic framing where nature is more tightly coupled with climate, land degradation and sustainable development. What might a new framing look like and what would its new science encompass?
To answer this question, the Luc Hoffmann Institute is leading a partnership in a process to convene interdisciplinary scientists in an intensive collaborative research process to examine how the concept and narrative of biodiversity has shaped our research, policy and institutions - and what the outcome of this has been in a world where biodiversity is still rapidly declining. The detailed inputs of hundreds of researchers in different disciplines are being sought to create the first comprehensive review of the concept, narratives, science, governance and systems that have emerged around biodiversity since its appearance in the 1980s.
The research process will ask whether and how biodiversity might best evolve, and what questions need to be addressed to support this evolution. The main output will be a new and integrated research agenda to be published in Nature Sustainability that should shape further investigations for the next five years to ten years. This session seeks the views of the conference participants and their inputs into this important process.

The Partners in Biodiversity Revisited
The partners in Biodiversity Revisited are the Luc Hoffmann Institute, Nature Sustainability, Future Earth, ETH Zurich Department of Environmental Systems Science, the University of Cambridge Conservation Research Institute (UCCR), the Centre for Biodiversity and Environment Research at University College London (CBER) and the World Wide Fund for Nature (WWF)

Biodiversity and climate change.

Cornelia Krug and Michael Schaepman

Chair: Cornelia Krug
Lead: Michael Schaepman
URPP GCB, University of Zurich; Zurich, Switzerland.

The same direct and indirect drivers act on biodiversity and on climate change, the interactions and feedbacks, however, are rarely considered together. Furthermore, in light of the need to curb emissions, and to achieve the goal of 1,5°C warming, a number of different climate mitigation and adaptation strategies are put in place. The impacts of these strategies on biodiversity and ecosystem function are not fully understood yet.
The proposed fishbowl will focus on the impacts of climate change on ecosystem function, on the feedbacks between ecosystem function and climate change, and the interaction of climate change with other drivers impacting on biodiversity and ecosystem function. It will further discuss what research is needed to investigate the impacts of climate mitigation strategies on biodiversity and ecosystem function, and highlight the contribution biodiversity and ecosystems make to adaptation and mitigation of climate change. The fishbowl should illustrate the synergies that can be achieved through the conservation of biodiversity and appropriate management of ecosystems.

Integrating food web concepts into biodiversity research.

Aleksandra Lewandowska

Chair: Fernando Pedraza Perez[1]
Lead: Aleksandra Lewandowska[2, 3]
[1]*URPP GCB, University of Zurich; Zurich, Switzerland.*
[2]*Institute for Chemistry and Biology of the Marine Environment, Carl von Ossietzky University of Oldenburg*
[3]*Tvärminne Zoological Station, University of Helsinki*

Climate change and human activities affect global biodiversity at an unprecedented scale. Many species have declined in abundance or are regionally extinct, which impacts the network of species interactions and functioning of ecosystems. However, we still lack a fundamental understanding of the consequences of biodiversity change for functioning and stability of complex food webs. This is because food web interactions and biodiversity-ecosystem functioning relationships have been largely explored in separation. There is a strong theoretical background how to link food web ecology and biodiversity research using allometric scaling and energy flux dynamics, but empirical studies are scarce and often limited to experiments with removal of high trophic levels. Here, we will discuss how to bridge across empirical and theoretical ecology to advance our knowledge on functioning of complex ecological networks. In particular, we would like to address following questions:
- How horizontal and vertical diversity interplay in maintaining ecosystem functions?
- What is the role of horizontal and vertical biodiversity for maintaining stability of ecosystems in the face of environmental change?
- How can we apply multitrophic biodiversity theories in empirical studies to improve predictions of the consequences of biodiversity loss?

Imagining the scope, elements, and aims of "diversity science".

Owen Petchey

Chair: Alejandra Parreño
Lead: Owen Petchey
URPP GCB, University of Zurich; Zurich, Switzerland.

If there is a science of diversity, what does it include, what does it exclude, and are its unique contributions? What theories concerning diversity would be core in a science of diversity? What problems (if any) can only be solved by the science of diversity, what problems require it, and what problems are unrelated? Can an agenda for diversity science be imagined and crystallized?

Why pure richness effects are still the only general result of 25 years biodiversity–ecosystem functioning research.

Bernhard Schmid

Chair: Maarten Eppinga
Lead: Bernhard Schmid
URPP GCB, University of Zurich; Zurich, Switzerland.

At the beginning of the 1990ies the first experimental manipulations of plant species richness were made to test if reducing the number of species in an ecosystem would affect its functioning. Before that, the general view was that it might not do so. After all, theory had predicted negative effects of system complexity on stability and very productive ecosystems often seemed to be characterized by low species richness. In agriculture the common view was that the best monoculture should always be more productive than the best mixture.

Interestingly, the manipulative experiments consistently found a reduction in ecosystem functioning when species richness was reduced. Initially the generality of these pure species-richness effects was very much doubted, with some researchers suggesting that it was due to simple sampling effects where the single best species would take over the mixture and explain the positive richness effects. This idea still lingers around as can be seen when authors write about species-identity or -composition effects being more important than species richness effects, a claim which is based on multiple misunderstandings including statistical ones.

Soon researchers found that it was necessary to go beyond demonstrating the generality of pure species richness effects. They thought there must be general biological mechanisms underlying the pure richness effects. In particular, it seemed logical that complementary resource niches of species could allow a diverse community to extract more resources from the environment and thus have increased ecosystem functioning. Therefore, many embarked on functional diversity instead of species richness per see as a better approach, and because it may not be clear which functional diversity, they also looked into phylogenetic diversity as alternative.

Now, 25 years after the first experiments, it is still extremely difficult to find good examples where the above and other attempts at finding underlying mechanisms of pure species-richness effects were met with success. In this fishbowl we want to discuss potential reasons for this, and possibly rehabilitate the value of the only general rule found so far, namely that pure species richness (often after log-transformation) is positively affecting ecosystem functioning. As a working hypothesis I propose that pure species richness can work via many mechanisms, which individually are depending on the particular context, including the environment, space, time, species composition etc. The challenge for future explanations of pure richness effects will be to allow multiple and sometimes opposing mechanistic explanations to be considered in single studies.

Data ownership and data sharing: perspectives from the biodiversity and ecosystem service community.

Meredith Schuman, Anna Deplazes-Zemp, Debra Zuppinger-Dingley and Veruska Muccione

Chair: Maarten Eppinga
Lead: Meredith Schuman
URPP GCB, University of Zurich; Zurich, Switzerland.

Over the last decade, the scientific standpoint in data sharing and distribution has changed dramatically and it has now become common practice to deposit data in a joint repository. An open attitude from science to support data management and sharing processes has reinforced scientific findings, promoted new research avenues and contributed to increased citation of source papers. Yet, issues surrounding data ownership and access are only seldomly discussed in terms of who is an author of data and who has the right to distribute and request data. Furthermore, the issues of data ownerships and access are very exceptionally (if at all) considered under the lenses of good scientific practice (GSP) and intellectual property (IP) rights. In this fishbowl discussion, we will be discussing the topics of data ownership and data access (both pre and post publication) guided by the criteria of GSP (authorship, data integrity, data availability) and IP (copy right and right to patent). The overarching aim of this discussion will be to inform the design of a consistent and transparent framework for data management in interdisciplinary research programs and projects.

SCIENCE CAFÉ

Do we need to fly so much in academia?

Anna Deplazes Zemp

Presenter: Anna Deplazes Zemp
URPP GCB, University of Zurich; Zurich, Switzerland.

Objectives
Nowadays international research collaborations and exchange of ideas and results at conferences and meetings are essential components of a flourishing research environment. However, for these international meetings academics travel around the world by plane. According to the 2018 sustainability report of the university of Zurich, air travel by its members accounts for the biggest portion of greenhouse gas emissions of the University of Zurich; the same is likely to be true for many other universities. There are international initiatives such as the petition "Flying-Less" or the "No-Fly Climate Sci" website, with the aim to reduce air travel in academia, but there is no evidence for declining numbers of flights in academia.
In this Science Café we want to exchange views and experiences with respect to questions such as:
- Do universities and /or individual researchers have an environmental responsibility to reduce flights in academia?
- Is such a potential responsibility bigger amongst researchers who study global change and loss of biodiversity?
- How could air travel be reduced in academia?
- What are the limits to reducing air travel in academia?

Raising Awareness with Headline Indicators: What is the 1.5°C target in Biodiversity?

Oskar Joensson

Presenter: Oskar Joensson
foraus - Forum Aussenpolitik, Environment, transport & energy programme, Zurich, Switzerland

Objectives

Global loss of biodiversity has reached highly alarming rates, yet still the gravity of the issue has largely escaped the attention of the general public. Despite business as usual scenarios with equal if not worse consequences, biodiversity loss receives less media coverage than climate change (Legagneux et al., 2018). While it is a futile debate what environmental issue is actually more important – after all, they also share common causes and effects – it is worth looking at differences in communication of the two issues. A striking difference are the numerous, quantitative indicators with which the effects of climate change can be communicated to the ordinary person (e.g. degrees of warming, meters of sea-level rise, tons of CO2-equivalents), as compared to the rather abstract biodiversity indicators (e.g. biodiversity intactness index, potentially disappeared fraction of species per area over time). At this science café, we will discuss what could be potential headline indicators for biodiversity (loss), what criteria they must fulfill and what data or methods would be needed to establish them.

Legagneux P, Casajus N, Cazelles K, Chevallier C, Chevrinais M, Guéry L, Jacquet C, Jaffré M, Naud M-J, Noisette F, Ropars P, Vissault S, Archambault P, Bêty J, Berteaux D and Gravel D (2018). Our House Is Burning: Discrepancy in Climate Change vs. Biodiversity Coverage in the Media as Compared to Scientific Literature. Front. Ecol. Evol. 5:175. doi: 10.3389/fevo.2017.00175

Should science communication be an integral part of an academic career?

Morana Mihaljević

Presenter: Morana Mihaljević
URPP GCB, University of Zurich; Zurich, Switzerland
AGORA Biodiversity Means Life; University of Zurich; Zurich, Switzerland

Objectives

We live in a time of fake news, alternative facts, mistrust in scientific process, and at the same time we are facing one of the biggest challenges in human history –rapid global change. Thus, there is an urgent need for better communication of science and research towards the general public. Is that a direct responsibility of researchers themselves? If yes, why don't more researchers reach out to the general public?

In this Science Café we will discuss attitudes of researchers toward public engagement and provide insight into some of the barriers and issues around encouraging researchers to communicate. This will include topics such as opportunities for development of science communication skills, formats of science communication and potential rewards for engaged researchers.

Do more species maximise more ecosystem functions?

Christopher Philipson

Presenter: Christopher Philipson
Department of Environmental Systems Science, ETHZ; Zurich, Switzerland

Objectives

The consensus is that maximizing more ecosystem functions requires more species. This is because ecosystem functions are imperfectly correlated as species contribute differently to each function. The degree to which species contributions are correlated and their identity are critical when determining how many species are required to maximise additional functionality.

Interdisciplinarity and interdisciplinary in global change research

Maria J. Santos, Debra Zuppinger-Dingley, Mollie Chapman

Presenter: Maria J. Santos
URPP GCB University of Zurich; Zurich, Switzerland

Many current global change problems require an interdisciplinary approach to broaden our understanding of their effects and societal implications. While interdisciplinary scholars are on demand, demonstrated by growing programs in sustainability, social-ecological systems, etc., interdisciplinary might mean many different things and have very different perspectives and dimensions. In this science café we will explore interdisciplinarity: what is it and what it means for you as a researcher, whether there is a need for it, and the challenges and barriers to achieving interdisciplinarity. We will also explore when and when not is interdisciplinarity needed, given the different dimensions and perspectives and scrutiny of science, and how to advance its integration in career development, and through activities such as teaching, research and societal outreach.

How can we rigorously detect meaningful but minor signals in noisy and complex data?

Meredith Schumann

Presenter: Meredith Schumann
URPP GCB; University of Zurich; Zurich, Switzerland

Objectives

Biodiversity and global change research involves large and complex datasets in which many small details are very important. In this science cafe, we will discuss how we can identify small but meaningful effects in these datasets. For example, relatively small changes in the remotely sensed reflectance of tree canopies (a few percent) can provide information about tree genotypes and species. What are similar examples in biodiversity and global change research that require the quantification of a relatively small, but meaningful change in complex and noisy data? What approaches can help us in these cases?

Career post PhD and Social Media for Researchers.

Sofia J. van Moorsel

Presenter: Sofia J. van Moorsel
URPP GCB, University of Zurich; Zurich, Switzerland
McGill University; Montreal, Canada

Objectives

In this Café we will discuss two topics and depending on the spectators' preference one topic could be weighed more.

Career post PhD

We will discuss the advantages and disadvantages of doing a postdoc abroad and under which circumstances this career direction makes sense. Participants will have the opportunity to share their experience, offer advice or ask questions (which may be prepared beforehand). We will also discuss life as a female postdoc in a mainly male-dominated environment, discuss strategies and possible scenarios. Questions will be treated confidentially on request, i.e. the question and the answer will not be included in the final report back. I will share my experience applying for a Swiss Postdoc grant (Early Postdoc Mobility) and conducting postdoctoral research abroad with early career researchers.

Social Media for Researchers

Researchers (including ecologists) all over the world are increasingly using Twitter. We will discuss how Twitter is a great tool for all researchers (both early career and late career) to connect with other researchers, to share ideas and frustrations and to learn about other people's experiences. We will further see how Twitter can help disseminate your research and increase your outreach. I joined Twitter a couple of years ago and have had many positive experiences. Participants with a Twitter account can share their "recipes" for a successful twitter handle and let us know how it positively (or negatively) impacted their life. We can make use of this opportunity to set up a Twitter account, tweet a very first tweet and give the @URPP_GCB a boost!

This Science Café is designed to benefit the participants who will therefore shape the direction of the discussions and the outcome. The discussion will be informal and follow a spontaneous flow.

Fearful probable futures and trustful preferred futures?

Rémi Willemin, Norman Backhaus

Presenter: Rémi Willemin, Norman Backhaus
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Objectives
How can we inspire trust when addressing global changes and biodiversity issues?

Probable futures of biodiversity are clearly depicting a "sixth extension" whose disastrous effects raise great fears. While acknowledging the fearful probable futures of biodiversity, alternative scenarios can inspire trustful preferred futures. According to Adam and Groves, in their book *Future Matters,* "numerous tools and methods have been developed to study not just probable and possible but also preferred futures" (2007, p. 32). In this Science café, we will discuss how to inspire trust in preferred futures respecting life on earth.