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DRAFT

## Date: Sunday, 23/Feb/2020

**4:00pm - 5:30pm** — Davos (2/3)

### Plenary 0: Opening Plenary

Session Chair: **Owen Petchey**, University of Zurich, Switzerland
Session Chair: **Michael E. Schaepman**, University of Zurich, Switzerland

**Sandra Díaz, National University of Cordoba, Argentina**

## Date: Monday, 24/Feb/2020

**8:30am - 10:00am** — Davos (2/3)

### Plenary 1: Plenary Session 1

**Jens-Christian Svenning, Aarhus University**

**Markku Oksanen, University of Eastern Finland**

**10:30am - 12:30pm** — Dischma

### 192S-1: Remote Sensing for Biodiversity Monitoring I

Session Chair: **Claudia Roeoesli**, University of Zurich, RSL, Switzerland
Session Chair: **Marc Paganini**, European Space Agency ESA, Italy
Session Chair: **Gary N Geller**, NASA / JPL, United States of America
Session Chair: **Michael E. Schaepman**, University of Zurich, Switzerland

**10:30am - 12:30pm** — Sertig

### 114S: Informally protected urban ecosystems: People, institutions and conservation opportunities

Session Chair: **ALIYU BARAU**, Bayero University Kano, Nigeria, Nigeria
Session Chair: **PEDI OBANI**, United Nations University Institute for Natural Resources in Africa, Accra, Ghana

**10:30am - 12:30pm** — Schwarzhorn

### 126S: Selecting relevant essential variables for monitoring mountain socio-ecological systems

Session Chair: **Carolina Adler**, Mountain Research Initiative, Switzerland
Session Chair: **Elisa Palazzi**, CNR, Italy
Session Chair: **Davnah Payne**, Global Mountain Biodiversity Assessment, Switzerland
Session Chair: **Roger G. Sayre**, U.S. Geological Survey, United States of America
Session Chair: **Aino Kulonen**, Mountain Research Initiative, Switzerland

**10:30am - 12:30pm** — Seehorn

### 158S: Assessment of biodiversity impacts from supply chains

Session Chair: **Alexandra Marques**, European Commission - Joint Research Centre, Italy
Session Chair: **Serenella Sala**, European Commission - Joint Research Centre, Italy

**10:30am - 12:30pm** — Wisshorn

### 123S: Biodiversity and the multi-dimensionality of ecological stability

Session Chair: **Ian Donohue**, Trinity College Dublin, Ireland
Session Chair: **Stuart Leonard Pimm**, Duke University, United States of America
Session Chair: **Owen Petchey**, University of Zurich, Switzerland
Session Chair: **Michel Loreau**, CNRS Theoretical and Experimental Ecology Station, France

Presentations will be followed by a 30 - minute discussion on how to best incorporate the multidimensionality of ecological stability into policy and management.

**2:15pm - 3:45pm** — Davos (2/3)

### Plenary 2: Plenary Session 2

**Pragati Sahni, University of New Delhi**

**David Tilman, University of Minnesota**

**4:15pm - 6:15pm** — Schwarzhorn

### 154S: Light Pollution: Biodiversity and Ecosystem functioning in an illuminated world.

Session Chair: **Eva Knop**, University of Zürich / Agroscope, Switzerland
Session Chair: **Franz Hölker**, Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Germany

**4:15pm - 6:15pm** — Wisshorn

### 102S: Resilience Management of ecological-economic systems

Session Chair: **Luc Doyen**, CNRS, France
Session Chair: **Martin Quaas**, German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Germany

## Date: Tuesday, 25/Feb/2020

**8:30am - 10:00am** — Davos (2/3)

### Plenary 3: Plenary Session 3

**Andy Purvis, Museum of Natural History London**

**Unai Pascual, Basque Centre for Climate Change**

**10:30am - 12:30pm** — Dischma

### 192S-2: Remote Sensing for Biodiversity Monitoring II

Session Chair: **Claudia Roeoesli**, University of Zurich, RSL, Switzerland
Session Chair: **Marc Paganini**, European Space Agency ESA, Italy
Session Chair: **Gary N Geller**, NASA / JPL, United States of America
Session Chair: **Michael E. Schaepman**, University of Zurich, Switzerland

**10:30am - 12:30pm** — Flüela

### 138W-1: Interaction Diversity: From Theory to Practice

Session Chair: **Gianalberto Losapio**, ETH Zurich, Switzerland
Session Chair: **Jacqueline Oehri**, University of Zurich, Switzerland
Session Chair: **Jake Alexander**, ETH Zurich, Switzerland

Talks are followed by 35 minute discussion.

**10:30am - 12:30pm** — Sertig

### 166S-1: Illuminating the black box

Session Chair: **Helen Phillips**, iDiv, Germany
Session Chair: **Léa Beaumelle**, iDiv, Germany

**10:30am - 12:30pm** — Schwarzhorn

### 238S: Mutualism and Biodiversity

Session Chair: **Jordi Bascompte**, University of Zurich, Switzerland
Session Chair: **Judith Bronstein**, University of Arizona, United States of America

Presentations will be followed by an in-depth discussion of the topic.

**10:30am - 12:30pm**

### 115S-1: Socio-economic and ecological implications and challenges of conserving

Seehorn

**biodiversity**
Session Chair: **Sergio Rasmann**, University of Neuchâtel, Switzerland
Session Chair: **Marco Moretti**, Swiss Federal Research Institute WSL, Switzerland

**12:45pm - 2:15pm** — **Posters 1: Poster Session 1**

Hallway

**2:15pm - 3:45pm** — **Plenary 4: Plenary Session 4**

Davos (2/3)

**Lenore Fahrig, Carleton University**

**Odette Curtis, Renosterveld Conservation Trust**

**4:15pm - 6:15pm** — **185S: The role of biodiversity in multi-functional landscapes**

Dischma

Session Chair: **Margot Neyret**, Senckenberg Biodiversity and Climate Research Centre, Germany
Session Chair: **Peter Manning**, Senckenberg Research Institute and Natural History Museum - Frankfurt Am Main, Germany
Talks will be followed by 30 minutes in-depth discussion.

**4:15pm - 6:15pm** — **138W-2: Interaction Diversity: From Theory to Practice**

Flüela

Session Chair: **Gianalberto Losapio**, ETH Zurich, Switzerland
Session Chair: **Jacqueline Oehri**, University of Zurich, Switzerland
Session Chair: **Jake Alexander**, ETH Zurich, Switzerland
Talks are followed by 40 minutes working group discussion and wrap up.

**4:15pm - 6:15pm** — **166S-2: Illuminating the black box**

Sertig

Session Chair: **Helen Phillips**, iDiv, Germany
Session Chair: **Léa Beaumelle**, iDiv, Germany

**4:15pm - 6:15pm** — **129S: The role of biodiversity and ecosystem services in adapting to global change**

Schwarzhorn

Session Chair: **Adrienne Grêt-Regamey**, ETH Zürich, Switzerland
Session Chair: **Aino Kulonen**, Mountain Research Initiative, Switzerland
Session Chair: **Andreas Heinimann**, CDE, University of Bern, Switzerland

**4:15pm - 6:15pm** — **115S-2: Socio-economic and ecological implications and challenges of conserving biodiversity**

Seehorn

Session Chair: **Sergio Rasmann**, University of Neuchâtel, Switzerland
Session Chair: **Marco Moretti**, Swiss Federal Research Institute WSL, Switzerland

## Date: Wednesday, 26/Feb/2020

**8:30am - 10:00am** — **Plenary 5: Plenary Session 5**

Davos (2/3)

**Emma Archer, University of Pretoria**

**Eduardo Brondizio, Indiana University Bloomington**

**10:30am - 12:30pm** — **176S-1: Ethics and Biodiversity Conservation**

Dischma

Session Chair: **Anna Deplazes Zemp**, University of Zurich, Switzerland
Session Chair: **Anna Wienhues**, University of Zurich, Switzerland

**10:30am - 12:30pm** — **120S-1: Aquatic Biodiversity - State and Challenges ahead**

Flüela

Session Chair: **Rosetta Blackman**, Eawag, Switzerland
Session Chair: **Ole Seehausen**, Eawag and Institute of Ecology & Evolution, University of Bern, Switzerland
Session Chair: **Florian Altermatt**, University of Zurich, Switzerland

**10:30am - 12:30pm** — **178S-1: Using Earth Observations to understand changes in biodiversity and ecosystem function**

Sertig

Session Chair: **Jeannine Cavender-Bares**, University of Minnesota, United States of America

**10:30am - 12:30pm** — **101S: Understanding cultural, ecosystem and environmental diversity across the world's mountains**

Schwarzhorn

Session Chair: **Robert Marchant**, University of York, United Kingdom
Session Chair: **Ricardo Grau**, Instituto de Ecología Regional, CONICET-National University of Tucumán, CC 34 (4107) Yerba Buena, Tucumán, Argentine Republic
Session Chair: **Julia Klein**, Colorado State University, Dept. Ecosystem Science & Sustainability, Campus Delivery 1476, Fort Collins, CO 80523 USA
Session Chair: **Aida Cuni-Sanchez**, University fo York, United Kingdom
Session Chair: **Christine Schmitt**, Center for Development Research, University of Bonn, Genscherallee 3, D-53113 Bonn, Germany

**10:30am - 12:30pm** — **190S: Integrated Pathways for Sustainable Biodiversity Futures**

Seehorn

Session Chair: **Eva Spehn**, Swiss Biodiversity Forum, Switzerland
Session Chair: **Andreas Obrecht**, SDSN Switzerland, Switzerland
Session Chair: **Davnah Payne**, Global Mountain Biodiversity Assessment, Switzerland
Session Chair: **Ariane Carole de Bremond**, Global Land Programme, Switzerland
Session Chair: **Hannah Moersberger**, Future Earth, France
Session Chair: **Gabriela Wuelser**, SCNAT Sustainability Research Initiative, Switzerland

**10:30am - 12:30pm** — **141S-1: Phylogenetic and genetic diversity**

Wisshorn

Session Chair: **Luc De Meester**, KU Leuven, Belgium
Session Chair: **Felix Forest**, Royal Botanic Gardens, Kew, United Kingdom

**1:30pm - 3:30pm** — **Posters 2: Poster Session 2**

Hallway

**3:00pm - 6:00pm** — **155S: The Future of Remote Sensing of Biodiversity**

Sertig

Session Chair: **Susan L. Ustin**, University of California Davis, United States of America
Session Chair: **Margarita Huesca**, University of California Davis, United States of America
Session Chair: **Maria Santos**, University of Zurich, Switzerland
Talks followed by panel discussion

**4:00pm - 6:00pm** — **003GS-1: Strategies for conservation of biodversity and ecosytem services**

Studio

**4:00pm - 6:00pm** — Dischma
**176S-2: Ethics and Biodiversity Conservation**
Session Chair: **Anna Deplazes Zemp**, University of Zurich, Switzerland
Session Chair: **Anna Wienhues**, University of Zurich, Switzerland

**4:00pm - 6:00pm** — Flüela
**120S-2: Aquatic Biodiversity - State and Challenges ahead**
Session Chair: **Rosetta Blackman**, Eawag, Switzerland
Session Chair: **Ole Seehausen**, Eawag and Institute of Ecology & Evolution, University of Bern, Switzerland
Session Chair: **Florian Altermatt**, University of Zurich, Switzerland

**4:00pm - 6:00pm** — Schwarzhorn
**125W: Connecting the human dimension and global marine ecosystem services**
Session Chair: **Andrea Belgrano**, SIME, Sweden
Session Chair: **Sebastian VILLASANTE**, University of Santiago de Compostela, Spain

**4:00pm - 6:00pm** — Seehorn
**572S: Solution-oriented scenarios to the loss and restore global biodiversity**
Session Chair: **Rob Alkemade**, Netherlands Environmental Assessment Agency, Netherlands, The
Session Chair: **Jelle Peter Hilbers**, PBL, Netherlands, The

**4:00pm - 6:00pm** — Wisshorn
**141S-2: Phylogenetic and genetic diversity**
Session Chair: **Luc De Meester**, KU Leuven, Belgium
Session Chair: **Felix Forest**, Royal Botanic Gardens, Kew, United Kingdom

## Date: Thursday, 27/Feb/2020

**8:30am - 10:00am** — Davos (2/3)
**Plenary 6: Plenary Session 6**
**Rashid Sumaila, University of British Columbia**
**Barend Erasmus, University of Pretoria**

**10:30am - 12:30pm** — Forum
**183DE: Panel discussion on new and disruptive approaches for biodiversity**
Session Chair: **Kathrin Ludwig**, Adelphi, Germany

**10:30am - 12:30pm** — Dischma
**004GS-1: People and Nature - Nature and People**

**10:30am - 12:30pm** — Flüela
**210S: Indigenous Knowledge in science-policy assessments**
Session Chair: **Rodrigo Cámara Leret**, University of Zurich, Switzerland
Session Chair: **Jordi Bascompte**, University of Zurich, Switzerland

**10:30am - 12:30pm** — Sertig
**178S-2: Using Earth Observations to understand changes in biodiversity and ecosystem function**
Session Chair: **Jeannine Cavender-Bares**, University of Minnesota, United States of America
Talks followed by 40 minutes discussion

**10:30am - 12:30pm** — Schwarzhorn
**146S-1: Nature-based solutions for for adapting and mitigating climate change**
Session Chair: **Nadia Castro**, University of Zurich, Switzerland
Session Chair: **Veruska Muccione**, University of Zurich, Switzerland
Session Chair: **Cornelia Krug**, Universität Zürich, Switzerland
Session Chair: **Maria Santos**, University of Zurich, Switzerland
Session Chair: **Christian Huggel**, University of Zurich, Switzerland

**10:30am - 12:30pm** — Seehorn
**165S: Drivers of success and failures in conservation management**
Session Chair: **Jutta Beher**, University of Melbourne, Australia

**10:30am - 12:30pm** — Wisshorn
**152S: Spatial Biodiversity Data Platforms: Current Resources and Future Opportunities**
Session Chair: **Davnah Payne**, Global Mountain Biodiversity Assessment, Switzerland
Session Chair: **Eva Spehn**, Swiss Biodiversity Forum, Switzerland
Session Chair: **Michelle Duong**, Yale University, United States of America
Session Chair: **Walter Jetz**, Yale University, United States of America

**12:30pm - 2:00pm** — Hallway
**Posters 3: Poster Session 3**

**2:15pm - 3:45pm** — Davos (2/3)
**Plenary 7: Plenary Session 7**
**Workineh Kelbessa, Addis Ababa University**
**Fabio Scarano, Federal University of Rio de Janeiro**

**4:15pm - 6:15pm** — Studio
**003GS-2: Biodiversity in Production Systems**

**4:15pm - 6:15pm** — Forum
**237S: Tropics with the highest biodiversity: Towards interdisciplinary studies**
Session Chair: **Kentaro K. Shimizu**, University of Zurich, Switzerland
Session Chair: **Michael O'Brien**, Universidad Rey Juan Carlos, Spain

**4:15pm - 6:15pm** — Dischma
**187S: Public Health and Biodiversity: Potential and Barriers to Integrated Policies**
Session Chair: **Mollie Chapman**, University of Zurich, Switzerland

**4:15pm - 6:15pm** — Flüela
**118S: Pastoralist Knowledge Practices and Management for Biodiversity**
Session Chair: **Serena Ferrari**, FAO, Italy
Session Chair: **Jesús Garzón**, Trashumancia y Naturaleza, Spain
Session Chair: **Luca Battaglini**, University of Torino, Italy
Session Chair: **SANTIAGO JOSE CARRALERO BENITEZ**, YURTA Association, Spain
Session Chair: **Ilse Köhler-Rollefson**, League for Pastoral Peoples and Endogenous Livestock Development, Germany
Session Chair: **Simon Tagourdeau**, CIRAD, France

**4:15pm - 6:15pm** — Sertig
**181S: Global Consequences of past and future biodiversity loss**
Session Chair: **Forest Isbell**, University of Minnesota, United States of America

**4:15pm - 6:15pm** — **146S-2: Nature-based solutions for for adapting and mitigating climate change**
Session Chair: **Nadia Castro**, University of Zurich, Switzerland
Session Chair: **Veruska Muccione**, University of Zurich, Switzerland
Session Chair: **Cornelia Krug**, Universität Zürich, Switzerland
Session Chair: **Maria Santos**, University of Zurich, Switzerland
Session Chair: **Christian Huggel**, University of Zurich, Switzerland
Schwarzhorn

**4:15pm - 6:15pm** — **165S-2: Drivers of success and failures in conservation management**
Session Chair: **Jutta Beher**, University of Melbourne, Australia
Seehorn

**4:15pm - 6:15pm** — **220S: Biodiversity in the Grisons - Threats and Opportunities in an alpine environment**
Session Chair: **Armando Lenz**, Pro Natura GR, Switzerland
Wisshorn

## Date: Friday, 28/Feb/2020

**8:15am - 9:45am** — **Plenary 8: Plenary Session 8**
Davos (2/3)
**Benis Egoh, University of California Irvine**
**Gary Varner, Texas A&M University**

**10:15am - 12:15pm** — **003GS-3: Biodiversity in the Anthropocene**
Dischma

**10:15am - 12:15pm** — **106S: Making ecosystem service assessment operational in environmental management**
Session Chair: **Martin Pusch**, Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB), Germany
Flüela

**10:15am - 12:15pm** — **135S: Enhancing biodiversity to support sustainabie crop production**
Session Chair: **Christian Schöb**, ETH Zurich, Switzerland
Session Chair: **Johan Six**, ETH Zurich, Switzerland
Session Chair: **Rob Brooker**, The James Hutton Institute, United Kingdom
Seehorn

**10:15am - 12:15pm** — **167W: Response and Effect of plant-trait diversity to climate and climate change**
Session Chair: **Kirsten Thonicke**, Potsdam Institute for Climate Impact Research (PIK), Germany
Session Chair: **Boris Sakschewski**, Potsdam Institute for Climate Impact Research (PIK), Telegrafenberg A31, Potsdam, Germany
Session Chair: **Jeremy Lichstein**, Department of Biology, University of Florida Gainesville, FL 32611, United States of America
Session Chair: **David Schimel**, JPL, United States of America
Session Chair: **Michael E. Schaepman**, University of Zurich, Switzerland
Wisshorn

**12:15pm - 1:15pm** — **Closing: Closing Plenary**
Session Chair: **Michael E. Schaepman**, University of Zurich, Switzerland
Davos (2/3)
**Andrew Light, George Mason University and World Resources Institute**

# Presentations

## Plenary 0: Opening Plenary

*Time:* Sunday, 23/Feb/2020: 4:00pm - 5:30pm · *Location:* Davos (2/3)
*Session Chair:* Owen Petchey, University of Zurich, Switzerland
*Session Chair:* Michael E. Schaepman, University of Zurich, Switzerland

### Sandra Díaz, National University of Cordoba, Argentina

**4:00pm - 4:45pm Warning: The presentations finish prior to the end of the session!**

**Three Problems with Nature: the Nature of Nature, Human Nature and the Nature we want**

**Sandra Díaz**
National University of Cordoba, Argentine Republic; sandra.diaz@unc.edu.ar

Recent evidence from the natural and social sciences point to an unprecedented crisis in nature and its vital contributions to people worldwide. I will explore this situation and possible ways forward from three perspectives. First, evidence of deep and extensive reconfiguration of life on Earth by human societies. Second, the multidimensional nature of the fabric of life, which defies a single easy-to-communicate descriptor. Third, the role of social narratives linking people and nature as the basis of the present situation and future alternatives.

# Plenary 1: Plenary Session 1

*Time:* Monday, 24/Feb/2020: 8:30am - 10:00am · *Location:* Davos (2/3)

## Jens-Christian Svenning, Aarhus University

## Markku Oksanen, University of Eastern Finland

**The maximum number of 0 presentations has been exceeded! There are now 2 presentations in this session.**

**8:30am - 9:15am**

### Towards a Biodiverse Future: Lessons from a Macro-scale Perspective on Ecology

**Jens-Christian Svenning**
Aarhus University, Denmark; svenning@bios.au.dk

The last few millions years (the Quaternary, starting 2.6 million years ago) have experienced extraordinary instability in climate and the rise of humans as a global ecological force. Hence, there is much to learn from biodiversity and ecosystem dynamics through this period for conservation, restoration and sustainable development in a future characterized by a rising human population and human-driven climate change. The strong Quaternary climate variations drove strong ecosystem reorganization, with dispersal and extinction playing major roles. Importantly, strong shifts to novel climates caused massive biodiversity losses, with enduring legacies. Further, there is a globally consistent pattern of strong biodiversity and ecosystem changes in the wake of the global spread of modern humans, *Homo sapiens*. Extinction and extirpation of large vertebrates are typical, and the associated trophic downgrading likely had profound ecological effects. For the last 10,000 years increasing land transformation through agriculture have exacerbated these impacts. Looking ahead, we can forecast further intensifying impacts from direct human activities and human-driven climate change under business-as-usual scenarios, with strong potential to lead to massive biodiversity losses with long-lasting consequences. Achieving a more positive future for biodiversity requires intensified, integrative efforts to solve the climate and biodiversity crises alongside sustainable, democratic societal development. We need to strengthen conservation efforts, with major foci on safeguarding biodiversity hotspots and intact ecosystems with special attention to areas buffered against future climate stress. Simultaneously, there is strong need for widespread ecosystem restoration through rewilding (restoration to restore self-managing complex ecosystems) to enhance the biodiversity capacity and resilience of natural areas, including via strengthening connectivity. Proactive approaches such as species translocations will be needed to overcome negative legacies and enhance adaptive responses to climate change. These efforts to secure biodiversity have major potential for sustainable development, contributing important co-benefits for climate mitigation and adaptation, livelihoods and livability.

**9:15am - 10:00am**

### Rights and Biodiversity

**Markku Oksanen**
University of Eastern Finland, Finland; markku.oksanen@uef.fi

My presentation addresses the role and significance of the concept of rights in biodiversity conservation. I am a moral and political philosopher and I would like to talk about one specific aspect within the moral landscape of biodiversity conservation: is there a place for the concept of rights in biodiversity conservation, and if there is, what it should be? Or, in more concrete terms: Do people have a moral right to a healthy environment? Or do biological species have a right to be preserved? So, I will think through certain formulations of rights that I consider important and relevant to biodiversity conservation. I will not examine domestic or supranational legal documents systematically although I do refer to them here and there. Thus, I am more concerned with moral rights than with legal rights. The difference between them, to put it simply, is that moral rights are independent of positive law, whereas legal rights are rights that the law recognises. For example, the human's right to a healthy environment is a part of a constitution in many countries, whereas the species' right to exist is merely an expression of moral attitude that can be referred in social criticism. The use to rights in conservation politics and science is largely an exercise of social criticism.

# 192S-1: Remote Sensing for Biodiversity Monitoring I

*Time:* Monday, 24/Feb/2020: 10:30am - 12:30pm · *Location:* Dischma
*Session Chair:* Claudia Roeoesli, University of Zurich, RSL, Switzerland
*Session Chair:* Marc Paganini, European Space Agency ESA, Italy
*Session Chair:* Gary N Geller, NASA / JPL, United States of America
*Session Chair:* Michael E. Schaepman, University of Zurich, Switzerland

Global observations and regular assessments are key to monitor and understand global biodiversity change and related drivers allowing to finally conserve biodiversity in space and time. Satellite based, remote sensing observations have demonstrated the capacity for global monitoring of biological diversity. This session discusses recent scientific progress and importance in using Earth observations from remote sensing platforms. Particular focus will be on priority setting of the choice and use of Earth observations as well as their complementarity and co-existence with in-situ measurements for global biodiversity assessment.

The Group on Earth Observation Biodiversity Observation Network (GEO BON) is currently developing a framework, based on the concept of Essential Biodiversity Variables (EBVs), for a global biodiversity observation network. We will discuss the contribution, development, production, operationalization and validation of remote sensing enabled EBV's (RS-enabled EBVs) to the EBV framework. Exemplary RS-enabled EBVs may include fragmentation, vegetation structure, canopy chlorophyll content or land surface phenology, but are not limted to these. Besides the development of algorithms and their implementation, the session invites also contributions discussing the relevance of such data products for policy makers, biodiversity indicator assessment, integration for biodiversity analysis and modelling, as well as assessing ecosystem services.

**10:30am - 10:50am**

## The ESA CCI Programme - learning from the ECV process

**Susanne Mecklenburg, Sophie Hebden, Marc Paganini**
European Space Agency, United Kingdom; susanne.mecklenburg@esa.int

The ESA Climate Office, being the focal point for climate activities in ESA, brings together world-leading experts across ESA Member States to leverage satellite assets for climate data records. Its flagship programme, the Climate Change Initiative (CCI), creates long-term, global time series for 22 Essential Climate Variables (ECVs), as defined by the Global Climate Observing System (GCOS). CCI climate data records thus provide the observational evidence to quantify the changes in the Earth's climate, underpinning the work of the UN Framework Convention on Climate Change and Intergovernmental Panel on Climate Change (IPCC assessments). For example, scientists from CCI projects authored five chapters of the recent IPCC special report on Oceans and Cryosphere and are leading working groups for the IPCC Sixth Assessment Report. The climate data records include fully-characterised uncertainties and are validated using independent, traceable, in-situ measurements.
The CCI climate data records have a significant uptake within the climate modelling community and are used in association with Earth System Models (ESMs) to study climate change and its impacts, as well as a variety of other applications, including for biodiversity studies. In this presentation we highlight the impact of the CCI programme, use-cases for biodiversity, complementarities CCI datasets have with Essential Biodiversity Variables (EBVs) and lessons learnt from the ECV process, and opportunities for informing the Global Stocktake required under the Paris Agreement.

**10:50am - 11:10am**

## Land Surface Phenology observed using dense time-series of Sentinel-2 and Landsat 8

**Claudia Roeoesli[1], Vladimir R. Wingate[1], Rogier de Jong[2], Isabelle Helfenstein[1], Michael E. Schaepman[1]**
[1]University of Zurich, RSL, Switzerland; [2]Swiss Re, Switzerland; claudia.roeoesli@geo.uzh.ch

Land Surface Phenology (LSP) characterizes recurrent events in the annual profile of vegetated land surfaces as observed from remote sensing. LSP is a widely used set of parameters used for assessing terrestrial ecosystem responses to changes in environmental conditions, and for characterising species composition and biodiversity. Monitoring LSP requires a sufficiently dense time-series of remote sensing data, in order to fit models to yearly vegetation activity profiles. This data is now available at high spatial resolution and sufficiently dense time-series since the launch of the European space Agency's (ESA) Sentinel fleet. Within the framework of ESA's GlobDiversity project, which focuses on the development of remote sensing-enabled Essential Biodiversity Variables (RS-enabled EBVs) for the development of a global biodiversity monitoring system, we have developed, after an inventory of the state of the art approaches followed by a trade-off analysis, an algorithm geared towards retrieving a global LSP product. The algorithm workflow encompasses vegetation activity data derived from Sentinel-2 and Landsat 8 satellite images. The dense time-series is then used, after pixel flagging and model fitting, to extract LSP properties, including the parameters Start of Season and Growing Season Length.

The algorithm is applied to several pilot sites distributed across different biomes and national parks around the globe. We then validate the results with observations and LSP properties derived from a network of ground-based phenocams. Importantly, we show that a robust time-series of LSP metrics can be processed from satellite-based vegetation activity datasets, which can be effectively used to study ecosystem change globally.

**11:10am - 11:30am**

## Scaling Functional Diversity Using Satellite Remote Sensing

**Leon T. Hauser, Joris Timmermans, Nadejda A. Soudzilovskaia, Peter M. van Bodegom**
Institute of Environmental Sciences (CML), Leiden University, The Netherlands; l.t.hauser@cml.leidenuniv.nl

Spatial functional diversity patterns are of key importance to monitor our ecosystems and provide insights in spatial patterns in ecosystem functioning. While species richness is known to be highly scale-dependent, such scaling is less understood for plant functional diversity. Advances in satellite remote sensing are opening new opportunities to study the effects of spatial scaling. Here, we analyzed Sentinel-2 satellite imagery over the vast and biodiverse region of Sabah, Borneo, to assess the relationship between functional diversity and area and its link to traditional scaling concepts in ecology. The remotely sensed functional diversity metrics were calculated over increasing grain, i.e. plot sizes, and are evaluated against land use, environmental drivers and null models.

The findings reveal consistent differences in functional diversity between land use types across scale. Functional richness increases with area, while evenness and divergence are relatively scale independent. The idiosyncratic scale dependency of different functional diversity metrics follows a similar curvature as random null-models, but digresses from a purely mathematical effect of increasing data. Instead our results indicate a spatial convergence of trait distributions consistent with environmental and biotic filtering. The functional diversity–area curvatures are moderately, yet increasingly with scale, associated with environmental

drivers that can be tied to habitat heterogeneity.

Using satellite remote sensing, the study thus highlights the continuous change in functional diversity over spatial scales and extents. Traditional concepts of alpha and beta diversity, which are more discrete, can still play a role in the interpretation of the findings. However, these patterns can now be observed in a non-discrete and show the gradual changes from within- to between-community dynamics. This continuity of scaling and spatial coverage contributes to the development theories that go beyond a discrete scaling of alpha and beta diversity.

**11:30am - 11:50am**

## Measuring Forest Biodiversity Status Through Changes in Forest Cover

**Samantha L.L. Hill[1,2], Andy Arnell[1], Neil D. Burgess[1]**

[1]UNEP-WCMC, Cambridge, United Kingdom; [2]Natural History Museum, London, United Kingdom; samantha.hill@unep-wcmc.org

The world's forests are crucially important for both biodiversity conservation and climate mitigation. New forest status and forest change spatial layers using remotely sensed data have revolutionised forest monitoring globally, and provide fine-scale deforestation alerts that can be actioned in near-real time. However, existing products are restricted to representing tree cover and do not reflect the considerable spatial variation in the biological importance of forests. Here we link modelled biodiversity values to remotely sensed data on tree cover to develop global maps of forest biodiversity significance (based on the rarity-weighted richness of forest mammal, bird, amphibian and conifer species) and forest biodiversity intactness (based on the modelled relationship between anthropogenic pressures and community intactness). The strengths and weaknesses of these products for policy and local decision-making are reviewed and we map out future improvements and developments that are needed to enhance their usefulness.

**11:50am - 12:10pm**

## Land Use and Fragmentation as Major Drivers of Biodiversity Change at the Planetary Scale

**Luis J. Gilarranz[1], Tobias Frey[1], Anita Narwani[1], Mary I O'Connor[2]**

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Habitat loss and habitat fragmentation have traditionally been regarded as two of the major drivers of biodiversity loss. Satellite images allow us to track these two processes over time at the planetary scale. However, similar coverage of biodiversity mapping is lacking. Spatial coverage of species records is extremely biased, and representative time series are scarce. Most of the knowledge we have about the processes affecting biodiversity is based on a compilation of studies limited in both their temporal and spatial dimensions. Fortunately, the recent abundance of publicly-accessible georeferenced data opens up a possibility to link biodiversity surveys with satellite images. By bridging across disciplines, here we provide strong evidence of the processes affecting biodiversity over time at the planetary scale. Then we zoom in to provide specific examples that may explain apparent increases in biodiversity as a function of the scale due to the increase in habitat fragmentation. Since land-use change and habitat fragmentation can be extrapolated over time, it is tempting to develop future scenarios of how biodiversity may change in the future. However, despite the apparent abundance of data, we are far from understanding biodiversity at a planetary scale in a comparable way to which we understand the climate, and yet, the stakes for human societies across the world are at least comparable to those derived from climate change.

**12:10pm - 12:30pm**

## Remote Sensing of Ecological Genomics

**Meredith C. Schuman[1,2], Felix Morsdorf[1], Owen Petchey[3], Bernhard Schmid[1,3], Kentaro K. Shimizu[3], Michael E. Schaepman[1]**

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On Christmas Eve 1968, astronaut Bill Anders snapped the first photo of the Earth rising over the moon. This image, later termed Earthrise, became an icon for the environmental movement. Now more than 50 years later, we have a multitude of sophisticated and specialized satellites, aircraft, and drones equipped with advanced measurement instrumentation designed to record images of the Earth's surface at a range of wavelengths, including and far beyond visible light – covering almost the full electromagnetic spectrum. There is already a body of expert literature on how remote sensing instruments, methods, and data can fill crucial gaps in our understanding of global ecology, and biodiversity, not least by providing data on regions which are poorly characterized by on-the-ground monitoring efforts. In this review, we focus on the potential of these technologies to reveal deeper information about the ability of ecosystems to adapt in a changing climate, including the potential to map phylogenetic diversity, the distribution of functional traits, and the responses of ecological communities to rapidly shifting landscapes of biotic and abiotic pressures. In doing so, we focus both on the promise and on the limitations of current imaging and data interpretation approaches, and suggest ways forward for scientists wishing to employ these approaches in biodiversity and global change research.

# 114S: Informally protected urban ecosystems: People, institutions and conservation opportunities

*Time:* Monday, 24/Feb/2020: 10:30am - 12:30pm · *Location:* Sertig
*Session Chair:* ALIYU BARAU, Bayero University Kano, Nigeria, Nigeria
*Session Chair:* PEDI OBANI, United Nations University Institute for Natural Resources in Africa, Accra, Ghana

Much is known and written about protected ecosystems that enjoy sub-national, national and international protection status. However, most protected ecosystem are located outside urban and peri-urban areas and often depend on heavy loaded budgets for maintenance. Nevertheless, individual households, palaces, public buildings, community open and green spaces, highways and railway corridors harbour habitats of biological diversity.

Little is known about composition, configurations, ecosystem services, and bioclimatic potentials of such ecosystems. This session seeks for papers from academics, communities, practitioners, industry and policymakers that can increase our understanding of types, functions and potentials informally protected ecosystems in relation to public health and wellbeing, food supplies, climate mitigation and adaptation, ecotourism, gender dimensions, and biodiversity protection among others. The session also seeks papers on the role of institutions and instruments supporting conservation of informally protected ecosystems. We also welcome papers that link informally protected ecosystem with implementation of SDGs. Other paper on the look out are those that explore the potentials of informally protected ecosystems in achieving international biodiversity protection and conservation instruments e.g IPBES, CBD, Aichi targets etc. The session will also feature a talk by His Royal Highness, Muhammad Sanusi II, The Emir of Kano (also UN Secretary General appointed SDGs Advocate), on indigenous tree conservation and amazing bats colony hosted in the 16th century Kano Emir's palace. The talk aims to highlight and profile the strength and stewardship of informal institutions in protecting urban and peri-urban ecosystems.

**10:30am - 11:00am**

## The City, Royalty and Conservation: the Kano Emir’s Palace as a Studio of Nature

**Muhammadu Sanusi II**
Kano Emir's Palace, Nigeria; aliyubarau1@yahoo.co.uk

I have been to Davos before for the World Economic Forum events. Coming to Davos this week for the ecology is a reflection of the global sustainable development imperatives. As a UN Secretary General’s appointed SDGs advocate, I understand the critical role of biodiversity conservation in realising the targets and indicators of the SDGs. Indeed, the global economy is not independent of the natural environment. Some years back, ecological economists argued that, with minimum estimated value of US$33 trillion per year, the nature benefits are much higher than global gross national product total of around US$18 trillion per year. In general, the utilities of nature can neither be quantified nor imagined. This is because of the intangible benefits of nature to people’s culture, heritage, values and well-being are immeasurable by monetary value. In many African countries informal institutions play more critical role in nature protection and conservation than their formal counterparts. A good example is in respect of gardens of the 16$^{th}$ century Kano Palace. These gardens have become green hotspot in Kano City, Nigeria’s second largest urban agglomeration. The Kano palace is not a habitat of the royalty alone, it is also a safe habitat for biological diversity from insects to different species of birds and fruit bats. Our palace gardens host the largest colony of fruit bats that one can probably see in any major Nigerian city. For centuries, the palace residents hold the gardens in awe. Such is one of the informal protection strategies that works to date. Fruit bats are known to spread plant seeds more than other mammals do. Our centuries old stewardship of the palace gardens has directly or indirectly supported the bats to disperse seeds and grow trees in the drylands of our region. This silently helps in combating climate change, biodiversity loss and enhances sources of nutrition for the poor. The bats fly out of the palace in the early evening hours, giving an incredible vista in the city skies at no cost. No one pays for such beauty that we would all miss if the palace has not conserved its trees.

**11:00am - 11:15am**

## Planning to make the Urban Century Greener for People and Nature

**Andressa Vianna Mansur[1], Henrique M. Pereira[1,3], Robert McDonald[2], Hyejin Kim[1,3]**
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Urbanization is one of the major drivers of biodiversity changes, as cities are growing impacting directly natural habitats and human well-being and indirectly through the use of resources and energy consumption. Global projections show that about 70% of the world’s population will be urban by 2050, and this will have significant implications for the sustainability of the planet. To ensure a bright future for nature and people we need to adequately plan for urban growth with solutions that can effectively safeguard biodiversity but also support economic growth and provisioning for human well-being. The goal of this presentation is to give an overview of an international effort towards mapping and assessing the impact of urban growth on biodiversity and ecosystem services, and introduce the application of Nature Futures Framework proposed by IPBES, to develop positive visioning for urban systems. First, we present results from scientific literature assessing the global direct and indirect impacts of cities on natural ecosystems and biodiversity. Then, we implement the NFF as a tool to explore what cities might look like if we put emphasis on protecting biodiversity and on enhancing nature’s contributions to human well-being, illustrating different visions for nature in cities. These visions can then be analyzed with models of drivers, biodiversity, ecosystems services and social-ecological feedbacks to develop fully constructed scenarios. We hope these scenarios can serve as a tool by the cities around the world to explore different planning options and assess how the preferences of different city communities result in different cityscapes and distribution of associated benefits.

**11:45am - 12:00pm**

## Modelling Biodiversity in Cities: a first case in Zurich

**Joan Casanelles Abella[1,3], Yohann Chauvier[2,3], Martin Obrist[1], Florian Zellweger[4], David Frey[1], Marco Moretti[1], Loïc Pellissier[2,3]**
[1]Biodiversity and Conservation,Swiss Federal Research Institute WSL, Switzerland; [2]Landscape Dynamics,Swiss Federal Research Institute WSL, Switzerland; [3]Department of Environmental Systems Science, ETHZ, Switzerland;; [4]Department of Plant Sciences, University of Cambridge, U.K.; joan.casanelles@wsl.ch

Increasing urbanization worldwide poses threats but also offering opportunities for biodiversity conservation. Even though the number of urban ecology studies is increasing, the knowledge on urban biodiversity is still hampered by the difficulty of extrapolating traditional biodiversity point measurements spatially explicit to a larger scale. In other words, to predict biodiversity through different metrics such as species occurrence, species richness or functional diversity at the city-scale. Species distribution models (SDMs) have proved to be a key tool to solve this shortfall in biodiversity knowledge in several ecological studies. However, SDMs have rarely been used in the context of urban areas due to either the lack of sufficient species records or high-quality predictors (e.g. meaningful ecological maps). From several years of urban ecology research, an extensive dataset of urban biodiversity composed of several taxonomic groups exists for the city of Zürich. Here, we used the species records (including several insects orders, isopods, snails and birds) collected in Zürich during the last decade and modelled at the city-scale species occurrences, species richness and functional diversity. We used a wide range of high-resolution predictors including climatic (e.g. temperature), pollution (e.g. particulate matter), land-cover and remote-sensing data (e.g. LiDAR). Using Zürich as a model city, we aimed to better understand urban biodiversity patterns by (1) mapping hotspots and coldspots biodiversity, using a combination of metrics, and check whether the patterns were consistent among taxonomic groups; (2) identifying the main predictors generating those patterns for the different metrics; and (3) assessing the potential of the generated maps for improving biodiversity conservation in urban areas.

**12:00pm - 12:15pm**

### Climate Change And Urban Biodiversity Conservation Management - The Case Study Of Thermophilic And Red List Species Ovalisia (Scintillatrix) rutilans

**Hasan Candan**

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This year for the first time *Ovalisia (Scintillatrix) rutilans*, a wood-boring beetle of the family Buprestidae was recorded for the city of Berne, Switzerland. *Ovalisia (Scintillatrix) rutilans* is indexed on the red list species in Switzerland and may benefit from urban heat effect and climate change. *Ovalisia (Scintillatrix) rutilans* is thermophilic and develops on lime trees *Tilia* × *euchlora spp.* that face heat and water stress with trees getting weak and may be a hazard for pedestrians or traffic participants and infrastructures. Urban decision makers now have to decide how to cope with this new found species and the infected trees. Instead of removing infected tress they can be safeguarded and act as structure element for conserving the threatened species and increase urban biodiversity. Moreover *Ovalisia (Scintillatrix) rutilans* can be used as biodindicator to reveal weak trees, save money and to improve urban tree management. The wonderful colored appearance of the beetle also can help to aware the citizens for the decline in urban biodiversity and insects in particular.

Keywords: Urban biodiversity management, climate change, adaptation, conservation, Buprestidae, Ovalisia (Scintillatrix) rutilans

**12:15pm - 12:30pm**

### The Role of Abattoirs in Maintaining Vulture Diversity in Katsina State, Northwestern Nigeria

**Muhammad Danjuma, Mustapha Zakariya**

Bayero University, Kano, Nigeria; mndanjuma.geog@buk.edu.ng

Vulture is an important component of both natural and human ecosystems. Given the strong association of humans with vulture, its populations have declined significantly in recent decades owing to many causes including habitat loss. However, these species are struggling to survive hence live in close habitats such as abattoirs and dumpsites. This study conducted a survey of abattoirs within 20km radius of urban urban Katsina to determine the role of the facilities in maintaining vulture diversity. The survey sampled 4 abattoirs of different plan based on the knowledge that these facilities are the last strongholds of vulture in urban Katsina. Relative abundance of vultures was assessed using counts when birds are at rest. In all, 12 vultures were observed in Kayauki abattoir while 2 were observed in Katsina old abattoir. They are the white-backed *Gyps africanus* which were last surviving species in the area. Snowball sampling was used to select participants (n=31) who works in the abattoir in order to capture their perspectives on the decline of vulture. Participants were asked to list and rank direct threats and underlying factors contributing to vulture diversity decline. Result of the interview confirmed that vulture had declined drastically since the year 2005 when the abattoirs were reconstructed to a closed-system.

# 126S: Selecting relevant essential variables for monitoring mountain socio-ecological systems

*Time:* Monday, 24/Feb/2020: 10:30am - 12:30pm · *Location:* Schwarzhorn
*Session Chair:* Carolina Adler, Mountain Research Initiative, Switzerland
*Session Chair:* Elisa Palazzi, CNR, Italy
*Session Chair:* Davnah Payne, Global Mountain Biodiversity Assessment, Switzerland
*Session Chair:* Roger G. Sayre, U.S. Geological Survey, United States of America
*Session Chair:* Aino Kulonen, Mountain Research Initiative, Switzerland

Mountains worldwide host rich biodiversity, are home to millions of people and provide upland and lowland inhabitants with vital ecosystem services and resources for their livelihoods. However, mountain regions are highly dynamic environments and undergo constant changes in their climate, natural hazards, land use, and in their political and socio-economic context. These changes are often amplified compared to lowland areas and driven by a multitude of biophysical and socio-economic factors. Accordingly, effective policies and management approaches that account for these changes are needed to safeguard the natural assets that underpin human wellbeing and ecosystems along elevational gradients and thereby adequately respond to international agendas such as the Strategic Plan for Biodiversity or the Agenda 2030 of the United Nations. These approaches in turn require effective monitoring frameworks that offer relevant, regular, timely, and harmonized data to generate information that responds to reporting needs. Incorporating Essential Variables (EVs) into monitoring frameworks offers a means to harmonize the collection of data pertaining to drivers and processes of change that are context-relevant, in this case through the in situ and remote monitoring of relevant biodiversity and societal variables from the local to the global scale. However, given their remoteness, their steep environmental gradients, diverse habitats and microclimates, diverse socio-cultural contexts, and complex social-ecological systems interactions, mountains are particularly difficult to monitor. To facilitate harmonised data compilation, essential mountain biodiversity and societal variables need to be identified that fulfil a set of criteria that incudes scalability, temporal sensitivity, feasibility, and relevance in mountains, specifically.

**10:30am - 10:45am**

## Background and Context for selecting relevant Essential Variables for monitoring Mountain Socio-Ecological Systems

**Carolina Adler[1], Elisa Palazzi[2]**
[1]Mountain Research Initiative, Switzerland; [2]CNR, Italy; carolina.adler@giub.unibe.ch

Background and context for the session.

**10:45am - 11:00am**

## Traits As Essential Variables To Monitor Mountain Plants

**Christian Rixen, IntraTrait Consortium**
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Climate warming is shifting the distributions of plant species to higher elevations, which relevant for numerous ecosystem services. Cold-tolerant plant species are receiving increasing pressure from novel and often more competitive neighbors that are encroaching from lower elevations. The ability to respond to such pressure can be expressed in the plasticity of traits within a species. Therefore, knowing intraspecific trait distributions along climatic gradients may be a useful measure of the potential adaptability of plants under climate change. Although some examples suggest their potential as a promising indicator for species' vulnerability to environmental change, intraspecific trait distributions along elevation understudied. To explore the relationship between elevation and trait variation, we studied intraspecific trait distributions along elevation gradients in mountains in four countries. Traits were chosen to be indicative of ecosystem functions and services such as biomass or slope stability.

Vegetative height, generative height, SLA and plant area decreased and flowering probability increased with elevation, while LDMC and patch area did not show a significant trend with elevation. Plants with preference for higher elevations expressed a more conservative range of vegetative and generative traits along their elevational distribution compared to plants with preference for lower elevations. High-alpine species were within their range relatively taller than neighbouring species, but decreased sharply in height relative to neighbours towards their trailing edge. Lower-alpine species on the other hand were relatively smaller than neighbours but retained a similar height ratio with their neighbours towards their trailing edge.

Understanding the relationship between plant traits and elevation is crucial and helps us to specify potential plastic responses and vulnerabilities of plants in a warmer climate. In a changing climate, it is crucial to understand such essential variables to estimate current and future biomass production, slope stability and other ecosystem functions that are particularly relevant in mountains.

**11:00am - 11:15am**

## Visualize the Invisible: Long-term Monitoring Of Biodiversity In Alpine Terrain

**Christian Körner[1], Martin Grube[2], Elisabeth Hainzer[3], Roland Kaiser[4], Erwin Meyer[5], Ulrike Tappeiner[5]**
[1]University of Basel, Switzerland; [2]University of Graz, Austria; [3]National Park Hohe Tauern, Austria; [4]Ennacon, Salzburg; [5]University of Innsbruck; ch.koerner@unibas.ch

The Austrian Nationalpark Hohe Tauern launched a long term monitoring program of alpine biodiversity in the central Alps that is adopting the permanent plot concept with a multitude of biodiversity markers collected within exactly the same monitoring perimeter. By defining and assessing sharp snow duration gradients created by topography, the regular census data include species range limits and thus, permit zooming into processes that might otherwise occur across large elevational gradients, but are near to impossible to capture at such large landscape scales. This 'sharp-gradient' approach may serve as a model for assessing slow changes in terrestrial biodiversity in many biomes, low stature vegetation types in particular. We will present data of the first three years of study, including microclimatology, productivity, plant and soil mesofauna species diversity as well as soil microbial diversity (bacteria and fungi). The eight research modules also include aquatic ecosystems and wildlife. The data illustrate and quantify biotic differentiation across few metres of distance driven by snow cover duration. We will not only illustrate this powerful tool in biodiversity research in the light of climatic change, but also discuss the logistic implications, the required multidisciplinary expertise, aspects of large scale and local scale replication, effects of environmental (year to year) stochasticity and scientific partnership issues (funding platforms, ethics). The protocol will serve both standardized repetition over many decades of monitoring, but is also very powerful to visualize results to a lay audience, and thus meets one of the tasks of tax-payer funded

nature reserves: evidencing and communicating the status of protected areas to the public. On a global scale, this gradient-focussed monitoring program contributes to the Global Mountain Biodiversity Assessment (GMBA) and the Long-term Ecological Research (LTER) initiative, and seeks partners in other parts of the world.

**11:15am - 11:30am**

### Biophysical Settings and Conservation Status of Global Mountains

**Roger G. Sayre[1], Madeline Martin[1], Deniz Karagulle[2], Charlie Frye[2], Carolina Adler[3], Elisa Palazzi[4], Jurg Krauer[5]**

[1]U.S. Geological Survey; [2]Esri; [3]Mountain Research Initiative; [4]National Research Council of Italy; [5]University of Bern; rsayre@usgs.gov

The distribution of global mountains has recently been characterized at a relatively fine spatial resolution (250 m) based on terrain characteristics (Sayre et al., 2018). We now turn our attention to the ecological classification of these mountain systems and characterize them according to their climate setting and their vegetation assemblages. We use new maps of World Climate Regions based on long term (50 years) averages of temperature and precipitation. We use 2015 ESA Global Land Cover to characterize the distribution of natural and semi-natural vegetation assemblages, croplands, and settlements in global mountain environments. We use the World Database on Protected Areas to assess the representation (protection) of global mountain ecosystems in protected areas. Herein, we report on the number, area, and conservation status of global mountain ecosystems, and relate these results to the reporting requirements of two global policy instruments, Aichi Target 11 and SDG Goal 15.

**11:30am - 11:45am Warning: The presentations finish prior to the end of the session!**

### Population And Population Changes In Mountain Ranges Of The World Between 1975-2015

**Daniele Ehrlich[1], Martino Pesaresi[1], Thomas Kemper[1], Michele Melchiorri[2]**

[1]European Commission, Joint Resarch Centre, Italy; [2]Engineering S.p.a, Italy; daniele.ehrlich@ec.europa.eu

This work delivers mountain population statistics and the population change in the 1975-2015 time frame, that on a global scale. The work uses over 1000 mountain ranges outlines made available through the USGS and other partners' contribution to GEO-GNOME, the Global Mountain Explorer (GME)[1] (see also Adler et al., 2018), and using the "K1" UNEP/WCMC definition of mountains (Kapos, 2000). The data are analyzed against one essential societal variables, the Population Density spatial grids, used to measure human presence on Planet Earth (Ehrlich et al., 2018; Freire et al., 2016). The generated statistics shows that mountain population – as defined by UNEP/WCMC - has increased from over 550 million in 1975 to over 1050 million in 2015. Population changes unevenly across the mountain ranges of the world. For example, large population growth occurs in the Ethiopian Highlands, the Himalayas, and Yemeni Mountain, and Hindu Kush – that all have experienced an increase of over 10 million over the 1975 -2015 time frame. Population has declined by over half million in the Apennines, Carpathian Mountains but also Ak Dag,Turkey; Naga Hills, Myanmar; Micang Shan, China. A number of mountain ranges in high latitude show to be un-inhabited. The analysis also focuses on quantifying urbanization patterns and trends in mountainous areas, based on the *New Global Definition of Cities and Rural Areas* (Dijkstra et al., 2018), that standardizes urbanization reporting globally. The analysis shows that urbanization in mountainous areas is lower than the global average and that varies greatly between mountain ranges. Understanding population sizes and growth as well as urbanization patterns is a preliminary step towards understanding sustainability trajectories in mountains. The shortage of quantitative information on mountain people needs to be addressed in order not to ***leave*** mountain people ***behind*** in the sustainable development process.

# 158S: Assessment of biodiversity impacts from supply chains

*Time:* Monday, 24/Feb/2020: 10:30am - 12:30pm · *Location:* Seehorn
*Session Chair:* Alexandra Marques, European Commission - Joint Research Centre, Italy
*Session Chair:* Serenella Sala, European Commission - Joint Research Centre, Italy

There is clear evidence that our consumption is increasingly generating pressures on terrestrial and aquatic biodiversity and ecosystems, but we still lack a deep knowledge about the impacts of these pressures. Life cycle assessment (LCA) is an established method to measure impacts of supply chains, as it considers the whole life cycle of products from raw materials extraction to disposal. LCA allows the systematic quantification of more than 15 different environmental impacts (for example, climate change, acidification, eutrophication, land use).

For more than 30 years, business and policy makers have been using LCA, to support environmental-related decisions. Moreover, since 2015, LCA is listed in the toolbox supporting the Better Regulation, making it as a tool to assess the outcomes of different policy options. Current LCA methods cannot yet fully address the environmental impacts on biodiversity, for which there is an increasing interest by both businesses and governments. In this session, we will discuss the main modelling approaches available to model biodiversity in LCA, and also how these could be improved or complemented from advances in the quantification of biodiversity from an ecology perspective. Further, we will discuss the role of assessing the impacts of consumption on biodiversity and ecosystems in the international policy context. More specifically, we will discuss how it can contribute to tackle biodiversity loss and ecosystem degradation, by unravelling the links between Sustainable Development Goals 12 (Responsible production and consumption) and 15 (Life on land).

**10:30am - 10:45am**

## Assessment of Biodiversity Impacts From Supply Chains: Challenges And Way Forward

**Alexandra Marques, Eleonora Crenna, Alessandra La Notte, Serenella Sala**
European Commission - Joint Research Centre, Italy; alexandra.penedo@gmail.com

Biodiversity loss implies important impacts on both the natural and the socio-economic systems worldwide. The consumption of materials and products is one of the drivers of environmental pressures and related impacts on ecosystems. Life Cycle Assessment (LCA) is considered a reference method for appraising the environmental performance of products along their supply chains. Currently, assessing biodiversity impacts in LCA present weaknesses in terms of drivers of impacts covered as well as indicators and metrics adopted. Moreover, an accepted impact assessment framework is lacking. Integrating sound ecological indicators and metrics is needed for better assessing supply chains' impacts on biodiversity on both global, regional and local scale.

Here, we present the state of the art concerning the assessment of biodiversity impacts through a life-cycle approach and of biodiversity metrics applied to assess the impacts from business, even if not adopted in LCA. The results highlight that the existing metrics of biodiversity impact assessment in LCA are poor in capturing biodiversity complexity. Operational models, at the midpoint level, exist (e.g. for biotic resource depletion). While they greatly expand the dimensions of biodiversity assessed, efforts are required to fully include these models in the LCA framework. In the business domain, many initiatives are developing frameworks to assess the impacts on biodiversity, including approach based on LCA or input-output databases for building inventories, which are then characterized by means of impact assessment models or indicators.

This shows that the current LCA framework is not sufficient to support biodiversity conservation-oriented choice. This presentation will serve as an introduction to session 158S and workshop 157W. Both aim at bringing together different communities (LCA, biodiversity, ecology, ecosystem services) with the goal to establish concrete guidelines for further improvement of biodiversity coverage in LCA. To complete the overview and stimulate the discussion, a sensitivity assessment of the results obtained applying different biodiversity impact assessment models in LCA are presented and discussed.

**10:45am - 11:00am**

## Understanding the Interacting Effects of Climate and Land-use Change on Biodiversity

**Tim Newbold**
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There have been big advances in recent years in understanding how land use affects biodiversity globally, and making predictions about the consequences of future land-use change under different scenarios. This science makes an important contribution to assessments of supply-chain impacts on biodiversity. However, the combined effects of climate change and land-use change, and the potential for interactions between these pressures, remains a major research gap. I will present our recent research demonstrating important synergistic interactions between land-use change and climate change, which are leading to much larger declines in biodiversity than expected based on treating these major pressures in isolation. Our results point toward a need for a more dynamic consideration of biodiversity in Life Cycle Assessment exercises.

**11:00am - 11:15am**

## Biodiversity assessment in Life Cycle Assessment and beyond

**Stefanie Hellweg**
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The quantitative assessment of biodiversity loss has undergone big advances in the last decade due to the increasing availability of data. Life Cycle Impact Assessment methods exist for land and water-use related terrestrial and freshwater biodiversity loss, while marine ecosystems are poorly covered so far. Existing case study applications range from analyzing the supply chain of single products of companies to quantifying the impact of human diets, biodiversity footprints of countries and the assessment of regional or global biodiversity status as well as future scenarios of land use. These studies point to hotspots in the supply chain in terms of products and geographical location where the impacts take place. This presentation reviews the state of the art of LCA biodiversity assessment methods as well as their application in case studies of supply-chain analyses within and outside of the LCA framework. The usefulness of studies for decision making and particularly policy making will be discussed. The presentation concludes with a summary of achievements and research gaps that need further attention.

**11:15am - 11:30am**

## Translating Science-based Targets For Biodiversity To Corporate Measurement Approaches

**Sebastian Bekker, Katie Leach, Samantha Hill**
UNEP-WCMC, United Kingdom; sebastian.bekker@unep-wcmc.org

Business around the world have responded to the Climate Science Based Targets Initiative by setting their own targets based on global emission targets. Progress in setting biodiversity and other related targets is lagging behind. A new network, the Science Based Targets Network as part of the Global Commons Alliance, will close this gap. We report on the initial thinking of a component of this initiative, the Biodiversity Hub, which aims to allocate global biodiversity targets to the level of businesses.

The majority of economic activities impact or depend on biodiversity either directly through their activities or indirectly through their supply chains. While healthy biodiversity can present an opportunity for businesses through, for example nature-based solutions, global biodiversity loss can lead to multiple forms of risk for businesses.

There is an increasing pressure on companies for credible reporting and disclosure on biodiversity impacts. This is mainly driven by investors, policy makers and businesses. Much of this is manifested through ambitious commitments or implementation of standards such as external financing standards in the case of financial institutions and investors, or company-internal standards. However, the success of such commitments is hampered by a lack of readily-available, scientifically robust, and broadly accepted approaches to measuring corporate biodiversity performance. This has, among other factors, led to corporate biodiversity commitments being predominantly qualitative rather than quantitative.

The Biodiversity Hub is building momentum to make available clear, practical, science-based targets for business with associated measurement approaches, which companies can use to measure their contributions towards biodiversity goals. Experts from the private sector, academia and the conservation community are coming together to address this issue.

This presentation will firstly draw parallels and lessons learned from recent successes in the global climate agenda to explore how these could be applied to biodiversity. It will then provide an overview of the suite of existing or developing models and measurement approaches allowing the private sector to assess and report on their performance relating to biodiversity. Finally, it will highlight how companies can use these measurement approaches to demonstrate their contributions to global biodiversity goals.

**11:30am - 11:45am**

## Influence Of Future Production And Consumption Patterns On Biodiversity

**Sandra Marquardt[1], Jonathan Doelman[2], Vassilis Daioglou[2,3], Andrzej Tabeau[4], Aafke Schipper[1,2], Sarah Sim[5], Michal Kulak[5], Zoran Steinmann[1,6], Elke Stehfest[2], Harry Wilting[2], Mark Huijbregts[1]**
[1]Department of Environmental Science, Radboud University Nijmegen, The Netherlands; [2]PBL Netherlands Environmental Assessment Agency, The Netherlands; [3]Copernicus Institute of Sustainable Development, Utrecht University, The Netherlands; [4]Wageningen Economic Research, Wageningen University and Research, The Netherlands; [5]Safety and Environmental Assurance Center, Unilever, United Kingdom; [6]Environmental and Analysis Group, Wageningen University and Research, The Netherlands; s.marquardt@fnwi.ru.nl

Linkages between production and consumption must be understood if biodiversity losses are to be minimized. The assessment of current production patterns is being increasingly applied to identify supply chain levers for reducing biodiversity impacts. However, forward-looking evaluations are also needed, in order to identify potential changes in the drivers of biodiversity loss and future corrective actions.

For 26 world regions, we evaluated potential future land-based biodiversity footprints reflecting biodiversity losses due to trade and regional consumption changes between 2010 and 2100. We restructured socio-economic and land use projections for three Shared Socio-economic Pathway (SSP) baseline scenarios generated by the MAGNET-IMAGE model into a multi-regional input-output format. We connected the land-use projections to changes in biodiversity based on the Biodiversity Intactness Index retrieved from the PREDICTS database and benchmarked results against the biosphere integrity planetary boundary.

In the sustainability scenario (i.e. SSP1), the majority of regions shifted towards lower total and per-capita biodiversity footprints and stayed within their allotted share of the planetary boundary. In contrast, increased regional fragmentation and unequal socio-economic development (SSP3), resulted in diverging regional biodiversity footprints with a reduction in Europe and North America compared to a doubling of the biodiversity footprint in South America. In the SSP3 scenario, five out of seven regions transgress their allotted share of the planetary boundary. Differences between regions and scenarios were primarily driven by changes in meat-based consumption and the ability to realize agricultural efficiency gains. Our findings indicate how region-specific shifts in production and consumption affect biodiversity. Future policy and business actions will occur against the backdrop of such shifts. Thus, informed decision-making can support shifts towards sustainable consumption patterns aimed at safeguarding biodiversity.

**11:45am - 12:00pm**

## Latest Advances On The Modelling Of Life Cycle Cause-Effect Mechanisms For Assessing Ecosystem Services

**Benedetto Rugani**
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Life cycle assessment (LCA) is a globally acknowledged method to account for biotic and abiotic resource extraction, land use and pollutant emission flows across the phases of a product life cycle (e.g. manufacturing, transportation, use, end-of-life), without neglecting to consider the larger economic segment, regional economy and inter-regional trades of goods and services associated with the production system. An LCA model thus allows capturing every relevant pressure of the technosphere on the geobiosphere, and eventually translating these pressures into cause-effect mechanisms to assess impacts on human health and ecosystems.

While such models are proven dramatically useful to guide sustainable decisions and support the development of environmental strategies and policy initiatives, the life cycle inventory and impact assessment frameworks in LCA do not fully encompass the notion of ecosystem services (ES). This is particularly true for the numerous regulation, maintenance and cultural/aesthetic services, which are not typically considered “market products”. Since, however, these underpin essential ecological functions (e.g. air/water quality and nutrients regulation, carbon sequestration, pollination, habitats for endangered species, etc.), their deterioration –caused by product life cycles– may generate harmful effects on ecosystems and undesirable consequences on the socioeconomic wellbeing of consumers and local communities. Neglecting these feedback loops in LCA does represent a severe lack within a method that has the ambition to become a reference for targeting sustainability development goals.

The present contribution therefore aims to provide an overview of the current state of scientific developments in the formulation and analysis of relationships between LCA models and their (positive and negative) impacts on ES, stressing on the gaps and discussing on the link between biodiversity and ES. A recently implemented LCA-based model is illustrated which assesses impacts on carbon sequestration and wild pollinators in Luxembourg, in order to showcase the relevance of considering ES in LCA models.

**12:00pm - 12:15pm**

## The Digital Observatory for Protected Areas And The Case Of Cocoa: Lessons Learnt From Coupling Life Cycle Assessment Tools With Global Data On Biodiversity And Ecosystems Services

**Marine Robuchon, Andrea Mandrici, Bastin Lucy, Alexandra Marques, Giacomo Delli, Serenella Sala, Andreas Brink, Gregoire Dubois**

European Commission - Joint Research Centre, Italy; Marine.ROBUCHON@ec.europa.eu

Biodiversity footprinting is considered a priority for policy makers and business to ensure that supply chain analysis connect production and consumption with environmental conservation and protection goals. Life cycle assessments (LCAs) have been at the core of such a process for many years and are key to estimate the potential impact of environmental policies on biodiversity. Yet, LCA methods still lack the means to assess local impacts, which can largely vary considering the heterogeneous distributions of species worldwide. Inversely, biodiversity conservation has been rooted in site-specific assessment whereas now more and more the link with supply chains and consumption patterns (as drivers of biodiversity loss) is clear.

We here discuss the lessons learnt in developing the capacity to quantify the loss of biodiversity and ecosystems outside of Europe in the context of cocoa production in Ivory Coast starting from our experience with the Digital Observatory for Protected Areas (DOPA). The DOPA is a biodiversity information system developed as a set of interoperable web services at the Joint Research Centre of the European Commission to assess and monitor the state of more than 40,000 Protected Areas (PAs) at the global scale. Cocoa production represents the main economy of Côte d'Ivoire but it has also triggered unprecedented levels of deforestation with almost all primary forest lost and dramatic consequences for biodiversity. A recent study on the impact of cocoa production for primate populations in protected areas found that 13 of 23 protected areas surveyed had lost their entire primate populations.

**12:15pm - 12:30pm**

## The Role of Value Judgement in Biodiversity-Related Life Cycle Impact Assessment

**Jan Paul Lindner**[1,2]

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This presentation highlights the valuing part in defining aggregated biodiversity indicators for use in the context of global supply chains. LCA practitioners (and LCA addressees) demand indicators that are simple, actionable, aggregated, and objective. LCA methodology development needs to resolve two major contradictions: simple indicators are rarely actionable, and aggregated indicators are generally not objective. Embracing the necessary value judgements – rather than avoiding it from a position of scientific neutrality – can be a pragmatic way forward.

This presentation features a methodology for biodiversity LCIA that is open to societal values. Such values may not be derived from the natural sciences, but using them in the definition of LCIA indicators bridges a gap that the natural sciences necessarily leave open. Biodiversity in the Land Use Framework of the Life Cycle Initiative is a land quality. In the methodology presented, naturalness serves as a proxy for the biodiversity-related quality value, i.e. a default judgement is given to ensure applicability. However, the definition can be refined if additional information is available for a world region (e.g. Europe tends to ascribe a high value to some cultural landscapes). Different understandings of what constitutes highly biodiverse land are accepted as a reality of a highly aggregated indicator. This is inconsistent from a strict natural sciences point of view, but consistent from a values point of view.

For future developments, a combination of mechanistic models and value-based models seems favorable. In this presentation, the LCIA methodology is presented mostly to highlight relevant points and to catalyze the discussion about the relation between the natural sciences and societal values.

# 123S: Biodiversity and the multi-dimensionality of ecological stability

*Time:* Monday, 24/Feb/2020: 10:30am - 12:30pm · *Location:* Wisshorn
*Session Chair:* Ian Donohue, Trinity College Dublin, Ireland
*Session Chair:* Stuart Leonard Pimm, Duke University, United States of America
*Session Chair:* Owen Petchey, University of Zurich, Switzerland
*Session Chair:* Michel Loreau, CNRS Theoretical and Experimental Ecology Station, France

Presentations will be followed by a 30 - minute discussion on how to best incorporate the multidimensionality of ecological stability into policy and management.

Human population growth and aspirations for higher living standards lead to our over-exploiting the land and oceans, disrupting the global climate, and driving species to extinction. Ecological responses to these harms are ineluctably complex, demanding measures that describe them succinctly. Collectively, these measures encapsulate the overall “stability” of the system. A highly fragmented and one-dimensional approach taken by ecologists has, however, led to confused communication of the nature of stability and a clear disconnect between the scientific and policy literature on the topic.

Both disturbances and stability are multidimensional. Our understanding of them is not. We have a remarkably poor understanding of the impacts on ecological stability of the characteristics that define many, perhaps all, of the most important elements of global change.To address the stability of ecosystems requires a quantitative approach based on rigorous theory and empirical evidence. Here, we bring together the leading researchers on the topic to describe the state-of-the-art of our understanding, and discuss how this understanding can be best applied to management and translated meaningfully into policy. The presentations will be followed by an in-depth discussion of how ecologists, policymakers and practitioners can best incorporate the multidimensional complexity of natural responses to environmental change – and the role of biodiversity in moderating those responses – into their research, policies and actions.

**10:30am - 10:45am**

## The Multifaceted Contributions of Individual Species to the Stability of Ecosystems

**Ian Donohue[1], Lydia White[2], Nessa E. O'Connor[1], Qiang Yang[3], Mark C. Emmerson[4], José M. Montoya[5], Yvonne M. Buckley[1], - Nutnet Consortium[6]**

[1]Trinity College Dublin, Ireland; [2]CNRS Roscoff, France; [3]University of Konstanz, Germany; [4]Queen's University Belfast, Northern Ireland; [5]CNRS Moulis, France; [6]University of Minnesota, USA; ian.donohue@tcd.ie

Exploration of the relationship between species diversity and ecological stability has occupied a prominent place in ecological research for decades. Yet, a key component of this puzzle – the contributions of individual species to the overall stability of ecosystems – remains largely unknown. Here, we show that individual species can not only simultaneously stabilize and destabilize ecosystems along different dimensions of stability, but also that their contributions to functional (biomass) and compositional stability are largely independent. By simulating experimentally the extinction of consumer species from a coastal rocky shore, we found that species contributions to some dimensions of stability could be predicted by the strength of their interactions in the system. However, the capacity to predict the combined contribution of multiple species to stability from the sum of their individual contributions varied among stability dimensions. These results imply that the nature of the diversity-stability relationship depends upon the dimension of stability under consideration, where species contributions may be additive, synergistic or antagonistic. Results from the analysis of experimental data from 60 grassland sites spanning six continents are fully consistent with this prediction. We conclude that, though the profoundly multifaceted and context-dependant consequences of species loss present a significant challenge, the predictability of species contributions to some dimensions of stability provide a way forward for ecologists trying to conserve ecosystems and manage their stability under global change.

**10:45am - 11:00am**

## The Inherent Diversity and Multidimensionality of Ecological Stability: Why We Need a Paradigm Shift

**Arnoldi Jean-Francois[1], Michel Loreau[2]**

[1]Trinity College Dublin, Ireland; [2]CNRS Theoretical and Experimental Ecology Station, France; ARNOLDIJ@tcd.ie

One of the reasons why the relationship between the diversity and stability of ecological systems has been so hotly debated over the past century is that classical ecological theory is based on stability concepts and metrics that are largely divorced from empirical data and whose properties are often poorly understood. For instance, empirical knowledge of diversity–stability relationships is often based on temporal variability, or its inverse, temporal invariability. Invariability, however, depends on external factors that act as disturbances, which makes comparisons across systems difficult to interpret. As a result, it has often been disqualified as a stability metric by theoreticians. But this widespread belief is incorrect ; it hinges upon the implicit assumption that stability is one-dimensional, and thus that it should be described by a single number. Invariability readily reveals inherent stability properties of ecological systems provided one accepts the the multidimensional nature of stability and one considers the whole set of invariability values generated by all possible perturbations. Doing so provides key new insights into the respective roles of common and rare species in shaping ecological stability and diversity–stability relationships. We need a paradigm shift in the way we approach ecological stability: we need to acknowledge that, since ecological systems are inherently complex, stability is, logically, inherently diverse and multidimensional.

**11:00am - 11:15am**

## Ecological Responses To Global Change Are Rarely Characterized By Thresholds

**Helmut Hillebrand[1,4], Kunze Charlotte[1,4], Donohue Ian[2], Harpole Stan[3], Hodapp Dorothee[4], Kucera Michal[5], Lewandowska Aleksandra[6], Merder Julian[1], Montoya Jose[7], Freund Jan[1]**

[1]Institute for Chemistry and Biology of the Marine Environment, University Oldenburg, Germany; [2]Trinity College Dublin; [3]German Centre for Biodiversity Research iDiv Leipzig & Univ Halle Wittenberge & Helmholtz Centre UFZ; [4]Helmholtz Institute for Functional Marine Biodiversity HIFMB Oldenburg; [5]MARUM – Center for Marine Environmental Sciences, University Bremen; [6]Tvärminne Zoological Station, University of Helsinki; [7]Centre for Biodiversity Theory and Modelling, Moulis, FR; helmut.hillebrand@uni-oldenburg.de

Concepts of thresholds, tipping points and regime shifts dominate current ecological frameworks aiming to understand ecosystem responses to anthropogenic global change. A prevailing framework is the search for, and definition of, threshold levels of pressure below which ecosystem responses remain within “safe ecological limits”, and above which response magnitudes and their

variances increase disproportionally. However, we lack a systematic quantitative synthesis of the overall evidence for the underlying assumption that pressures exceeding a certain threshold frequently lead to qualitatively different states. Here, we present the results of two major meta-analyses. First, based on 36 meta-analyses measuring more than 4600 global change impacts on natural communities, we find that threshold transgressions were rarely observed either within or across meta-analyses and were typically limited only to the most extreme pressures. Instead, ecological responses were characterized mostly by progressively increasing magnitude but also variance when pressure increased. Global change biology needs to abandon the general expectation that system properties define thresholds that separate minor from major ecosystem responses. Rather, evidence for highly variable responses, even under weak pressures, would suggest that 'safe-operating spaces' are unlikely to exist, which has profound implications for how we manage nature under global change. Second, we present a meta-analysis of 528 (semi-)natural field experiments globally distributed across marine, terrestrial and freshwater ecosystems, all of which monitored the response to a single pulse disturbance. We found recovery to be the norm and nearly complete when considering abundance (94%), biomass (82%), and univariate measures of diversity (88%), but not when considering compositional dissimilarity. Despite the slower recovery, few experiments showed a further deviation after the control, which would indicate the trnasition towards a novel state. Together, both analyses show that our understanding of ecosystem responses to changing environments has to take into account multidimensional aspects of stability

**11:15am - 11:30am**

### Effects Of Disturbance Properties On Correlation Among Stability Measures

**Viktoriia Radchuk[1], Frederik De Laender[2], Juliano Sarmento Cabral[3], Isabelle Boulangeat[4], Michael Crawford[5], Friedrich Bohn[6], Jonathan De Raedt[7], Cédric Scherer[1], Jens-Christian Svenning[8], Kirsten Thonicke[9], Frank Schurr[10], Volker Grimm[5,6], Stephanie Kramer-Schadt[1,11]**

[1]Leibniz Institute for Zoo and Wildlife Research, Germany; [2]Institute of Life-Earth-Environment, Namur Institute of Complex Systems, Belgium; [3]University of Würzburg, Germany; [4]University Grenoble Alpes, Irstea, France; [5]Institute for Biochemistry and Biology, University of Potsdam, Germany; [6]Helmholtz Centre for Environmental Research – UFZ, Germany; [7]Ghent University, Belgium; [8]Aarhus University, Denmark; [9]Potsdam Institute for Climate Impact Research (PIK), Germany; [10]Institute of Landscape and Plant Ecology, University of Hohenheim, Germany; [11]Technische Universität Berlin, Germany; radchuk@izw-berlin.de

Anthropogenically-caused global change currently poses multiple threats to populations and communities. The responses to such disturbances are various, necessitating measuring several stability properties such as resistance, recovery, and invariability. High correlation among these stability properties would simplify the monitoring of environmental effects on populations and communities, because measuring fewer stability properties would be sufficient. Such high correlation, therefore, would reflect a low dimensionality of stability. To date we know little about the effects of different disturbance types on the dimensionality of stability. Yet, such understanding is essential to assist the monitoring and management of natural systems in face of unprecedented environmental change. We here assessed the effect of three disturbance types (random, species-specific, and local) applied at four intensity levels, on the correlation among stability properties measured at the population and community level. To this end we used previously developed process-based models that represented dynamics of five natural communities. We demonstrate that correlation among stability properties was affected by the disturbance type but not intensity, and this effect was found only at the population level. Importantly, the correlation among stability properties varied a lot among species and communities. Therefore, our study indicates that stability assessments cannot be simplified to using a single metric. Future studies shall show how sensitive this conclusion is to other disturbance types that were not investigated here and when using measurements taken at different spatial and temporal scales.

**11:30am - 11:45am**

### Disturbance Type Produces Contrasting Results On Ecosystem Stability

**Jose M Montoya**

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Ecosystem stability can increase or decrease depending on the type of disturbance affecting ecosystems. I will exemplify this by focusing on the type of habitat loss, random or contiguous, affecting modelled communities with multiple interaction types—hybrid communities. Our model reveals changes in stability—temporal variability in population abundances—that are dependent on the spatial configuration of habitat loss. Our findings highlight that habitat area determines the variability of populations via changes in the distribution of species interaction strengths. The divergent responses of communities to random and contiguous habitat loss result from different constraints imposed on individuals' mobility, impacting diversity and network structure in the random case, and destabilising communities by increasing interaction strength in the contiguous case. Analysis of intermediate HL suggests a gradual transition between the two extreme cases. Our results highlight the importance of the complexity of disturbances to understanding different dimensions of ecological stability.

**11:45am - 12:00pm Warning: The presentations finish prior to the end of the session!**

### Is Understanding Biodiversity and Overall Ecosystem Stability an Insurmountable Challenge?

**Owen Petchey**

University of Zurich, Switzerland; owen.petchey@ieu.uzh.ch

Understanding how changes in biodiversity affect ecosystem stability is complicated by the multidimensional nature of both biodiversity and stability. Biodiversity has functional, taxonomic, and phylogenetic components, the diversity of which can be measure in multiple ways. Stability may be of population, community, and ecosystem components, can be in response to any of many single environmental changes and to multifarious environmental change, and also can be measured in multiple ways. I will compare and contrast some of the approaches for dealing with this complexity, including approaches borrowed from ecosystem multifunctionality research and from multivariate data analysis. One key question arising is how frequently biodiversity may increase one stability component and yet reduce another in the same ecosystem, and then what mechanisms are responsible when this occurs. Another is what types and scales of experimental and observational biodiversity-ecosystem stability studies could contribute particularly significant advances in understanding relevant for decision support.

# Plenary 2: Plenary Session 2

*Time:* Monday, 24/Feb/2020: 2:15pm - 3:45pm · *Location:* Davos (2/3)

**Pragati Sahni, University of New Delhi**

**David Tilman, University of Minnesota**

**2:15pm - 3:00pm**

## Origins, Impacts and Preservation of Biodiversity

**David Tilman**
University of Minnesota, United States of America; tilman@umn.edu

The most amazing feature of Earth is life. The most amazing aspect of this life is its diversity. The diversity of life on Earth is the direct result of evolutionarily unavoidable tradeoffs that all life has faced since, at the least, the Cambrian explosion. Because of universal interspecific tradeoffs, newly emerging species coexisted with, and did not displace, established species. For similar reasons, waves of species entering a new biogeographic realm coexisted with established species. These same tradeoffs explain why greater diversity is associated with greater and more stable ecosystem productivity, and with increased resistance to invasion by novel species. Humans have escaped these tradeoffs by breaking some of the fundamental rules of life, including having our functioning become independent of our morphology, having our disease incidence decrease despite greater abundance, and our ability to chemically create a major limiting factor, biologically available nitrogen. We, the Earth's first superspecies, have caused waves of extinction of large land animals around the globe during the past 50K years. In this, the final period of rapid increases in human environmental impacts, another massive wave of species extinctions seems likely. Preventing this imminent extinction event will require greatly increased efforts at conservation and major changes to fossil fuel use, diets, and agriculture.

**3:00pm - 3:45pm**

## Status of Plants: A Brief Exploration of Early Buddhism and Jainism

**Pragati Sahni**
University of Delhi, India; pragatisahni@hotmail.com

Do plants and trees capture the imagination of ancient Indian philosophical traditions? Do the latter recognize value in plants and accord them some status? Are there commonalities of approach within the traditions? In this paper I attempt to explore the status of plants as well as possible reasons that may underlie the ethical consideration of plants in the earliest forms of two Indian traditions: Buddhism and Jainism. There is no defined environmental ethics in these ancient traditions but many scholars have worked tirelessly on scriptures and other resources that are associated with them to frame possible ecological arguments. Plants have also been of interest and scholarly work in this area is not unusual. In this paper I shall go back to some portions of the scriptures to assess whether more inroads can be made into what these traditions truly believe. My paper largely consists of further analysis such that may provide some more insight into addressing the treatment of plants in the world today. I shall explore some associated ideas on biodiversity as I go along in my quest.

# 154S: Light Pollution: Biodiversity and Ecosystem functioning in an illuminated world.

*Time:* Monday, 24/Feb/2020: 4:15pm - 6:15pm · *Location:* Schwarzhorn
*Session Chair:* Eva Knop, University of Zürich / Agroscope, Switzerland
*Session Chair:* Franz Hölker, Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Germany

The invention and widespread use of artificial light is one of the most important human technological advances, but the fundamental transformation of nightscapes is increasingly recognised as having adverse effects on nature. Since the biological world is organised to a large extent by natural cycles of variation in light and darkness, artificial light at night can influence a wide range of processes, from gene expression to ecosystem functioning.

Artificially illuminated area at night has rapidly increased since the 19th century with an estimated increase of about 2 - 6% per year, with individual countries having increases of more than 10%. The problem is that artificial light has been introduced in places, at times, spectra and intensities at which it does not naturally occur, and many organisms have had no chance to adapt to this new stressor.Although we know that organisms do respond to artificial lighting with changes in behaviour and physiology, there is little known about the impact on biological diversity and ecosystem functioning. Also, evidence for evolutionary adaptations of species and communities to artificial light is still scarce. In this session, we aim to bring together on-going work and cutting edge evidence of the ecological and evolutionary impact of artificial light at night on biodiversity and ecosystem functioning. We thereby intend to include evidence from aerial, aquatic, and terrestrial ecosystems, and to cover a broad spectrum of taxa and ecosystem functions. This will allow to synthesize the current knowledge on the on-going changes and help to make predictions of future biodiversity and ecosystem functioning in an increasingly illuminated world.

**4:15pm - 4:35pm**

## Effects Of Luminaire Shape And LED Light Color On Insect Abundance And Bat Activity

**Janine Bolliger[1], Beat Wermelinger[1], Stephan Blum[2], Jörg Haller[2], Martin K Obrist[1]**
[1]WSL Swiss Federal Research Institute, Switzerland; [2]EKZ Zürich; janine.bolliger@wsl.ch

Recent comprehensive reviews emphasize that artificial light at night is an environmental stressor with overall negative effects on most aspects of the ecological environment. At the same time, current developments in LED technology have contributed to more sustainable and energy-efficient lighting that effectively contribute to reduce electricity consumption and to minimize environmental impacts.

The effects of light presence/absence, different light levels (dimming) and light colors on biodiversity range among the best-studied properties of LED luminaires. Impacts of other facets of luminaire characteristics such as its design and shape that determine the light-emission volume or direction have not yet been considered. We present the results of a field experiment in which we compared the relative effects of two luminaire types with two different light-emission volumes and directions in relation to three light colors (1750K, 3000K, 4000K) on nocturnal insect abundance and bat activity. First results show that the light-emission volume and direction plays a decisive role in the determination of night-time light effects on insects and bat communities that may exceed the effects LED colors.

As light at night provokes conflicting interests and opportunities of public, economic and environmental concern, we conclude that ecological impact assessments are required on all (interacting) effects of a luminaire's property in order to identify common denominators on which to ground sustainable lighting futures.

**4:35pm - 4:55pm**

## The Effects Of Artificial Light At Night On Animal Movement

**Gregor Kalinkat[1], Jechow Andreas[1], Voigt Christian[2], Hölker Franz[1]**
[1]Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Germany; [2]Leibniz-Institute for Zoo and Wildlife Research, Germany; kalinkat@igb-berlin.de

Continuously growing levels of artificial light at night (ALAN) on a global scale have been documented recently and there are no signs of abatement of this trend. Although a lot remains to be investigated in relation to ALAN, negative effects on humans and wildlife are evident, affecting public health, biodiversity and ecosystem services. Consequentially, ALAN is becoming a target of policy responses and environmental regulations. However, we are only beginning to acquire the mechanistic understanding that would be required to shape management strategies and build sustainable technologies with minimized negative impacts. Biologically these mechanisms can be studied at the molecular, cellular, physiological or at the behavioral level. Here we focus on behaviorally mediated effects of ALAN where animal orientation, navigation, and, consequentially, directed movement is drastically altered in the presence of elevated levels of ALAN. We review studies that investigated impaired orientation and movement of birds, bats, insects and other organisms where documented effects may scale up to affect populations, ecological communities and even ecosystem processes. Notably, light installations potentially act as barriers obstructing animal movement and further fragmenting natural landscapes. To investigate these issues we include various types of active animal movement including migration, dispersal, and foraging. Further, we identify research gaps in relation to ALAN and its effects on animal movement and discuss further conservation and management implications.

**4:55pm - 5:15pm**

## Bending The Curve By Spectral Change? The Potential Of Adapting The Colour Of Artificial Light At Night

**Kamiel Spoelstra, Marcel E. Visser**
Netherlands Institute of Ecology (NIOO-KNAW); K.Spoelstra@nioo.knaw.nl

The nocturnal illumination of our planet has increased dramatically over the last decades, and will continue to increase. Light pollution is recognized as one of the main future challenges for ecosystems; effects have been reported for virtually all species for which its impact has been studied – including for ourselves. The impact of light may be particularly severe for nocturnal species, and vary from direct mortality by attraction to habitat loss by deterrence. As many nocturnal species move along hedges and tree rows, the illumination of infrastructure along or crossing these corridors may further amplify effects, as species may no longer reach unaffected, suitable habitat. More latent effects such as changes in inter-species competition, ecological niches and consequences for food web interactions remain largely unknown. Furthermore, little is known on how populations are eventually affected. This is of major importance as viable populations are essential for biodiverse ecosystems. Hence, a key challenge is to minimize impact of artificial light at night. With the development of LED lighting, light sources can now be highly customized. This

opens the possibility to reduce the ecological impact by changing the spectrum of light in situations where light cannot be avoided. Evidence on the effects of the colour composition of light is now accumulating, with clear indications that, generally, a reduction of the blue part of the spectrum is important to minimize impact on terrestrial habitat, especially for nocturnal insect and mammal species. However, not all species react in a comparable way, and furthermore the response may vary with the local environment and type of activity. A careful application of light spectra may nevertheless be key to bend the curve for populations of several nocturnal species – and hence their diversity in our ecosystem.

**5:15pm - 5:35pm**

### The Darkness Defeated: Artificial Light At Night Modifies Ecosystem Functioning Beyond The Illuminated Area

**Simone Giavi[1], Sina Blösch[1], Guido Schuster[2], Eva Knop[1]**

[1]Agroscope, Switzerland; [2]Hochschule für Technik Rapperswil, Switzerland; sgiavi@protonmail.com

Artificial light at night (ALAN) is a relatively new and rapidly increasing global change driver. While evidence on adverse effects of ALAN for biodiversity and ecosystem functioning is increasing, little is known on the spatial extent of its effects. We therefore tested whether ALAN can affect ecosystem functioning beyond the edges of directly illuminated sites.

Using LED street lamps we illuminated previously dark ruderal meadows and kept other meadows undisturbed as control. We exposed two phytometer species on sites subjected to three treatments of ALAN: sites directly illuminated, sites adjacent to the directly illuminated sites, control sites without illumination. We tested the effect of the treatments on pollination and in one species on seed predation. To understand the underlying mechanism of the seed predation found in the field, we tested in the laboratory flower visitation and oviposition of the main seed predator in relation to distance from a light source.

Pollination was reduced on directly illuminated sites compared to control sites and sites adjacent to directly illuminated sites. In contrast, compared to dark control sites, seed predation was significantly increased on dark sites adjacent to illuminated sites, which resulted in a significantly reduced relative reproductive output of the plants. This is most likely explained by the main seed predator being able to fly away from the light source and interacting with its host plant in the darkest area available as the results of the experiment in the laboratory shows.

We conclude that the effects of ALAN on ecosystem function can propagate to areas not directly illuminated, thereby acting at a much larger spatial scale than previously thought.

**5:35pm - 5:55pm Warning: The presentations finish prior to the end of the session!**

### Impacts of Artificial Light at Night on Marine Ecosystems

**Svenja Tidau[1,2], Thomas W. Davies[1]**

[1]University of Plymouth, United Kingdom; [2]Bangor University, United Kingdom; svenja.tidau@plymouth.ac.uk

The ecological impacts of Artificial Light at Night (ALAN) are increasingly well documented. Yet, despite the fact that 23% of the global population live within 100 km of a coastline, we know little about how ALAN impacts marine organisms and biodiversity. We present the small but growing body of empirical studies into ALAN impacts on marine ecosystems. Collectively, they illustrate the widespread and profound impacts of ALAN across marine taxa, biological complexity, and geographical scale. Our synthesis covers the latest advances in ALAN effects on gene expression to assessing global exposure to ALAN. Finally, we indicate advances in diverse approaches covering field and laboratory experiments, remote sensing and spatial analysis.

# 102S: Resilience Management of ecological-economic systems

*Time:* Monday, 24/Feb/2020: 4:15pm - 6:15pm · *Location:* Wisshorn
*Session Chair:* Luc Doyen, CNRS, France
*Session Chair:* Martin Quaas, German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Germany

Resilience factors into many decisions and policies including risk management in the private sector, development and finance investments and management objectives of influential multilateral and UN agencies. In particular, resilience is included in several Sustainable Development Goals (SDGs). Resilience describes the ability of a system to cope with shocks arising from natural or anthropogenic events such as climate catastrophes, pollutions, financial crisis. In this general context, the session will pay attention to the resilience of biodiversity, ecosystems and ecosystem services.

It includes applications to marine or coastal ecosystems, agro-ecosystems, and forest ecosystems. The intrinsic complexity of these ecosystems and socio-ecosystems at the interface of human dynamics and natural dynamics requires interdisciplinary approaches and in particular an ecological-economic viewpoint. In this framework, the session intends to give major insights into the following issues: How to quantify the ecological-economic resilience? What are the drivers of this resilience? Which management, public policies and scenarios can improve this resilience? This interdisciplinary session will bring together economists, ecologists, and modellers.

**4:15pm - 4:40pm**

## Operationalize the Three Rs of Resilience through Ecoviability

**Luc Doyen**
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Scientists and decision-makers lack a shared understanding of resilience, and practical applications in renewable resources management including biodiversity management are rare. Here, we define ecological-economic resilience as a property of ecological-economic systems that includes three main characteristics — resistance, recovery and robustness (the 'three Rs'). We define ecological-economic resilience management as planning, adaptation and transformational actions that may foster these three Rs characteristics. We show to what extent ecoviability modeling provides a relevant framework to operationalize such ecological-economic resilience management. Applications to fisheries and land-use illustrate the general approach.

**4:40pm - 5:05pm**

## Markets and Resilience Management of Fisheries

**Martin Quaas**
German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Germany; martin.quaas@idiv.de

Fisheries are a prime example of coupled ecological-economic systems where ecosystem dynamics and economic decisions interact. We set up a generic ecological-economic model to explore the role of output (fish and seafood) and input (labor and capital) markets for the resilience of the system. We show that ignoring market feedbacks, i.e. price changes induced by changes in the ecosystem, may lead to an overly optimistic assessment of the fishery's resilience. In a multi-species perspective, market feedbacks couple the dynamics of fisheries around the globe. We show that these feedbacks are particularly relevant for fisheries on species that are close substitutes on the market. We study how unilateral management changes for a domestic fishery should take into account the effects of management on the resilience of other fisheries under coupling by international markets and identify management challenges for the rebuilding of overfished stocks.

**5:05pm - 5:30pm**

## Generic Approach To Assess Trade-Offs And Tipping-Points In Complex Socio-Ecological Systems: An Application To Agro-Ecosystems

**Adrienne Grêt-Regamey, Maarten Van Strien**
Planning of Landscape and Urban Systems (PLUS, ETH Zürich), Switzerland; gret@ethz.ch

For understanding the resilience of complex social-ecological systems (SESs) it is necessary to have a thorough understanding of the system behaviour under changing political, economic, and environmental conditions (i.e., external system stressors). Such behaviour can be predicted if one knows the stable and unstable equilibrium states in a system and how these equilibria react to changes in the system stressors. The state of the system rapidly or gradually changes either toward (i.e., stable equilibrium) or away from (i.e., unstable equilibrium) an equilibrium. However, the equilibrium states in a SES are often unknown and difficult to identify in real systems.

In this contribution, we show a generic approach to identify stable and unstable equilibria states with agent-based SES models. We illustrate our approach in an alpine mountain region in the Canton of Valais, Switzerland. Land-use change in this region is highly driven by a range of external drivers such as agricultural direct payments, prices for agricultural produce or climate. We identified equilibria in intensive and extensive agriculture and assessed their sensitivity to these external drivers. The external drivers had a strong influence on the equilibrium states. Interestingly, we identified an unstable equilibrium in intensive agriculture, whereas extensive agriculture showed a stable equilibrium. We also found that a minimum amount of direct payments was necessary for agricultural extensification to take place. The developed approach provides valuable insights into furthering agricultural extensification in our case-study region, on one hand. On the other hand, the approach can also be applied to other SES models to better determine and communicate the resilience of SES to various drivers.

**5:45pm - 6:00pm Warning: The presentations finish prior to the end of the session!**

## Understanding socio-ecological change and transformation of coastal ecosystem in Low Elevated Coastal Zone (LECZ)

**Sathaporn Monprapussorn**
Srinakharinwirot University, Thailand; satha13@hotmail.com

Low elevated coastal zones (LECZ), the contiguous area along the coast with less than 10 meter elevations, are densely populated and economically developed. LECZ is the frontline of climate change impacts in which ecosystem is exposed to increasing risks of extreme events and sea level rise. The expansion of populations and socioeconomic activities in LECZ has resulted in growing pressure on coastal ecosystems and biodiversity i.e. mangrove, coral reef and seagrass bed. In the meantime, effects of human pressures and interventions on coastal ecosystem are very difficult to separate from the effects of ecological pressures, limiting our

understanding of social-environmental systems as well as co-benefits of these systems to protect coastal environment.

The Socio-ecological systems provide useful guidance of how to assess human-environmental interactions to increasing coastal resilience in term of protecting marine biodiversity and its services. A clearest example of socio-ecological system change is effect of transformation of coastal land on ecosystem services. Coastal shrimp culture, coastal pollution and tourism infrastructure development, for example, have caused coastal resources and habitats declines while climate change has also driven widespread collapse of coral reef ecosystems. An integrated framework of ecosystem restoration, comprehensive spatial planning and capacity building in LECZ will give more insight in understanding relationship between socio-ecological change driving transformation of coastal land and its impact on ecosystem services. The aim of this presentation is to focus socio-ecological system and its impact on biodiversity and ecosystem services in LECZ with a case study of coastal zones of Thailand.

# Plenary 3: Plenary Session 3

*Time:* Tuesday, 25/Feb/2020: 8:30am - 10:00am · *Location:* Davos (2/3)

## Andy Purvis, Museum of Natural History London

## Unai Pascual, Basque Centre for Climate Change

**8:30am - 9:15am**

### Biodiversity Loss: Drivers, Consequences and Mitigation

**Andy Purvis[1], Pedro Jaureguiberry[2], Nicolas Titeux[3], Samantha Hill[4], Ricardo Gonzalez[1], Adriana de Palma[1]**

[1]Natural History Museum, United Kingdom; [2]Instituto Multidisciplinario de Biología Vegetal (IMBIV), CONICET and FCEFyN, Universidad Nacional de Córdoba; [3]UFZ – Helmholtz Centre for Environmental Research; [4]UNEP World Conservation Monitoring Centre; andy.purvis@nhm.ac.uk

The main direct drivers of biodiversity loss – land/sea-use change, direct exploitation, climate change, pollution and invasive alien species – are likely to have their greatest impacts on different kinds of species and ecosystems. I will discuss the likely consequences of these 'signatures', combined with the drivers' relative importance in recent decades, for biodiversity and ecosystem functioning. Both these consequences and our limited ability to predict some of them have implications for how we should set biodiversity targets and actions, and for how we should monitor progress towards them. Focusing on the PREDICTS (Projecting Responses of Ecological Diversity In Changing Terrestrial Systems), I will show how protected areas and Indigenous Lands have been effective in conserving species and ecosystems; outline some of the challenges and opportunities presented by agriculture and restoration; and show how an ambitious set of integrated changes to agricultural supply, societal demand and global land-use policy could arrest – and even begin to reverse – biodiversity declines.

### The Messy Business of Valuing Biodiversity and the Risks of Pragmatism

**Unai Pascual**

Basque Centre for Climate Change, Spain; unai.pascual@bc3research.org

Biodiversity matters differently to people. This is one of the reasons why there is a lack of a clear discourse in society about the need to conserve biodiversity and hence why mobilizing society to help meeting biodiversity-related targets may sometimes be seen as an elusive endeavour. Science provides knowledge and clear rationalities that could be used to leverage positive social behaviour towards biodiversity conservation and its sustainable use. But often such efforts clash with entrenched values and powerful interests thereby precluding social action at the scale that would be required. At the same time, science is often tempted to offer politically palatable solutions in the name of pragmatism but generally without questioning the underlying social values that underpin the current biodiversity crisis. In order to better connect biodiversity science and transformative social action we need to pay more attention to the formation and evolution of the different cognitive models about human-nature relations within society, and the way the resulting diversity of values may be orchestrated, especially by explicitly recognizing and bringing to the table the values and knowledge systems of marginalized people in society.

# 192S-2: Remote Sensing for Biodiversity Monitoring II

*Time:* Tuesday, 25/Feb/2020: 10:30am - 12:30pm · *Location:* Dischma
*Session Chair:* Claudia Roeoesli, University of Zurich, RSL, Switzerland
*Session Chair:* Marc Paganini, European Space Agency ESA, Italy
*Session Chair:* Gary N Geller, NASA / JPL, United States of America
*Session Chair:* Michael E. Schaepman, University of Zurich, Switzerland

Global observations and regular assessments are key to monitor and understand global biodiversity change and related drivers allowing to finally conserve biodiversity in space and time. Satellite based, remote sensing observations have demonstrated the capacity for global monitoring of biological diversity. This session discusses recent scientific progress and importance in using Earth observations from remote sensing platforms. Particular focus will be on priority setting of the choice and use of Earth observations as well as their complementarity and co-existence with in-situ measurements for global biodiversity assessment.

The Group on Earth Observation Biodiversity Observation Network (GEO BON) is currently developing a framework, based on the concept of Essential Biodiversity Variables (EBVs), for a global biodiversity observation network. We will discuss the contribution, development, production, operationalization and validation of remote sensing enabled EBV's (RS-enabled EBVs) to the EBV framework. Exemplary RS-enabled EBVs may include fragmentation, vegetation structure, canopy chlorophyll content or land surface phenology, but are not limted to these. Besides the development of algorithms and their implementation, the session invites also contributions discussing the relevance of such data products for policy makers, biodiversity indicator assessment, integration for biodiversity analysis and modelling, as well as assessing ecosystem services.

**10:30am - 10:47am**

## Mapping Human Impact On Forests At Global Scale

**Myroslava Lesiv[1], Dmitry Schepaschenko[1], Marcel Buchhorn[2], Steffen Fritz[1]**

[1]IIASA, Austria; [2]VITO, Belgium; lesiv@iiasa.ac.at

Current global tree cover maps do not distinguish f between natural forests, plantations, native or non-native trees, nor do they specify the degree of forest management intensity. The conversion and degradation of natural forests is not only considered among the greatest threats to biodiversity, but also an important source of greenhouse gas emissions. The lack of accurate spatial data on forest management globally is a serious obstacle to informing policies towards forest protection, sustainable forest management and forest restoration.

Whereas remotely sensed based datasets can depict tree cover and other land cover types, it has not yet been used to depict untouched forest and different degrees of forest management. We show for the first time that with sufficient training data a differentiation of different levels of forest management is possible.

Hence, in spring 2019 we launched a series of Geo-Wiki campaigns. We involved forest experts from different world regions to explore which forest information could be collected by visual interpretation of very high-resolution images from Google Maps and Microsoft Bing, including Sentinel time series and normalized difference vegetation index profiles. Based on the results of this analysis, we expanded the campaigns by involving broader group of participants, mainly people recruited from remote sensing, geography and forest research institutes and universities.

In total, we collected forest data for 130000 locations. Based on this data set, we developed a remotely sensed based global forest management layer at a 100m resolution for 2015. The map includes such classes as intact forests, forests with signs of human impact, including clear cuts and logging, replanted forest, woody plantations with a rotation period up to 15 years, oil palms and agroforestry. Overall accuracy is 75%.

We will present the results of the Geo-Wiki campaigns, the resulting map, and statistical area estimates of by continents and ecoregions.

**10:47am - 11:04am**

## Biodiversity Effects at Novel Scales of Organization

**Pascal A. Niklaus[1,2], Florian Altermatt[1,2], Merin Chacko[1], Sarah Mayor[1,2], Jacqueline Oehri[1,2], Michael Schaepman[2,3], Gabriela Schaepman-Strub[1,2], Bernhard Schmid[1,2,3]**

[1]University of Zurich, Switzerland, Dept. of Evolutionary Biology and Environmental Studies; [2]University Research Priority Programme Global Change and Biodiversity; [3]University of Zurich, Switzerland, Dept. of Geography; pascal.niklaus@ieu.uzh.ch

A vast body of research has addressed the relationship between biodiversity and ecosystem functioning (B-EF) in plot-scale experiments with artificially established plant communities. These studies have generally shown that more diverse communities are more productive and that productivity is more stable through time. However, whether these B-EF relationships also apply in natural and human-dominated real-world landscapes that provide essential ecosystem services remains to be tested. Such real-world landscapes differ from experimental communities in many respects, including additional scales of space and ecological organization that may support or modify diversity-functioning patterns through emergent mechanisms.

B-EF research so far has focused on interactions among plant individuals and the diversity of communities has been described in terms of properties of these individuals, for example their species identity (metrics of species diversity) or their traits (metrics of trait diversity). However, complex landscapes can be seen as hierarchically organized, with levels ranging from genes to individuals, communities, ecosystems, all the way up to landscapes that integrate these ecosystems in a spatial mosaic.

To test for diversity effects at the landscape level in study areas in Europe and North America, we selected landscapes that differed systematically in land-cover composition. We inferred vegetation activity and land-surface phenology in these landscapes based on MODIS vegetation indices, at a spatial resolution of 250 m. Analyses of these data indicate that interactions among entire ecosystems indeed promote landscape level functioning, and that at least part of these effects depends on emergent mechanisms independent of species diversity. These effects may represent a novel class of mechanisms that underpin diversity effects at the landscape level. We contend that landscape-level diversity–functioning relationships deserve increased attention, not least because they underlie the delivery of ecosystem services to humans.

**11:04am - 11:21am**

## Merging Spectral and Phylogenetic Diversity to Assess Macrophyte Traits and Functions Along Ecological Gradients

**Paolo Villa[1], Andrea Coppi[2], Rossano Bolpagni[3], Maria B. Castellani[2], Alice Dalla Vecchia[3], Lorenzo Lastrucci[4]**
[1]National Research Council (CNR), Italy; [2]University of Florence, Italy; [3]University of Parma, Italy; [4]Natural History Museum, University of Florence, Italy; villa.p@irea.cnr.it

As littoral and riparian environments are in decline and survival of many aquatic plants is threatened by anthropic activities all over the globe, the conservation of macrophyte diversity should be considered a priority, because of their key role in freshwater ecosystems.

High-throughput techniques, such as remote sensing spectroscopy, genetics and phylogenetics, have been explored in the last decade to support and enhance operational diversity monitoring. These techniques have opened new ways of measuring biodiversity, especially in forest and grassland systems, but a sound link between spectral and phylogenetic features with plant functional characteristics has yet to be established.

The idea behind macroDIVERSITY, a new national project, funded by the Italian Ministry of Education, University and Research (2020-2023), is that phylogenetic and spectral diversity measures can be integrated into a multidimensional data-driven framework for mapping plant traits and functions across scales and gradients.

To this objective, we will collect data on macrophyte traits, diversity, and spectral reflectance from plots sampled over selected lakes and wetlands in Italy, according to robust experimental design. A fully resolved supertree, obtained from DNA markers analysis integrating available data and new sequencing, will be used for assessing the evolutionary diversity of the species assemblage, highlighting the phylogenetic signal in the context of the community traits information. Hyperspectral imaging data acquired from proximal platforms and airborne drones at centimetre scale will be used for modelling bio-chemical and functional macrophyte traits (e.g. canopy morphology, productivity, pigments and nutrients content). Environmental parameters collected and diversity metrics derived will be eventually merged into a machine-learning framework for mapping macrophyte functional diversity (richness and divergence).

The project outcomes are expected to impact on applied ecology studies focusing on delineating plant diversity using remote sensing data, and investigating the role played by species interactions and community complexity in regulating aquatic ecosystem quality.

**11:21am - 11:38am**

## Global, High-resolution, Annual Data On The Extents Of 75 Terrestrial, Marine, And Freshwater Ecosystem Types

**Carsten Meyer, Ruben Remelgado**
German Centre of Integrative Biodiversity Research (iDiv), Germany; carsten.meyer@idiv.de

Widespread changes in the area, fragmentation, and integrity of ecosystems are a major driver of biodiversity change and loss of ecosystem services worldwide. These changes are expected to further accelerate under future land-use and climate changes, potentially leading to widespread environmental degradation and socioeconomic hardship. Detailed information on global, spatiotemporal dynamics in the extents of major ecosystem types is thus essential to understand, anticipate, and address a broad range of environmental problems. Accordingly, the Group of Earth Observations Biodiversity Observation Network (GEO BON) identified the development of global data products on ecosystem extents as an Essential Biodiversity Variable, and a priority for global biodiversity monitoring. We will present a series of global, high-resolution gridded data cubes that capture the annual areas of occupancy for each of 75 standardized terrestrial, marine, and freshwater ecosystem types over a 24-year period. To achieve this high thematic detail, we built on decades of global environmental mapping efforts by integrating 24 global products (>200 TB in total, mostly remote-sensing derived) covering land-cover, hydrology, climate, NDVI, elevation, coastal and stream topography, soil, and other environmental dimensions. The depicted ecosystem types conform to the habitat classification scheme of the International Union for Conservation of Nature's Red List of Threatened Species, assuring interoperability with ongoing assessments of the species habitat preferences. Exemplary application fields include monitoring of species habitats to support conservation interventions, testing hypotheses on biodiversity-change drivers and mapping of global ecosystem services. We will characterize recent dynamics in selected ecosystems to showcase the potential of the presented datasets, which will be published soon as open-access products following FAIR principles. Finally, we will discuss an envisioned community-driven curation and quality-assurance system for the continuous further improvement of these products.

**11:38am - 11:55am**

## Towards Automated Mapping and Modelling of Habitat Types at the National Extent for Switzerland

**Bronwyn Price, Nica Huber, Robert Pazur, Christian Ginzler**
Swiss Federal Research Institute WSL, Switzerland; bronwyn.price@wsl.ch

Habitats are increasingly used to assess the status of biodiversity. Mapping the distribution of habitats is vital for successful conservation, management and monitoring of biodiversity. The habitat classification of Delarze, Gonseth et al. (2015) is the most widely used in Switzerland. While there has been some regional modelling of this classification, there is currently no spatially explicit map of these habitats across Switzerland. This study will take advantage of advances in remote sensing technologies and develop a semi-automated methodology to map the current extent of habitat types in Switzerland, taking into account impacts of human disturbances and interventions. We employ an extensive suite of earth-observation and mapping data as inputs in an approach involving habitat distribution modelling, image segmentation and classification. High-resolution 3D information from digital aerial photogrammetry allows differentiating shrubs and trees and identifying buildings. Phenological dynamics are determined from seasonal variation in vegetation indices (e.g. NDVI), derived from high temporal resolution Sentinel-2 satellite imagery. Data describing climate, topography, soil and land use (from the topographic landscape model TLM) provide additional covariates. Habitat distribution models are developed via machine learning approaches trained with field data available from large scale Swiss vegetation and biodiversity monitoring programmes. Within the software eCognition, airborne orthoimagery (1m resolution) is segmented into 'image primitives' on the basis of reflectance in the RGB and NIR bands, and values of the metrics NDVI and NDWI. In a rule-based approach, habitat types can be assigned to segments based on the input data and distribution models, resulting in a high spatial resolution Swiss-wide map of habitat types. This semi-automated approach can be re-applied with updates of the base data at specified time intervals, enabling use for monitoring purposes. The methodology has been tested in a first national-scale prototype.

**11:55am - 12:12pm**

## Monitoring, Understanding And Forecasting Global Biomass Flows Of Aerial Migrants Using Continental Networks Of Weather Radars

**Silke Bauer[1], Felix Liechti[1], Baptiste Schmid[1], Judy Shamoun-Baranes[2], Andrew Farnsworth[3], Peter Desmet[4], Jarmo**

**Koistinen[5]**

[1]Swiss Ornithological Institute, Switzerland; [2]University of Amsterdam, The Netherlands; [3]Cornell Lab of Ornithology, Ithaca, USA; [4]INBO, Belgium; [5]Finnish Meteorological Institute, Helsinki, Finland; silke.s.bauer@gmail.com

Trillions of animals, encompassing thousands of tons of animal biomass, move annually through the air above our planet. Through a variety of transport and trophic effects, migratory animals can uniquely alter nutrient and energy flow, food-web topology and stability, and represent a powerful yet underappreciated dimension of biodiversity that also represent services and disservices to human infrastructure, agriculture and welfare at a global scale.

Many migrant populations have alarmingly declined over past years, and these declines often go undetected, especially if they concern non-charismatic species or those with a clandestine life-style. Furthermore, their aerial and terrestrial habitats have changed dramatically over the past decades and are expected to change further, particularly from rapid climate change, increased urbanization, wind energy installations, and habitat fragmentation. Preserving migrants' roles in structure and functioning of ecological communities as well as better using their services and reducing their disservices requires long-term and large-scale monitoring tools for quantifying migrations across continents and the identification of the drivers behind changes in movement patterns and migrant abundances.

Existing continental networks of weather radars provide an excellent opportunity to achieve these aims as they also detect "biological targets" and therefore, can assess migration traffic rates and biomass transported. In a BioDivERsa-project, we will tap these resources and quantify biomass flows of aerial migrants across Europe and North America and relate timing and intensity of movements to a suite of atmospheric, climatic and landscape variables. We present preliminary results, outline scientific and societal challenges that we will address, and relevant stakeholders for whom there are numerous future opportunities to leverage such research.

**12:12pm - 12:29pm Warning: The presentations finish prior to the end of the session!**

## Detecting Bark Beetle Infestation Using Plants Canopy Chlorophyll Content Retrieved from Remote Sensing Data

**Roshanak Darvishzadeh[1], Abebe Mohammmed Ali[1,2], Andrew Skidmore[1,3], Haidi Abdullah[1], Claudia Roeoesli[4], Marco Heurich[5], Marc Paganini[6]**

[1]University of Twente, Netherlands, The; [2]Wollo University, Ethiopia; [3]Macquarie University, Australia; [4]university of Zurich, Switzerland; [5]Bavarian Forest National Park; [6]European Space Agency; r.darvish@utwente.nl

The European bark beetle (Ips typographus, L.) is a potentially severe invasive species in the UK and North America. It is resulting in a high degree of fragmentation, forest productivity, and phenology. Understanding its biology, as well as developing early detection based on its behavior, is an important aspect of its successful management and eradication. Bark beetle infestation causes changes biochemical and biophysical characteristics such as chlorophyll water and nitrogen content. This study showcases the potential of the Canopy Chlorophyll Content (CCC) product derived from remote sensing datasets to detect early bark beetle infestation in Bavarian forest national park. We generated time series CCC maps from RapidEye and Sentinel-2 images of the study area through Radiative transfer model inversion. The CCC products were then classified into infested and healthy using CCC mean and variance collected in 2015 and 2016 from infested and healthy Norway spruce trees in the Park. Reference data obtained from processing and interpretation of high resolution (0.1m) color aerial photographs were used to validate the accuracy of the infestation maps. Our results demonstrated that CCC products as derived from remote sensing data were a rigorous proxy to early detect bark beetle infestation. Validation of the infestation maps revealed > 70% classification accuracy throughout the time-space. Hence, CCC products play a significant role to understand the dynamics of the infestation and improve the management of bark beetle outbreaks in forest ecosystem. Despite these promising results, other plant traits such as dry matter content and Nitrogen content will need to be investigated as additional predictors, which may considerably improve the accuracy of early detection of bark beetle infestation using remote sensing derived products.

# 138W-1: Interaction Diversity: From Theory to Practice

*Time:* Tuesday, 25/Feb/2020: 10:30am - 12:30pm · *Location:* Flüela
*Session Chair:* Gianalberto Losapio, ETH Zurich, Switzerland
*Session Chair:* Jacqueline Oehri, University of Zurich, Switzerland
*Session Chair:* Jake Alexander, ETH Zurich, Switzerland

Talks are followed by 35 minute discussion.

Within natural systems, an impressive diversity of interactions links species within ecological networks composed of both mutualistic and antagonistic partners. Biologists have long recognized that these interactions shape the structure and functioning of ecological communities, as well as the evolution of biological diversity itself, and that a diversity of interactions is key to the stability of ecosystems. Yet, in contrast to species or genetic diversity, interaction diversity is an often ignored and underappreciated dimension of biodiversity. The goal of this workshop is to explore what shapes interaction diversity and its functional significance, and consider how a greater appreciation of interaction diversity might guide the conservation of biodiversity and sustainable use of ecosystems.

While the diversity of genes and species provides the building blocks of ecosystems, it is the diversity of interactions between species that determines how these functions are combined and bring ecosystems to life. It is currently well established that biodiversity increases ecosystem functioning. Specifically, the diversity of genes and species increases the productivity of ecosystems and stabilizes multiple ecosystem processes. Yet, the exact mechanisms behind positive effects of biodiversity on ecosystem functioning are still poorly understood and the role of interaction diversity in mediating these effects remains unclear. Indeed, ecological communities with the same number of genes or species can function differently, likely due to variation in species interactions and the organization of the ecological networks.Furthermore, ecological theory predicts that biodiversity decreases the rates of species invasions and species extinctions and facilitates community recovery after environmental perturbations, in such a way that communities hosting a higher number of species are more resilient than species-poor communities. The specific architecture of ecological (interaction) networks affects their resilience to perturbations, with most natural communities displaying architectures that maximize resilience and reduce species loss by limiting extinction cascades. However, how interaction and network diversity mediate the response of species to environmental change, mitigate species loss or facilitates the recovery of ecosystems after perturbations remains poorly understood.Whilst causing species to be lost from ecological networks, environmental changes are also forcing new interactions between species. This arises as new species become integrated into ecological communities following distribution shifts, for example, as species migrate in response to changing climate or through biological invasions. New interactions can exacerbate some of the negative impacts of environmental change on communities, but can also compensate for lost interactions and contribute to biodiversity maintenance. A key goal of current research is therefore to predict which interactions will arise when environments change, and what their outcomes will be. Such an understanding may help guiding efforts to anticipate and manage new and changing species interactions to meet management and conservation goals. The interactive workshop (4-hour) will bring together researchers with theoretical, empirical and applied perspectives on interaction diversity. The expected outcome of the workshop is a perspective publication synthesizing knowledge about the drivers and functional significance of interaction diversity, and paving the way for new studies addressing the role of interaction diversity in natural and anthropogenic ecosystems.

**10:30am - 10:55am**

## Spatial and Temporal Factors Influencing Interaction Diversity in Hummingbird-Plant Mutualisms

**Catherine H. Graham**
Swiss Federal Research Institute (WSL), Switzerland; catherine.graham@wsl.ch

The impacts of climate and land-use change will increasingly affect biological diversity, species interactions, and ecosystem services. One key question is how the changes in species identity, composition, and abundance will alter trophic interactions. Network ecology aims to quantify interactions of species in a given assemblage, but rarely addresses changes in interactions across time and space. These interactions, such as a pollinator visiting a given plant species, form the architecture of biodiversity, and understanding this architecture requires knowledge of both the generation and maintenance of interacting lineages individually as well their interactions. Using hummingbirds and their food plants, I explore models that focus on identifying the mechanisms underlying interactions, and in particular the importance of functional traits in interactions. I will also provide perspectives on how we can scale-up local studies to develop a predictive geographic framework for interaction diversity and beta-diversity.

**10:55am - 11:20am**

## Modelling Stochastic Community Dynamics

**Gian Marco Palamara**
Eawag, Switzerland; gianmarco.palamara@eawag.ch

Species Interactions such as competition, predation, commensalism or mutualism act simultaneously in determining the resilience and stability of ecological communities. Measuring species interactions and their diversity is therefore critical to gather a predictive understanding of ecosystem dynamics and to develop successful managing strategies. On the other hand, due to their stochastic nature, species interactions are elusive and often difficult to quantify. Stochastic models of population and community dynamics, when coupled to Bayesian inference can be useful tools to measure species interactions, especially when different sources of information and multiple datasets are available. Starting from a simple toy model, we will discuss different methodologies to infer interspecific interactions in ecological communities. We will then assess the applicability of such methods based on the available empirical data, with the goal of providing guidelines on how to improve theoretical and empirical approaches to quantify interaction diversity.

**11:20am - 11:45am Warning: The presentations finish prior to the end of the session!**

## Biodiversity Change And Network Persistence

**Jes Hines**
German Centre for Integrative Biodiversity Research (iDiv), Germany; jessica.hines@idiv.de

The world is currently experiencing a period of rapid biodiversity change. I will evaluate the results of three case studies in which changes in biodiversity influence the composition, structure, and functioning of ecosystems. I will show that some food webs assemble in predictable ways that are based on the species richness of basal resources. However, environmental conditions can modify turnover of consumer species and their influence on key ecosystem functions like decomposition and primary production. These results highlight the importance of combined approaches that include theory, experiments, and system specific

observations.

# 166S-1: Illuminating the black box

*Time:* Tuesday, 25/Feb/2020: 10:30am - 12:30pm · *Location:* Sertig
*Session Chair:* Helen Phillips, iDiv, Germany
*Session Chair:* Léa Beaumelle, iDiv, Germany

Soils harbour some of the highest biodiversity. Yet, soil organisms are understudied in terms of their taxonomy, global distributions and the threats they face. It is important we understand life in the soil, as these organisms provide a variety of ecosystem functions that are vital for human wellbeing, such as decomposition, plant growth, and climate regulation, amongst many others. Despite their importance, soil biodiversity is often overlooked in large-scale and global biodiversity assessments, as well as in policy directives and conservation planning.

This session aims to shed light on the most recent advances in soil biodiversity research, with emphasis on three facets. The latest advances on methods to assess where soil organisms are, and which processes or drivers are shaping their distribution. How anthropogenic impacts are affecting soil biodiversity, in terms of their distribution and their diversity. And finally, what changes in distribution and diversity of soil organisms may mean for our wellbeing, given the importance of soil biodiversity in the provisioning of many ecosystem functions.We will consider a variety of soil organisms, from micro-organisms to soil invertebrates, all of which play important roles for ecosystems by their interactions with each other and with plants. As well as a variety of scales, from the mechanistic approaches using experiments to unravel the complexity of soil communities and foodwebs all the way to macroecological approaches that are key to highlight current and future global biodiversity trends.

By bringing together this soil biodiversity research, we hope to advance the field in terms of conservation of the soil organisms. As well as highlight the importance of integrating soil organisms into policy-making and targets, and large-scale assessments.

**10:30am - 10:50am**

## Soil Biodiversity And Chemical Stressors: Global Review And Roadmap For Future Research

**Léa Beaumelle, Lise Thouvenot, Jes Hines, Carlos Guerra, Malte Jochum, Nico Eisenhauer, Helen Phillips**
iDiv, Germany; lea.beaumelle@idiv.de

Soils harbour highly diverse invertebrate communities that play crucial roles for ecosystem services, including the mitigation of pollution. Chemical pollutants, such as pesticides, pharmaceuticals, microplastics, and metals, are being increasingly spread to many ecosystems due to human activities. We use a systematic review of the literature to quantify current state of knowledge with respect to effects of soil pollutants on soil fauna by taxonomic groups, trophic level, exposure scenario, and geographical coverage. This review, which is the most comprehensive general synthesis to date, reveals several important biases. First, despite a large number of case studies reporting chemical stressors' impacts on soils, the reports of chemical effects on invertebrates have been based mostly on individual and population responses to short-term exposures, giving limited insights on the complex response of soil communities and food webs. Second, most research has had limited spatial scope, with a strong bias towards temperate/Northern hemisphere regions. Third, most studies have focused on the effects of single chemical stressors, overlooking the importance of synergistic and context dependent effects of multiple stressors. Given that chemical stressors are changing at rates that can surpass that of other global drivers, such as climate change, we recommend that future research should strive to understand more realistic consequences of these important global change drivers. We specifically highlight multivariate food web and ecosystem responses to multiple chemical stressors as a key research priority.

**10:50am - 11:10am**

## A Can of Worms: How Many Species of Earthworms are there on Earth?

**Thibaud Decaens[1], Emmanuel Lapied[2], Samuel W. James[3], George G. Brown[4], Erin Cameron[5], Nico Eisenhauer[6], Stuart Pimm[7], Helen Phillips[6], Consortium sWorm[6]**
[1]Université of Montpellier, France; [2]Taxonomia Biodiversity Fund, France; [3]Kansas University, USA; [4]Embrapa Floresta, Brazil; [5]Saint Mary's University, Canada; [6]IDIV, Germany; [7]Duke University, USA; Thibaud.Decaens@cefe.cnrs.fr

The question how many species there are on Earth has long captivated scientists, and is still an important issue for the description of global biodiversity distribution and the setting of conservation priorities. It is particularly relevant and challenging for soil organisms, which comprise a significant proportion of global species diversity and are involved in key ecological processes. For instance, about 5 000 earthworm species have been described so far, while the real diversity of the group still remains unknown. In this study, we used a global checklist of valid species names and their occurrences by countries (Drilobase), and a worldwide dataset with nearly 200 regional species lists (Phillips et al. 2019 Science) to explore earthworm macroecological patterns, assess the extent of the taxonomic deficit, and provide optimized estimations of global species number using a combination of approaches.

We found no clear latitudinal gradient in species richness distribution, mainly because of a sampling bias resulting in a peak of species richness in the Australasian region. We also found that most species were restricted to a single country, resulting in high species composition turnover (>95%) between both latitudinal bands and eco-realms. Our estimates of global species numbers ranged from 20 000 when using the global checklist without further partitioning to more than 40 000 when taking into account the latitudinal turnover in species composition. Analysing the regional list dataset highlighted a higher beta-diversity, and a lower sampling effort and sample coverage in tropical compared to temperate regions. The reliability of species number estimates is therefore likely to decrease from higher to lower latitudes, resulting in an under-estimation of species numbers in the tropics. As a consequence, even the higher of our global estimations is probably a strong underestimation of the real species diversity of this key group of soil organisms. These results imply that in order to better understand the global distribution and key drivers of biodiversity, a lot more work on soil organisms is needed, also on more well-known taxa like earthworms.

**11:10am - 11:30am**

## Microbial Biogeography In The French Soils: A Nation-Wide Investigation

**Battle Karimi[1], Sébastien Terrat[1], Samuel Dequiedt[1], Nicolas Chemidlin[1], Jean Villerd[1], Christophe Djemiel[1], Mélanie Lelièvre[1], Julie Tripied[1], Virginie Nowak[1], Nicolas Saby[1], Antonio Bispo[1], Claudy Jolivet[1], Dominique Arrouays[1], Patrick Wincker[2], Corinne Cruaud[2], Lionel Ranjard[1]**
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The French Soil Quality Monitoring Network (Réseau de Mesure de la Qualité des Sols= RMQS) intends to study the soil microbial diversity on the territory scale and to decipher the relationships between microbial communities and environmental heterogeneity

such as soil parameters, land-use or climate. The intensive and systematic sampling of 2,200 soils has provided innovative and generic results on the bacterial and archaeal biogeography in terms of spatial distribution and environmental drivers of the bacterial diversity, community structure, taxa distribution, ecological networks and microbial habitats. Complementary to academic validation of the overall results, our objective was to popularize them to a large public by writing a Microbiological Atlas of French soils. In the first part, the Atlas presents a global view of soil microbial life, i.e. the bacterial diversity level, molecular biomass and community composition on the French territory scale. The second part is composed of ID card for the 35 bacterial *phyla*observed in French soils by describing the known functions, the occurrence and geographical distribution, the main environmental drivers and the biotic relationships with other taxa. The third part of the Atlas details for the first time the 16 soil microbial habitats found across the territory with a precise description of abiotic factors specific to each habitat and a comprehensive presentation of its specific bacterial community (diversity, molecular biomass, community composition, interaction network). The design of these habitats should allow to upgrade the micro-organisms at the same level than macro-organism in the ecosystem conservation policies.

Overall, this Atlas targets a large range of public, from the students to the researchers but also all the actors of soil, to enforce the common knowledge on the soil biodiversity.

**11:30am - 11:50am**

## Global Biogeography And Diversity Óf Soil Microbes

**Mohammad Bahram**[1,2]

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Bacteria and fungi are fundamentally important for soil nutrient cycles in many terrestrial ecosystems. Recent advances in molecular methods have greatly facilitated the identification of microbes and advanced community ecology studies of microbes. In particular, high-throughput sequencing techniques have enabled us to determine millions of genes and identify thousands of microbial taxa from a single sample. Such information provides useful insight to disentangle the effects of environmental filtering and biotic interactions in structuring microbial communities. We have used these methods to understand various aspects of the biogeography of microbes. In my talk, I will discuss our recent findings on the global distribution of soil microbes, including the followings: i) there is a global latitudinal gradient in topsoil with the highest bacterial gene and phylogenetic diversity found in temperate zones across all major biome types; ii) topsoil bacterial and fungal taxonomic composition and gene functional potential depend on soil and climatic factors rather than dispersal limitation on a global scale; iii) bacteria and fungi dominate complementary sites across the latitudinal gradient, reflecting niche differentiation; and iv) fungal-bacterial antagonism is reflected in the distribution of antibiotic resistance genes in soil, consistent with a role of fungally produced antibiotics in microbial competition.

**11:50am - 12:10pm**

## Global Effects Of Land Use On Local Soil And Leaf-litter Biodiversity

**Victoria J. Burton**[1,2], **Paul Eggleton**[1], **Andy Purvis**[1,3]

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Human activities, particularly land-use change and habitat degradation, are driving major changes in biodiversity worldwide. However, studies of such effects have focused overwhelmingly on above-ground taxa: the effects on soil organisms are less well known, despite their importance in nutrient cycling, water drainage and developing soil structure.

Having expanded the soil assemblage data in the PREDICTS database (a global compilation of biodiversity data from assemblages in different land uses), we show that the soil-dwelling and above-ground organisms respond differently to land use, and that these responses are mediated by soil properties in ways that again differ between soil and above-ground taxa.

A more detailed analysis of just the soil assemblages showed that, unlike above-ground biodiversity, both soil organism abundance and species richness were lower in secondary vegetation than in primary vegetation. Both measures were much lower in cropland and plantation forest but not in pasture. The effects of land use on species richness, and particularly, abundance depended on soil organism size: large taxa are more abundant in cropland assemblages than in primary vegetation, whereas the opposite is true for small taxa. Soil properties influenced the composition of soil assemblages in ways that depended upon land-use type and organism size.

To estimate how local soil biodiversity worldwide may respond to different scenarios of land use change, we projected these models using land use projections from the Intergovernmental Panel on Climate Change (IPCC) Shared Socioeconomic Pathways (SSP) scenarios corresponding to different intensities of global climate change. Intensive agriculture has already reduced local soil biodiversity across the world and expansion and intensification of agriculture in the IMAGE 2.6 and MESSAGE 8.5 scenarios would be expected to reduce it further.

**12:10pm - 12:30pm**

## Links Between Soil Microbial Communities, Functioning And Plant Nutrition Under Altered Rainfall In Australian Grassland

**Raul Ochoa-Hueso, Valentina Arca, Manuel Delgado-Baquerizo, Kelly Hamonts, Juan Piñeiro, Lilia Serrano-Grijalva, Sally Power**

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The size, frequency and timing of precipitation events are predicted to become more variable worldwide. Here, we carried out three years of rainfall manipulation – altering the size (both increased [+50%] and reduced [-50%]) and timing (reduced frequency and an extreme summer drought) of rainfall events – at the DRI-Grass facility, a unique experimental platform located in a mesic grassland in eastern Australia. We evaluated the spatio-temporal responses of multiple ecosystem attributes including microbial biomass, community composition and activity, soil nutrient content and availability, and plant nutritional status to altered rainfall. Changes in precipitation resulted in multiple direct and indirect changes in microbial communities and soil and plant nutrient content, including greater availability of soil N and reduced availability of micronutrients under drought, and taxon-specific changes in the composition of soil microbial communities. Soil nutrient availability and plant macronutrient contents were both related to soil microbial community structure and significantly affected by changes in precipitation regimes. Furthermore, whilst plant macronutrient content was related to soil macronutrient availability, plant micronutrient content was solely predicted by changes in microbial attributes. Many of the variables evaluated also varied greatly between sampling years and showed significant interactions between treatments and sampling seasons, suggesting complex system-level responses to climate change. Some of these interactions

manifested as alterations in the coefficient of variation of variables, particularly in response to changes in the timing of precipitation events and summer drought, suggesting that trophic cascades may occur if communities fail to follow the environmental clues that allow them to match their phenology with that of their biotic and abiotic environment on which they may depend. Therefore, a detailed understanding of plant-soil interactions, and the role of climate in modifying these linkages, is key for adapting the sustainability of ecosystems to a future that will undoubtedly be shaped by climate change.

# 238S: Mutualism and Biodiversity

*Time:* Tuesday, 25/Feb/2020: 10:30am - 12:30pm · *Location:* Schwarzhorn
*Session Chair:* Jordi Bascompte, University of Zurich, Switzerland
*Session Chair:* Judith Bronstein, University of Arizona, United States of America

Presentations will be followed by an in-depth discussion of the topic.

The rationale beneath this session is that in order to better understanding the relationships between mutualism and biodiversity, one needs more work in integrating across systems, scales, and methodological approaches. Among the latter, special emphasis should be given to the combination of phylogenetic approaches, theory, and experiments. This session tries to do so by combining a heterogeneous group of scientists representing different approaches and systems. We envision a session where talks will be brief so that the main focus is in the following in-depth discussion. The main goal is moving towards a better understanding of the role of mutualistic interactions for biodiversity maintenance.Mutually beneficial interactions among species have shaped much of biodiversity on Earth. And yet, the study of mutualism has not the same rich historical tradition than studies on competition or predation. Indeed, mutualistic studies have been somehow decoupled from an integrative approach relating them with major theoretical frameworks in ecology and evolutionary biology, thus remaining particular case studies. Another difficulty is that the relationship between mutualism and biodiversity can be studied at different scales, from macroevolution to community ecology, with little cross-talk between such scales. The direct consequence of this state of affairs is that while there is agreement about the role of mutualisms in generating biodiversity, there is more uncertainty about how complementary processes and hypothesis related to each other in modulating this overall effect (see a recent review in TREE by Chomicki et al. 2019).

**10:30am - 10:40am**

## Plant-Animal Mutualistic Networks: the Architecture of Biodiversity

**Jordi Bascompte**
University of Zurich, Switzerland; jordi.bascompte@uzh.ch

It is widely assumed that mutualistic interactions have played a major role in the diversification of life on Earth. But the relationships between mutualism and diversity are not yet clear. This is mainly due to the fact that the traditional approach focused on a life-history attribute of either the plants or the animals, thus hindering a conceptual unification of mutualism into a framework similar to the one existing for competition or predation. Here I will review recent work on mutualistic networks aimed at understanding under what conditions mutualism increases the number of coexisting species. Two key considerations are that mutualism has to be understood as a balance to competition and that network architecture should be regarded as being affected by both stability and feasibility constraints.

**10:40am - 10:50am**

## Mutualism and the Maintenance of Diversity

**Sharon Y Strauss**
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Mutualisms can play important roles in the maintenance of diversity. For plants, these can entail associations with microbes that are shared across species, and also associations with pollinators. Members of plant communities may possess traits that reflect interactions with mutualists, rather than competition for resources, and that influence patterns of local diversity. I will describe one such case in *Trifolium* (clovers).

**10:50am - 11:00am**

## Mutualisms Play Crucial Roles in Population Persistence and Species Distributions

**Michelle E Afkhami[1], Aaron David[1], Khum Thapa Magar[1], Pedro Quintana-Ascencio[2], Eric Menges[3], Patrick McIntrye[4], Sharon Strauss[5], Christopher Searcy[1]**
[1]University of Miami, United States of America; [2]University of Central Florida, United States of America; [3]Archbold Biological Station, United States of America; [4]NatureServe, United States of America; [5]University of California, Davis, United States of America; michelle.afkhami@miami.edu

Protecting biodiversity in the changing world of the Anthropocene will require a mechanistic understanding of the biotic and abiotic factors that underpin community structure and diversity. Mutualism, species interactions in which participating organisms benefit from the association, can play a major role in influencing biodiversity of a community through its impact on the distributions of species. By ameliorating stress, mutualisms can allow persistence of species in challenging environmental conditions and expansions of species distributions at landscape and even rangewide scales. Here, I will discuss evidence for mutualist-mediated effects on population persistence and species distributions. First, combining field surveys of 92 populations, 10 common garden experiments spread throughout the range, species distribution models, and greenhouse experiments, I will show that mutualistic fungal endophytes ameliorate drought stress and broaden the geographic range of their native grass host by thousands of square kilometers (~ 20% larger) into drier habitats. Second, I will touch on work combining greenhouse experiments, long term demographic field data, and integral projection modeling to demonstrate soil microbiomes are required for population persistence of an endangered plant in high stress, marginal habitats, and that microbial-mitigation of stress can explain landscape scale distributions of plants. These studies emphasize the crucial role mutualism plays in determining where species are distributed across large and small spatial scales, which will have important consequences for biodiversity faced with changing climates and land use.

**11:00am - 11:10am**

## Hidden Compartmentation Reduces Conflict Among Symbionts In Multi-partner Symbioses

**Guillaume Chomicki**
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Symbiotic mutualisms in which partners spend most their lives in physical proximity are pervasive. Many symbioses involve one host species having several mutualist partners, yet theory predicts that conflicts among these partner species are harmful to the host. How such conflict can be avoided is not well understood. Species in the plant genus *Squamellaria* receive nutritional benefits from multiple symbionts, including ants, earthworms, and cockroaches, that live in the host plant. Here we show that in this system,hosts reduce conflict among these symbionts by offering unlinked compartments in the plant-provided nesting site

(domatium). Using computed-tomography 3D models, we discovered that each symbiont species inhabits a distinct compartment with a separate entrance. In the experimental absence of compartments, contact among symbionts leads to conflict, but when provided different compartments, they coexist peacefully and share food resources. Mathematical models parameterized with field data on partner aggressiveness imply that compartmentation increases the time hosts are occupied by beneficial symbionts, even when host invasion by aggressive symbionts fluctuates over time. These results unveil a simple conflict-reducing mechanism that allows hosts to take advantage of unrelated symbionts. I anticipate that this mechanism may be widespread in multi-partner mutualisms and should be considered in models of mutualistic cooperation. This in turn shows how even in intimate mutualisms, coexistence of multiple species can peacefully occurs within the same host. Harnessing the power of the coexistence-promoting effects of mutualisms will be essential for successful conservation and restoration projects.

**11:10am - 11:20am**

### The Importance Of Animal-Mediated Seed Dispersal For The Maintenance Of Plant Diversity

**Haldre S Rogers[1], Evan Fricke[2], Elizabeth Wandrag[3], Hugo Thierry[1], Evan Rehm[4], Henry Pollock[5], Ann Marie Gawel[1], Hernani Oliveira[1]**

[1]Iowa State University, United States of America; [2]National Socio-Environmental Synthesis Center (SESYNC), United States of America; [3]University of New England, Australia; [4]Austin Peay State University, United States of America; [5]University of Illinois, Urbana-Champaign, United States of America; haldre@iastate.edu

Nearly 50% of temperate and 75-90% of tropical forest trees are adapted for dispersal by animals, yet the importance of seed dispersal for the maintenance of plant diversity often goes unrecognized in science and conservation. Seed dispersal typically occurs over large spatial scales and the impacts play out over long temporal scales, making it a difficult process to study. However, recent declines, extinctions, and range contractions of frugivores have highlighted the importance of animal-mediated seed dispersal.

Here, we demonstrate the importance of animal frugivores for plant populations and communities using an accidental experiment on the island of Guam, where the invasive brown treesnake caused the functional extirpation of all native vertebrate frugivores. To determine how frugivores affect forest composition and structure, we compared Guam to nearby islands with vertebrate seed dispersers using surveys, manipulative experiments, and a forest model. We demonstrated that vertebrate seed dispersal increases species richness and influences the physical structure of forests, with treefall gap regeneration slowing in its absence. Small-seeded, fleshy-fruited, quick-growing tree species are the most demographically dependent upon vertebrate dispersal, and thus the most likely to experience reductions in a complete disperser loss scenario. However, these also tend to be the species with the most frugivore partners, which limits their risk of coextinction to the most extreme defaunation situations. In most systems, large-bodied frugivores have been lost, affecting primarily large-seeded species.

Given the widespread effects of defaunation on plant communities, mutualistic rewilding must be a conservation priority. To develop a strategy for restoring seed dispersal to Guam, we first assessed the effectiveness of native and non-native frugivores and selected the most effective as candidates for reintroduction. Then we used a spatially-explicit model to identify the highest priority areas for rewilding, and are working with land managers to plan range expansions and and reintroductions for the purposes of restoring the lost mutualism. Guam provides an unprecedented demonstration of the importance of seed dispersal for biodiversity, a cautionary tale for systems experiencing defaunation around the world, and a potential model for mutualistic rewilding.

**11:20am - 11:30am Warning: The presentations finish prior to the end of the session!**

### The Gift That Keeps On Giving: Why Does Biodiversity Accumulate Around Mutualilsms?

**Judith Bronstein**

University of Arizona, United States of America; judieb@email.arizona.edu

How can diversity accumulate within ecological communities, when they are structured by consumer-resource interactions in which key species are continuously being killed? Generations of ecological theory have been developed to explore this paradox. Mutualisms are a subset of consumer-resource interactions in which the resource species is not (or only rarely) consumed. Rather, it produces a product, often continuously, that sustains the consumer; in turn, the use of that product returns a benefit to the producer. I argue that the underlying ecology of such positive consumer-resource interactions leads them to be wellsprings of biodiversity within ecological communities. In support of this argument, I highlight three features of mutualism biology. First, for both ecological and evolutionary reasons, most consumers of mutualistic resources are rather generalized: a single resource species sustains many consumers, and in turn many consumers return benefits to it. Diversity therefore accumulates around individual mutualistic consumer and resource species. This process also creates cross-linkages within interaction networks that generate resilience in variable and changing environments. Second, mutualistic resources are generally cheap, but they are difficult to produce in exactly the right quantity to sustain mutualistic consumers. Consequently, these resources are commonly produced in overabundance. This opens the door to grazers that provide no benefits in return. Some of these non-mutualist consumers function as mutualists of other resource-offering species, generating yet more cross-linkages within communities. Others are highly specialized and have diversified dramatically in association with their use of excess mutualistic resources. Third and last, different types of mutualisms form links with each other and mutualisms form links to antagonisms, generating robust multiplex structures that may further accumulate and sustain biodiversity. We now know a great deal about how the structure of mutualistic communities generates robustness and hence maintains diversity, but the role of mutualism as a wellspring of diversity itself has not been well-appreciated. I conclude by offering a set of simple predictions to move its study further.

# 115S-1: Socio-economic and ecological implications and challenges of conserving biodiversity

*Time:* Tuesday, 25/Feb/2020: 10:30am - 12:30pm · *Location:* Seehorn
*Session Chair:* Sergio Rasmann, University of Neuchâtel, Switzerland
*Session Chair:* Marco Moretti, Swiss Federal Research Institute WSL, Switzerland

Most of the basic needs of society depend on biodiversity, nonetheless the anthropocene is characterized by the dramatic and fast disappearance of species diversity worldwide. The causes of biodiversity erosion are multiple, including habitat fragmentation, pollution or climate change, and its impact are multiple, including particularly, the loss of genetic diversity, and with that, proper ecosystem functioning and services provision for the society. To counteract biodiversity loss, conservation programs have been put in place, but with mitigated, or only local, success.

The scope of this symposium is to bring together world-renowned experts in conservation biology and socio-economic sciences for discussing future venues for better conserving biodiversity and ecosystem functioning. Particularly, we aim to discuss whether to conserve species that deliver services or, rather to conserve biodiversity per se. What shall the society focus on? What is the responsibility of research, people, society, economy and policy? How can we bring biodiversity to the top ranks of the society and political agenda?

**10:30am - 11:00am**

## Are You Still Conserving Species Or Do You Already Favour Biodiversity?

**Urs Tester**
Pro Natura, Switzerland; urs.tester@pronatura.ch

The Swiss conservation organisation Pro Natura was founded in 1909. Through ownership and contracts with other landowners, Pro Natura has secured 724 protected areas with a total surface area of 269 km2. 130 of these areas, with a total surface area of 107 km2, are part of regional nature parks or World Heritage Sites. In 494 protected areas, Pro Natura is involved in or responsible for the whole management. In these protected areas, the management objectives are defined in a management plan. We base the management objectives on the biodiversity priciples of Pro Natura decided by our council of delegates in 2005 : In a world of changing climate the conservation of species on a specific site is impossible. So we do'nt focus on the conservation of endangered species that are actually present when planning the management of our reserves. The reintroduction of extinct species is also not a priority of Pro Natura. We want to favour biodiversity in the entire country. For this protected areas are very important. Every protected area has its own specific objectives. In some of them, the main objective is protecting the ecosystem by allowing natural processes to develop freely. In some of the sites, management interventions are used to favour specific habitat conditions. A third group of protected areas focuses on habitats with a high species richness which has developed as a result of traditional agriculture. The management activities promote the species richness by imitating these traditional activities.

**11:00am - 11:15am**

## Integrating Spatial Biodiversity Modelling With Nature Contributions To People Into Conservation Prioritization Frameworks

**Antoine Guisan**
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An important challenges of conservation planning is to balance biodiversity conservation with nature contribution to people. This leads increasingly to integrate biodiversity components with services offered by ecosystems (ES) into spatial conservation planning that also account for socio-economic criteria (e.g. geographically weighted political support). However, as biodiversity data rarely cover the whole region where conservation planning is needed, spatial biodiversity predictions can additionally be used to support conservation planning. In my talk, I will illustrate a framework integrating both real species observation, socio-economic constraints, spatial biodiversity predictions, and mapped ecosystem services, and show that using different weights for these different elements can lead to contrasted spatial conservation prioritization solutions. I will then discuss various implications related to the use of spatial models and the mapping of ES in this context, and conclude with some perspectives.

**11:15am - 11:30am**

## The Importance of Pollinator Protection and a Scalable Win-win-approach for Pollinator and Biodiversity Protection

**Stefanie Christmann**
ICARDA, Morocco; s.christmann@cgiar.org

As 87% of all flowering plants depend on pollinators, all ecosystem services, namely those provided by these 87% of flowering plants can simultaneously decrease and cause interlinked poverty spirals with high potential of various kinds of conflicts. Adaptive or counterproductive human activities are not studied at all. Pollinators might be the most important terrestrial species for biodiversity and humankind, but social scientists rarely work on pollinators. State of the Art of pollinator protection are wildflower strips, mostly within reward-systems for farmers, as they dislike and reject seeding weeds in parts of their fields. Within this approach, farmers are paid service providers only, neither they learn anything on pollinators nor do they get a productivity-related incentive for pollinator protection. Due to high costs for reward systems, the approach is not scalable to Low and Middle Income Countries anyway. The new Farming with Alternative Pollinators (FAP) approach conflates socio-economic, policy and agro-ecologic research and targets farmer-friendly pollinator protection and policies. Instead of wildflowers, FAP uses marketable habitat enhancement plants and nesting and water support out of local materials. Impacts are assessed versus monocultural control fields concerning diversity and abundance of pollinators, natural enemies, pests and net income per surface. FAP proved high income increase per surface convincing farmers in Uzbekistan and Morocco. FAP is a self-sustaining low-cost approach requiring only capacity building for farmers, as they know little about pollination, pollinators and habitat requirements according to recent studies in different countries. FAP highly reduces pest abundance. FAP results induced the Moroccan government to mainstream the approach also by policies. The example of Morocco shows, that farmers and policymakers take action for pollinator protection based on enhanced understanding of their value and a scalable low-cost approach. Social science is key to combat pollinator decline and thus contributes to three Aichi targets.

**11:30am - 11:45am**

## Soil Biodiversity And Soil Microbiome Complexity Predict Ecosystem Functioning And Sustainability

**Marcel van der Heijden, Franz Bender, Klaus Schlaeppi, Eiko Kuramea, Sarah Pellkofer, Yann Hautier, Cameron Wagg**
University of Zurich, Switzerland; marcel.vanderheijden@agroscope.admin.ch

The soil microbiome is highly diverse and comprises up to one quarter of Earth's diversity. Yet, how such a diverse and functionally complex microbiome influences ecosystem functioning and sustainability remains unclear. We manipulated soil microbiome complexity and soil biodiversity in experimental grassland ecosystems and observed that microbiome diversity and microbial network complexity positively influenced multiple ecosystem functions related to nutrient cycling (e.g. multifunctionality). Grassland microcosms with poorly developed microbial networks and reduced soil biodiversity had the lowest multifunctionality due to fewer taxa present that support the same function (redundancy) and lower diversity of taxa that support different functions (reduced functional uniqueness). Moreover, we observed that microbiome richness promoted ecosystem stability. These findings indicate the importance of microbial interactions within and among fungal and bacterial communities for enhancing ecosystem performance and demonstrate that the extinction of complex ecological associations belowground can impair ecosystem functioning. We are now testing under field conditions whether the manipulation of soil biodiversity and soil microbiome in agricultural systems can be used for soil ecological engineering and to promote the agricultural sustainability.

**11:45am - 12:00pm**

## Examining Interventions For Forest Conservation, Building Local Capacity And Enhancing Livelihoods

**Maria J. Santos**
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Multiple interventions are planned and implemented to meet concurrent goals of biodiversity and ecosystem service conservation, building capacity at local scales and promoting livelihoods. The premise is that through interventions natural resources and biodiversity are preserved and provide dividends in other livelihood dimensions allowing to achieve sustainable systems. However, such interventions might conflict with each other, challenging the achievement of the outputs that they aim to achieve at scale. Here I examine the extent to which forest conservation, building local capacity and enhancing livelihoods can be synergistic through agroforestry. I propose that a properly designed scaling process built on multidimensional livelihood assets will allow reaching the desired synergies between forest conservation and livelihoods. To illustrate the approach, I will present the results of agroecological management of avocado farms in Mexico and shaded-coffee plantations in Peru. The results show that (i) in the case of Mexico, the intervention only increased natural capital, and (ii) in the case of Peru, the intervention increased both natural and social capital. These cases illustrate how interventions to build local capacity to implement agroforestry systems may produce counter-intuitive outcomes, and that we need to better understand how and whether the livelihood capitals can indeed be useful to provide the necessary scaling effects and prevent trade-offs between conservation and livelihoods.

**12:00pm - 12:15pm Warning: The presentations finish prior to the end of the session!**

## Conserving Wildflower Biodiversity In Cities: Understanding And Designing At The Intersection Of Human Actions And Ecological Processes

**Kevin Vega[1], Martin Fischer[1], Juanita Schlaepfer[1,2], Alex Widmer[1], Christoph Kueffer[1,3]**
[1]ETH Zurich, Switzerland; [2]Zurich-Basel Plant Science Center; [3]HSR Hochschule für Technik Rapperswil; kevin.vega@env.ethz.ch

Cities are dynamic living ecosystems in which human actions directly intertwine with natural processes- mutating, promoting or impeding them. The plants that occur within cities often seem to exist only at our will: we plant and sow, mow and trim the greenery of our urban spaces. Our priorities and lack of understanding can result in the creation of "Potemkin Gardens"- false mirages of beautiful ecological systems hiding a dysfunctional reality. Looking beyond these botanical tableaus, however, reveals that certain species are succeeding in making urban green spaces their own. For these species, seed dispersal, pollination, colonization, and competition are still major drivers of plant diversity, evolution, and biogeography in cities. We believe that with the right design, species selection, and promotion, we can work with rather than against these 'wild' natural processes in our pursuit of helping make cities sites of biodiversity conservation. Our work explores this interplay between human dispersal/maintenance and biologically driven patterns in urban wildflowers in Zurich. By surveying across the city, we examined how socioeconomic factors, design, and land use history have impacted the biogeography of Zurich's flora. We explored the ecological patterns associated with isolation and patch size in determining the biodiversity of even tiny green "islands" spread throughout a sea of concrete. Utilizing modern genetic methods, we have examined how species' life histories determine their connectivity and how human sowing may be introducing and mixing new genotypes with established urban genotypes. While cities represent a system in constant flux due to rapid human actions, they also present an opportunity to directly engage with and influence the system's key shapers and drivers. Working with a local citizen science network, we have set up a project to highlight the self-dispersing flower species which emerge in our gardens/balconies of their own volition. In doing so, we brought volunteers into dialogue about wildflowers in cities, their self-propagated dispersal, the importance of ecological connectivity, and the perception of wilderness and wildflowers in a city.

# Posters 1: Poster Session 1

*Time:* Tuesday, 25/Feb/2020: 12:45pm - 2:15pm · *Location:* Hallway

## Contemplating Spatial and Temporal Components of Functional Diversity: Full Exploitation of Satellite Data for Biodiversity Monitoring

**Christian Rossi[1,2,3], Mathias Kneubühler[2], Martin Schütz[3], Rudolf Haller[1], Anita Risch[3], Michael Schaepman[2]**

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The ongoing mass extinction of species and the associated decline of ecosystem services vital for sustaining human life demand a comprehensive monitoring of plant biodiversity. Measuring biodiversity in the field on large areas generates issues like the need of a robust sampling design, the high demand on human and monetary resources and different biases introduced by humans and environmental conditions. These circumstances have recently triggered an extended use of remote sensing data to quantify biodiversity in a cost- and time-efficient way. Remotely sensed datasets represent the Earth surface at a certain point in time. Yet, it is not well studied what the use of a single dataset in time implies for biodiversity estimates. The functional dimension of biodiversity, expressed through functional traits within or between species, varies according to the phenological cycle. Further in grasslands, mowing and grazing events lead to temporal variations in the remotely sensed diversity. We provide an approach in which we integrate the temporal dimension in the quantification of biodiversity from space. Functional diversity is partitioned into a spatial and a temporal component. In particular, Sentinel-2 satellite datasets are well suited for this purpose, providing a complete landscape picture with high revisit time. In our study case, the incorporation of the temporal dimension and the interaction between spatial and temporal diversity by employing multiple datasets improves the retrieval of functional diversity in differently managed alpine grasslands. In comparison to the use of a single dataset, our approach provides more reliable recommendations for conservation and restoration decision-making on a regional scale.

## Copernicus Operational Global Land Cover Service – a Flexible, User-Oriented and Multi-Scale Mapping Approach

**Ruben Van De Kerchove[1], Marcel Buchhorn[1], Myroslava Lesiv[2], Nandin-Erdene Tsendbazar[3], Bruno Smets[1], Luc Bertels[1], Daniele Zanaga[1], Martin Herold[3], Dainius Masiliunas[3], Jan Verbesselt[3], Steffen Fritz[2]**

[1]VITO, Belgium; [2]IIASA, Austria; [3]Wageningen University & Research, The Netherlands; ruben.vandekerchove@vito.be

The Copernicus Global Land Service is the component of the European Copernicus service which ensures a global systematic monitoring of the Earth's land surface. Newly, the service provides dynamic yearly global land cover maps from 2015 onwards with a focus on real-time environment monitoring targeting a large set of different land management user communities (i.e. forest, biodiversity, crop monitoring, desertification and Sustainable Development Goals monitoring). The classified map is provided together with a set of continuous cover layers (forest, shrub, grassland, cropland, moss & lichens, bare, built-up, permanent water) and land cover change layers in near-real time. Recently, the first global map set at 100m spatial resolution for the year 2015 and yearly change layers for 2016 and 2017 for Africa have been released.

The system is setup as operational service able to operate on multiple scales. Currently the mapping is done at moderate scale of 100m, but first regional maps at high spatial resolution were generated (i.e. Landsat 30m, Sentinel1/2 10-20m). The training and validation datasets are continuously collected as part of this operational service and independent of any land cover legend to have the flexibility of being used for 10-100m resolution mapping. The initial maps are derived from the PROBA-V time-series, fully reprocessed to improve accuracy at high latitudes, to align with the Sentinel-2 tiling grid and to generate an Analysis Ready Data (ARD) archive. Moreover, VITO has developed a solution to deploy its workflow from its private cloud onto a public cloud (e.g. DIAS), and hence deal with the exponential expansion of the required resources for high resolution mapping. This solution enables a more flexible, user-oriented on-demand regional mapping in the cloud.

We will present the system, the global 2015 land cover map with focus on the cover fraction layers, and the yearly change layers for Africa.

## Linking In-situ And Space-borne Observations To Study Spatial Plant Functional Diversity Patterns

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Functional diversity serves as an important link between biodiversity and ecosystem functioning. Satellite earth observation has demonstrated potential to address the lack of information on large-scale continuous patterns of terrestrial plant functional diversity. The spatial extent and pixel-based observations of satellite remote sensing, however, poses challenges to validation and interpretation. This study demonstrates the mapping of functional diversity using Sentinel-2 imagery while offering a validation approach that links leaf and canopy traits and functional diversity from in-situ measurements with satellite remote sensing observations.

Through both traditional field methods and satellite retrieval we measured plant trait data (Leaf Area Index, chlorophyll and carotenoid concentrations, canopy water content and dry matter contents) for 120 plots in 15 locations in the Montesinho National Park, Portugal. Space-borne functional diversity metrics were derived from spectral reflectance data of Sentinel-2 imagery by radiative transfer model inversion. Canopy measurements were taken across the georeferenced plots representative of Sentinel-2 pixels. For both space-borne and in-situ trait data, functional diversity metrics were calculated for each location and compared for validation.

The results allow us to assess the performance of satellite remote sensing to infer multiple individual traits, trait-trait relationships and functional diversity metrics. The validation demonstrates the capabilities to map functional diversity with currently operational satellite imagery while examining the accuracy, robustness and uncertainties of estimates. On the one hand, the demonstrated approach underlines the challenges involved in obtaining field measurements representative of pixel observations. On the other hand, the study highlights the potential of space-borne functional diversity metrics to advance our understanding on macro-ecological patterns without the need for repeated in-situ canopy trait measurement field campaigns.

## Remote Sensing of Plant Ecological Genetics

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Plants are the trophic basis of terrestrial ecosystems and their diversity structures ecological communities. Genetic diversity is a key determinant of adaptive potential for species in a changing climate, and both plant genetic and species-level diversity has large effects on biodiversity experiments. To determine their importance in natural communities requires methods for large-scale and long-term monitoring. Remote sensing technologies have this potential. This project seeks to develop the use of remote sensing technologies to quantify plant genetic diversity.

We first aim to identify associations between genetic variants and variation in optical spectra from leaves, obtained using an ASD FieldSpec4 and leaf clip. We used a Multiparent Advanced Generation InterCross (MAGIC) population of the wild tobacco *Nicotiana attenuata* comprising a set of recombinant inbred lines (RILs) from 26 founders. We conducted association studies on leaf spectra and Single Nucleotide Polymorphisms (SNPs) of the RILs and the parental lines. The preliminary results identify five SNPs associated with reflectance at certain wavelengths. This is a step towards identifying specific genes that contribute to leaf optical properties, and improved understanding of underlying physiological mechanisms.

Such associations could apply to remotely sensed data from canopies and landscapes. With the potentials to link remote sensing and genetic diversity, remote sensing technologies, including airborne and spaceborne instruments, may offer possibilities to understand changes in biodiversity and ecosystem function.

## Towards Global Mapping of Canopy Chlorophyll Content from Sentinel 2

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Quantifying Canopy chlorophyll content (CCC) is fundamental for the understanding of terrestrial ecosystems through monitoring and evaluating terrestrial ecosystem properties such as carbon and water fluxes, productivity, light use efficiency as well as nutritional and environmental stresses. Information on the amount and distribution of CCC helps to assess and report biodiversity indicators related to ecosystem processes and functional aspects of biodiversity. However, robust and rigorous methods for regional and global mapping of CCC from remote sensing data is not well defined. This study aimed at evaluating the spatiotemporal consistency and scalability retrieval methods for large scale mapping of CCC. Four methods (i.e., Radiative transfer models (RTMs) inversion using look-up table (LUT), the Sentinel application platform (SNAP toolbox), simple ratio vegetation index (SRVI), and partial least square regression (PLSR), were investigated for their performance across biomes. Statistical measures were computed and spatiotemporal consistency pairwise comparison applied to evaluate the similarities and differences among CCC products generated by the four methods in four biomes (Temperate forest, Tropical forest, wetland, and Arctic Tundra). All the tested methods, except PLSR showed similar patterns and no significant difference in the spatial distribution in temperate forests. The CCC products obtained using the SRVI and the SNAP toolbox approach result in a systematic over/under-estimation of CCC. RTMs inversion by LUT (INFORM and PROSAIL) resulted in a non-biased, spatiotemporally consistent predictions of CCC with range closer to expectations. Therefore, the RTM inversion using LUT approaches, particularly INFORM for 'forest' and PROSAIL for 'short vegetation' ecosystems are recommended for CCC mapping from Sentinel-2 data for regional and global mapping of CCC. Further validation of the two RTMs using in situ CCC data in different terrestrial biomes is required in the future.

## Towards a Multi-Temporal Assessment of Functional Diversity in Alpine Areas Using Remote Sensing Data

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Our research aims at multi-annual monitoring of the Swiss National Park by using a suite of combined remote sensing data, consisting of high-resolution imaging spectrometer data, laser scanning data, and spaceborne optical data of the Copernicus Sentinel 2 constellation to monitor biodiversity alterations in this high alpine ecosystem. The research project observes morphological and physiological ecosystem functioning components within the national park. As such, it tries to link changes in biodiversity and productivity over a multi-annual time span. Multi-temporal maps of functional diversity from remotely sensed vegetation traits will be produced. Their interpretation will shed light on the cause-effect relation between biodiversity and climate change in a complex high alpine ecosystem for a ten-year time span. As ecosystem functioning typically shows gradual changes over longer periods, Airborne Prism Experiment (APEX) imaging spectroscopy data from 2010 to 2020, as well as LiDAR data and Copernicus Sentinel 2 data to be acquired over the study area from 2017 on will be utilized to predict ecosystem functioning changes on a multi-temporal scale.

## High resolution Land Surface Phenology: The Potential of a Global Algorithm for Biodiversity Monitoring

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Within the framework of the GlobDiversity project, we developed a globally applicable method to derive Land Surface Phenology (LSP) computed from a dense time-series of Sentinel-2 and Landsat 8 vegetation activity data. LSP characterises recurrent events in the annual profile of vegetation activity, and includes such parameters as Growing Season Length, among others. Trends in these parameters have typically been monitored for characterising ecosystem processes or studying their response to climate change. Importantly, LSP has been shown to be useful for characterising biodiversity at the ecosystem scale, and this potential is expected to be enhanced when LSP parameters are computed using high spatial resolution vegetation activity data. By using the newest generation of high spatial resolution satellite data, we narrow the gap between individual plant phenology and satellite-derived LSP. In developing a globally applicable LSP algorithm, we contribute to the development of a global biodiversity monitoring system, which will help in evaluating progress toward biodiversity targets such as those of the Convention of Biological Diversity. As such, we designed a generic workflow to derive LSP as a remote sensing enabled Essential Biodiversity Variable (RS-enabled EBV); this algorithm can be applied globally across different biomes, ranging from tropical forests to tundra. Here, we present the results of several key LSP parameters derived for different project pilot site distributed around the globe. We discuss the results in the context of local ecological, environmental and climatic conditions; for example, they include the limitations encountered and addressed when deriving LSP parameters for temperate forest, arctic tundra and so forth. Finally, we present an outlook on how these datasets complement local observations, and how they can support researchers and conservation practitioners in their efforts at biodiversity assessments and monitoring.

## A Global Map Of Species Terrestrial Habitat Types

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The loss of species habitat - described as the entirety of the physical conditions, e.g. land cover and climate - is one of the primary causes of biodiversity decline globally. Knowledge about species habitats is critical to design landscape management plans and conservation prioritizations. Here, we provide a global spatial-explicit characterization of 47 terrestrial habitat types directly relevant to biodiversity conservation. These habitat types broadly follow the standard habitat classification system defined by the International Union for Conservation of Nature (IUCN), which is widely used for assessments of species extinction risk. This habitat type map was produced by intersecting currently best available data on land-cover, climate and land use from a variety of ancillary datasets. We furthermore validate this map using independently derived estimates of observed habitats from biodiversity occurrence records. Overall, these data broaden our knowledge of habitat types globally and will be highly useful for broad-scale ecological studies and a spatial guide for upcoming IUCN redlist assessments. We hope that this data will spur further development of biodiversity-relevant habitat type maps on a global scale.

## Beirut Biomimics

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In Lebanon there has been a public health crisis due to severe damage to the natural ecosystems. In fact, the rate of cancer patients in Lebanon has increased 5.5% yearly from 2005 to 2016 and contributing factors include air pollution, waste burning and contamination of drinking and irrigation water. Our natural ecosystem's ability to withstand this harm and regenerate itself has been continuously compromised by the government's choice of technologies and policies. Basics like clean water and healthy agricultural systems are at risk in a region that is known as the "bread basket" of the Middle East. Given the urgent nature of this crisis a whole new approach is needed. What if the solutions have been right here all along but we just have not been looking for them in the right way? Nature has survived thanks to its zero waste cycle, a cycle that manages to keep everything in balance, however humanity in the last few hundred years has managed to severely damage natural ecosystems on all levels. Inspired by Greta Thunberg's call for action on the topic of climate change, millions of kids have hit the streets to protest and continue to spread her message that the leaders of today act before it is too late. At sixteen, I realized that raising awareness is not enough, our generation will have to be the solution providers. Therefore, I created Beirut Biomimics, a group focused on high school curriculum using biomimicry as a scientific methodology. Time is not something we can afford to lose and nature has 3.8 billion years of proven research and development that we can use immediately. Saving the planet means saving ourselves and biomimicry is a way to inspire leaders of tomorrow to look first to nature for sustainable solutions.

## Farmers awareness on Agrobiodiversity Conservation in Georgia

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Conservation of Agrobiodiversity and natural habitats are the most important drivers of global losses in biodiversity and associated processes. Agricultural intensification at local and landscape scales tends to make land-use systems less resilient and more vulnerable to disturbances while environmental change and climate extremes and weather constraints call for a higher adaptation capacity than ever. Agro Biodiversity loss and Genes Erosion means that ecosystem services are also endangered, affecting the functioning of managed and natural ecosystems.

Methodology: Conservation of the Agrobiodiversity in-Farm and on – Farm also within protected areas receives increasing attention, but the management of human-dominated landscapes, including forest remnants and forested land-use systems, is still a major challenge. In this regard we – Association for Farmers Rights Defense, AFRD provide our Farmers be more innovative and devoted to novel agro-ecological practices to ensure their long-term sustainability, improve the food they produce and the land that they produce it by Agricultural Biodiversity. They are also innovation driving and Agricultural co-operatives approaching the benefits if the local (traditional) knowledge transferred and mixed with modern and innovative technologies and digital technologies in order to learn from one another.

Results: Such forms of innovation may be the kinds of innovation that we need in agriculture to transform current destructive practices and maintain the capacity of conservation soils Biodiversity, to Plant and Animals Biodiversity ex-situ and in – situ conservation to continue to produce the novel food for future generations.

## How DGVMs Can Improve Model Predictions on Animal Biodiversity

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Dynamic global vegetation models (DGVMs) are taking into account most of the key drivers in an ecosystem to investigate its future pathways, such as impacts of climate change, atmospheric CO2 or land-use change. However, animal population and biodiversity are also key components to all terrestrial ecosystems, but their impact through herbivory and higher trophic levels on ecosystem carbon and nutrient cycling has not yet been comprehensively studied. Likewise, model approaches that seek to simulate changes in animal populations in response to environmental drivers are lacking process based carbon fixation and vegetation submodels as mechanistic link between plants and herbivores.

In our work, we seek to overcome these shortcommings by coupling Madingley, a model of multi-trophic functional diversity, with vegetation stock data from an advanced DGVM (LPJ-GUESS). Our goal is to explore how changes in vegetation productivity impacts heterotroph-autotroph ratios and biomass distribution across animal functional groups. In an initial step we present here the impact of an empirical based versus a process based vegetation model on functional animal diversity in Madingley. We carry out 8 simulations across a number of regions spread around the globe. These regions represent different biomes and climate conditions which will help us analyse the regional impacts on the simulated ecosystems.

In a next step we explore also how future climate change impacts on vegetation will affect animal populations and their diversity in different ecosystems. To do so, we will model vegetation stocks under the influence of climate change scenarios with LPJGUESS and couple the resulting stock data to the Madingley model. We aim to make an assessment on how sensitive the different animal functional types are to climate change related shifts in different ecosystems.

## Relative Importance Of Tree Diversity, Traits And Microenvironment In Shaping Soil Macroinvertebrates

## Community In European Forests

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Soil organisms rely on plants as they provide leaf litter and root exudates, create habitat composed of leaf litter, deadwood and herbs, and regulate the microclimate through their canopy. Plant diversity can shape soil communities and modulate their effect on processes such as decomposition. The study of these aboveground-belowground linkages is key to predict soil organism effects on ecosystem functioning, but our knowledge is still limited to grasslands and young experimental forests. As a result, studies investigating the effect of tree diversity on soil macrofauna diversity and abundance reported positive, negative or no relationship.

In this study, we sampled macroinvertebrates in forest plots composed of one or three tree species varying in species composition across four countries (Italy, Romania, Poland and Finland). We evaluated the relative importance of tree species richness, proportion of evergreen as well as litter quality, trait diversity, microhabitat type, microclimate variability, and soil quality in shaping macrofauna communities. Macrofauna communities were described at the order and trophic group level, and five groups were identified to species level. We also measured body mass, as an important trait linked to many function at the organism level.

Mixing tree species did not result in a shift of soil macrofauna community composition, but increased order diversity, richness and evenness. Evergreen dominance decreased earthworm density, and favour predators groups such as spider and centipedes by producing a thicker layer of slow-decomposable litter. Microclimate variability decreased predator species richness and diversity but had less effect on detritivores. Litter quality increased the total biomass of soil fauna, but had a negative effects on predator diversity. Detritivore diversity increased with litter quality, and to a lesser extent litter trait diversity.

The contrasted responses of soil macrofauna groups stress the complexity of trees – soil macrofauna linkages, and the need of more consideration.

## Species and Land-Cover Richness Promote Landscape-Level Functioning

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Research of the past decades has shown that biodiversity is of fundamental importance to the functioning and stability of ecosystems. However, most of this research has focused on experimental grassland communities at small spatial scales, leaving it unclear if identified biodiversity-ecosystem functioning (BEF) relationships apply under so-called “real-world” conditions found in complex natural and managed landscapes.

Therefore, we investigated diversity – functioning relationships across large scales of space, time and ecological organization in real-world landscapes in Central Europe (Switzerland). Specifically, we tested landscape-level species richness and land-cover richness effects on >15-year time series of satellite-sensed landscape functions including vegetation productivity, phenology, land surface albedo and the temporal stability of these variables. We investigated species richness effects (plants, butterflies and birds) in over 440 landscape plots 1km$^2$ in size and regularly spread across Switzerland (biodiversitymonitoring.ch). We tested land-cover richness effects using a quasi-experimental study design in 4,974 landscape plots 6.25 or 25 ha in size.

We found that species and land-cover richness were significantly related to an increased landscape-level average vegetation productivity and the inter-annual stability of productivity in the years 2000-2015 and 2000-2016, respectively. Additionally, species richness was related to an increased trend of growing season lengthening, which suggests a faster adaptation to climate warming in species-rich landscapes. Interestingly, land-cover rich landscapes exhibited higher average summer near-infrared albedo, which indicates that land-cover richness could be important for surface energy budgets and climate dynamics.

The species and land-cover richness effects we found were robust and consistent across the large environmental gradients covered by our investigation. Species and land-cover richness effects were as large or even larger than those reported from smaller scale BEF-experiments. These findings suggest that biodiversity is an important factor promoting landscape functioning and stability in the real world and at scales relevant for land management and human well-being.

## The Biodiversity Ecosystem Functioning Relationship at the Landscape Scale

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There is substantial evidence supporting the negative impacts biodiversity loss has on ecosystem functioning at the finer scales and biodiversity loss is now ranked among the top global stressors affecting species and ecosystems. However, there are still large uncertainties when predicting the direction and intensity of biodiversity loss on ecosystem functioning at the larger spatial and temporal scales, where people tend to experience and manage ecosystems. Here, we explore these questions in a real-world context looking at the role of landscape heterogeneity in a meta-ecosystem and its relationship with landscape functioning We use observational data in an experimental set up to isolate the effect of diversity alone. This implies we incorporate all flows of organisms, materials and energy between the mosaics of patches that form meta-ecosystem, which are otherwise ignored by plot-level experiments. We found a positive relationship between land cover type richness – used here as a measure of landscape heterogeneity – and remotely sensed landscape-scale productivity in Switzerland (Oehri, 2017). We pursued this study by comparing this relationship across different biomes in the EU to better understand the underlying mechanisms. Answering these questions will help move away from experiments that detail local biological processes towards understanding landscape-scale patterns, which are relevant for the management and sustainability of ecosystems, and the services they generate.

## Centre for Urban Environments

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The Centre for Urban Environments (CUE) is an interdisciplinary centre based at the University of Toronto, Canada. Our vision is to discover how to make cities healthier and more sustainable for all life. CUE's faculty, staff and students provide local and global leadership on urban environmental issues as it relates to research, education and training, community engagement and governmental policy. The poster provides an overview of some of CUE's activities and initiatives.

## The University of Zurich Research Priority Program on Global Change and Biodiversity: A bridge across disciplines, for nature and people.

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Global change refers to processes of natural and anthropogenic origin affecting biodiversity and ecosystem services, a major challenge for humankind. The University of Zurich Research Priority Program on Global Change and Biodiversity aims at understanding and predicting global change effects on and feedbacks with biodiversity, ecosystem services and human well-being across scales to address one of the main global challenges of our time: biodiversity loss. Our research explores feedback mechanisms, interactions and scale effects between biodiversity and global change drivers.
Our research program spans natural and social science disciplines working at 7 research sites: Kytalyk, Siberia; Haibei, Tibetan Plateau; Lake Zurich, Laegern, Swiss National Park, Switzerland; Danum Valley, Lambir Hills, Borneo and Aldabra Atoll, Seychelles. We use an interdisciplinary, multidimensional approach to integrate biophysical, biological and chemical changes, i.e. Earth drivers, with social, economic and political changes, i.e. World drivers. Our research projects are grouped into four thematic clusters: essential biodiversity variables, earth system processes, ecosystem services, and resource frontiers with the overlap and synergies between clusters intersecting the Earth and World drivers. We achieve such research through a network that promotes interactions between, and participation, with a range of stakeholders including local populations, companies using natural resources, academics, environmental lawyers, policy makers and educators in the research process.
Through our poster, we aim to inform on global change and biodiversity research at the University of Zurich that is increasingly focused on the multi-dimensionality of drivers affecting biodiversity and ecosystems and the feedback on global change at different scales. Our approach includes the use of novel methods ranging from theoretical to experimental, observational, and synthesis in ecology, environmental ethics, genomics, earth system science, social science, environmental science, and remote sensing.

## Implementing Green Infrastructure: Integrating Biodiversity, Connectivity, and Ecosystem Services into Landscape Planning Decisions

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The protection of terrestrial ecosystems to halt biodiversity loss is represented at the international level by Sustainable Development Goal (SDG) 15. Target 15.9 is related to Aichi Biodiversity Target 2 (CBD Secretariat, 2010), and states that by 2020, ecosystem and biodiversity values should be integrated into local and national planning, accounting, and reporting systems.

The concept of Green Infrastructure (GI) emerged in response to the need to integrate natural values in spatial planning, and is formulated as a “strategically planned network of natural and semi-natural areas” (European Commission, 2013). It promotes the multifunctional use of landscapes, and is based on principles of landscape ecology and systematic conservation planning to identify and prioritize areas of high ecological value for wildlife and people.

We have proposed an adaptable and scalable GI mapping framework, and have applied it to the canton of Geneva, Switzerland. Our approach is based on the separate evaluation of three GI ‘pillars’—biodiversity, ecological connectivity and ecosystem services—using different GIS and modelling techniques. The pillars are then integrated into the final map using spatial prioritization methods with Zonation software (Moilanen, Wilson, & Possingham, 2009).

This approach allows the attribution of different weights to selected features, which ensures that each constituent is represented according to the conservation objectives agreed upon with stakeholders. The resulting GI map indicates top priority conservation areas to optimize the preservation of biodiversity and ecosystem services, and will help local spatial planners minimize potential conflicts between environmental preservation and other land use interests.

## Morpho-structural Adaptations To Environmental Stress In Plant Species From Subalpine Habitats (Bucegi Natural Park, Romania)

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Bucegi Natural Park is situated in the South-Eastern part of the Romanian Carpathians and it hosts a great diversity of vascular plant species, many of them endemic, rare or vulnerable, included in the e Red List of Higher Plants of Romania (Oltean et al. 1994). Climate change is an additional pressure exerted on plants that live in the subalpine habitats - with consequences on biodiversity that can be dramatic. The structural and functional plasticity can represent an asset of the plant species in the struggle for survival in environments with increased levels of stress. In this work we will highlight the structural and micromorphological features of some herbaceous species that grow on the plateau of the Bucegi Mountains (in the subalpine area). Architecture of the photosynthetic apparatus and vascular system, as well as the structure of the epidermal complex (with emphasis on cuticle structure, morphology and density of trichomes) will be presented in the context of adaptation of the analysed plant species to the environmental stress. The investigations were based on methods of plant histology, histochemistry and scanning electron microscopy (SEM). The plant material was collected in June 2019, the species being at the anthesis stage.

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## The Distribution of Bird Attractiveness in Urban Areas Varies With Landscape Structure

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Understanding how landscape structure (composition and configuration) influence the distribution of species traits is key to determine the relationship between species diversity and ecosystem services in transformed landscapes. Whereas some species traits influence species responses to landscape change, others influence species contributions to specific ecosystem functions and

services. For example, evaluating the distribution species traits related to attractiveness may give insights about how urbanisation affect cultural services and people-nature interactions. Here, we investigated the impacts of landscape structure and vegetation structure on the distribution of bird species traits across different spatial scales in Brisbane, Australia. We focused on two types of species' traits: 1) traits related to species responses to landscape change: body size, dispersal ability, clutch size and specialisation degree and 2) traits related to bird attractiveness: colour pattern, call complexity and body size. We show that changes in landscape structure not only affect the distribution of response traits, but also the distribution of bird attractiveness traits. Even if at local scales vegetation structure was diverse, response trait and bird attractiveness diversity decreased if fragmentation at the landscape scale is high. When vegetation cover was low at landscape scales, the presence of small-bodied species with low dispersal capacities depended mostly on having well-connected patches. In addition, when fragmentation increased, we found a decline in the proportion of small colourful birds with a melodious call. Thus, local actions aimed at increasing species diversity that ignore landscape structure effects may favour species with "less attractive traits" that are already more adaptable to urban landscapes. This study provides new key new insights into how landscape structure affects not only species diversity, but also the potential of assemblages to connect people to nature.

## Assessment of Vegetation Dynamics in a Siberian Tundra Lowland

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Climate change is causing the Arctic to warm at a much faster rate than the rest of the planet. Arctic warming is predicted to foster shifts in species richness and plant communities. For example, expanding shrubs outcompete native lichen and moss species, resulting in decreased biodiversity and evenness of cryptogams. Warming is also increasing permafrost thaw, which triggers changes in area covered by ponds and wet sedges, resulting in strong effects on the carbon cycle through methane emissions. The lowland tundra landscape is characterized by small-scale (around meter-scale) heterogeneous patterns, and thus it is difficult to monitor and quantify vegetation dynamics with satellite data. In this study, we used high resolution (5cm) drone imagery collected from 2014-2019 to identify changes in vegetation communities and pond area in the Kytalyk Nature Reserve Northeast Siberia. Preliminary results show vegetation dynamics tightly linked to a highly dynamic surface water system. For example, *Sphagnum* species occur near water, and their abundance is linked to the variability of the surface water. This study increases our understanding of pond area dynamics and vegetation succession and effects on species and landscape diversity in the rapidly changing Arctic landscape.

## Statistical and Physical Models for Mapping Canopy Chlorophyll Content from Sentinel-2 Data

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Assessment of canopy chlorophyll content (CCC) is an essential variable in developing indicators for biodiversity monitoring and climate change studies. The Sentinel-2 Multi-Spectral Imager (MSI) is expected to improve the prediction accuracy of vegetation chlorophyll content. In this work, we assessed the performance of several statistical and physical-based methods in retrieving CCC from Sentinel-2 in Bavarian forest national park, Germany. Fourteen statistical-based methods, including 13 different vegetation indices (VIs) and a non-parametric statistical approach, and two physical-based methods such as INFORM and PROSAIL radiative transfer models (RTM) were used to assess the CCC prediction accuracy. A field data collected in July 2017, and cloud-free Sentinel-2 image acquired on 13 July 2017 were used for evaluating the performance of the methods. The leave-one-out cross-validation technique was used to compare the VIs and the non-parametric approach. Whereas physical-based methods were calibrated using simulated data and validated using the *in situ* reference dataset. The statistical-based approaches such as the modified simple ratio (mSR) vegetation index and the partial least square regression (PLSR) outperformed all other techniques. The modified simple ratio (mSR3) (665, 865) gave the lowest cross-validated RMSE of 0.21 g/m$^2$ ($R^2$ = 0.75). The PLSR resulted in the highest $R^2$ of 0.78, and slightly higher RMSE = 0.22 g/m$^2$ than mSR3. Further, the physical-based approach-INFORM inversion using look-up table resulted in an RMSE = 0.31 g/m$^2$, and $R^2$ = 0.67. Although mapping CCC using these methods revealed similar spatial distribution patterns, over and underestimation of low and high CCC values were observed mainly in the statistical approaches. Further validation using *in situ* data from different terrestrial ecosystems is imperative for both the statistical and physical-based approaches' effectiveness to quantify CCC before selecting the best operational algorithm to map CCC from Sentinel-2 for large scale mapping.

## Aquatic Heatwaves Decouple Predatory Contributions To Spatial And Temporal Stability

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Understanding the factors that drive ecological stability is a central goal of ecology. Yet stability research has primarily focused on a single or few dimensions of stability, namely temporal variability, which disregards the multiple dimensions of ecological stability including resistance, resilience, recovery rate, and spatial variability. Here, we examine the temporal and spatial stability of algae in a novel aquatic mesocosm experiment in response to artificially induced heatwaves. Our experiment was conducted in the Horonai stream of Tomakomai forest in Hokkaido, Japan; a stream in which the trophic ecology and nutrient fluxes are well understood. We expose naturally assembled communities of algae and macroinvertebrates to combinations of predator removal (extinction) and aquatic heatwaves at three levels (heatwave absent, current-day heatwave [+2.8C], or projected future heatwave [+6.1C]). Our statistically downscaled heatwave mimicked the temperatures for heatwaves in the grid square including Tomakomai forest for the years 1995-2017 (current-day heatwaves) and 2076-2096 (projected heatwaves). We found that algae were remarkably resilient to both heatwave conditions, and that extinction (removal) of the predatory fish had no clear effect on temporal stability of algae. However, when using log response ratios to quantify the contribution of the predator to functional and compositional stability, aquatic heatwaves decoupled the relationship between the spatial and temporal dimensions of stability. That is, spatial and temporal variability showed a damped relationship in terms of the contribution of the predatory fish to algal functional and compositional stability. Ultimately we reveal the contribution of top predators in the linkage between the spatial and temporal dimensions of ecological stability under a realistic climate change scenario.

## Eco-evolutionary Processes in Plant Communities: Species Diversity Influences Selection Processes within Grasslands.

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Interaction networks among species may develop over time in plant communities, making them more productive and stable. Species complementarity increases over time as shown in several biodiversity–ecosystem functioning experiments. This increase is potentially a consequence of complementary resource use or pathogen load among species. However, selection for reduced competition via increased niche differentiation, indicated by greater trait divergence, and facilitation in plants selected in experimental mixtures, suggest plant legacy may drive positive biodiversity effects. Plant–soil feedbacks have also been proposed to contribute to increasing complementarity effects. We ask whether increasing complementarity effects are driven by soil or plant legacy or the interaction between the two. Complementarity effects increased for plants with a legacy of eight years of selection in mixtures and increased in the presence of a co-evolved soil community. In contrast, plants with monoculture legacy performed best planted in monocultures and appeared to be selected for increased defense against pathogens. One of the underlying mechanisms explaining increased performance of mixture communities with mixture legacy may be increased trait differences between species indicative of selection for increased niche differentiation in mixed-species plant communities. Increased facilitative plant interactions also evolved in mixed-species communities. In conclusion, increasing biodiversity effects on plant productivity over time in biodiversity experiments can be due to the evolution of increased complementary through increased niche differentiation and increased facilitation.These results demonstrate that species diversity can influence selection processes within plant communities. Plant individuals within monoculture and mixture communities may be sent on different evolutionary trajectories over time through coadaptation to selection processes occurring within such communities. Our results suggest that older communities may be more stable and have higher productivity than newer communities of similar species composition, with consequences for ecosystem restoration.

## Uncertainty Estimation In A Food Web Model Predictions

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Knowing the food web structure is crucial in understanding its dynamics and response to environmental changes. Hence, models have been used to predict the structure. Most of the studies only look at single model predictions. However, to make predictions more realistic it is important to estimate uncertainty in the model prediction as well. Hence, we use network model selection and parameterisation via approximate Bayesian computation (ABC) to estimate the uncertainty. We have implemented the rejection algorithm in ABC to parameterise a food web model which is Allometric Diet Breadth Model (ADBM). Along with the model parameters, ABC also quantifies the underlying uncertainties (distributions).

## Unifying the Concepts of Stability and Resilience in Ecology

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Characterizing how ecosystems are responding to rapid environmental change has become a major focus of ecological research. The empirical study of ecological stability, which aims to quantify these ecosystem responses, is therefore more relevant than ever. However, since first being introduced in the context of ecological research in the 1950s, a growing number of definitions and measures of stability have been proposed. While several studies have already attempted to unify the concept of stability, this plurality remains a major cause of confusion and an impediment to synthesis. Given the immediacy of the threat posed by global change and the recent upsurge of conceptual papers, there is an urgent need to resolve this ambiguity.

In addition to the multitude of synonyms and definitions that have been proposed to characterize stability, we argue that there is another cause at the root of this confusion that has so far been largely overlooked. Historically, two main movements relating to the study of the stability of ecological systems can be distinguished. Based on a historical review and a bibliometric analysis of the conceptual and intellectual structure of the literature on ecological stability, we demonstrate the segregation of the scientific work on stability and resilience. Although both dealing with systems under changing conditions, the two fields of research have largely progressed in parallel with little overlap. This limited integration hampered the exchange of ideas and resulted in a separated literature and research lexicon.

We reconcile existing concepts of stability and resilience in ecology into a unified field of ecological stability. The framework integrates the partial focus of both views and takes into account all facets of the behavior of systems exposed to changing conditions. In addition, we propose standardized, operational metrics to quantify the multifaceted concept of ecological stability, thereby paving the way for future research.

## Species Interactions and the Resilience of Aquatic Ecosystems to Eutrophication

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It is a major challenge to understand the determinants of ecosystem functioning and stability in the face of disturbance. Shallow freshwater ponds provide a model system to study how species interactions among key species can mitigate ecosystem responses to eutrophication. We manipulated experimental ponds to test how two key species (a macrophyte and a mussel) affected ecosystem stability in response to nutrient additions. Individually, each species tended to increase rates of recovery from disturbance, but together the species reversed these effects, particularly with larger nutrient additions. This reduced rate of recovery was mediated by high cyanobacterial dominance of the community, and associated with reductions in trait evenness in the phytoplankton community. Our work highlights the important role of key species and their interactive effects in determining responses of ecosystem functioning to disturbance.

## Diversity Of Soil Bacterial Communities Across The Complex Landscape Of Switzerland

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Soil bacterial communities play important roles in soil functions such as nutrient cycling and as a consequence food and biomass production. To date, limited information on effects of human impacts and climate change on bacterial communities is available. In order to monitor changes in bacterial communities it is vital to assess their overall richness, distribution, frequency and habitat preferences. These questions were the aim of our study, in which soil bacterial communities were assessed in the regular sampling

grid of the Biodiversity Monitoring (BDM) across Switzerland. The sampling included 255 sites of which bacterial communities were assessed using metabarcoding of the 16S marker gene. Also, 23 soil physico-chemical, geographic and climatic factors as well as land-use types and biogeographic regions were determined. In total, 48,568 bacterial taxa belonging to 52 different phyla were detected. Bacterial communities differed significantly among land-use types, i.e., forest, grassland and arable land as well as biogeographic region, i.e., the Jura mountains, the Central Plateau, the Northern Alps, the Central Alps and the Southern Alps. The strongest factors explaining variation in bacterial communities was pH ($R^2$ = 29%), followed by an indicator for nutrients, altitude and clay content. In total, 2,494 bacterial taxa were significantly associated to one or more of the considered factors. In this study, it was shown that bacterial communities have very specific biogeographic distribution patterns and are shaped by environmental factors.

## Soil Biodiversity For The Future! - But How To Manage The Billions Living Belowground?

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Soil biodiversity is hugely important, both due to its role in ecosystem functioning *in situ*, but also as a source of bioremediation and medicinal potential to society. Many studies now started to document the 'who is there' (taxonomic diversity) and even the 'what can they do' (functional diversity) of soil biodiversity. However, it is still unknown how to manage and use this belowground diversity to our service.

In this contribution, I will explore newly arising methods to manage entire soil microbiomes. In the soil, thousands of microbes co-exist through a manifold of competitive, predatory, symbiotic and more types of interactions. Due to this intricate web of interactions, strains of beneficial bacteria introduced by humans often fail to persist and deliver their intended function for long in real (agro)ecosystems: they suffer the consequences of laboratory domestication. This is a key limitation on many efforts for nature restoration as well as sustainable management of agricultural soils.

Drawing on a range of lab and field experiments, I will show how diversity in inoculants is key for long-term and effective management outcomes. Next, I will highlight the potential, though yet unrealized, value of host-mediated selection procedures to engineer soil microbiomes for ecosystem functioning. Finally, I will argue the need for ex-situ conservation of intact soil microbiomes for future research and functions to society. This needs to start with a thorough assessment of where this potential resides (biogeography, season, and habitat). Overall I will argue that in order to effectively manage our ecosystems we need to integrally manage whole soil microbiomes, and the plants they associate with, for optimal ecosystem functioning.

## Observing and Forecasting Macroecological Change in Seed Dispersal Networks

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Seed dispersal is the most widespread mutualistic function provided by vertebrates, and animal-mediated seed dispersal is the mechanism that roughly half of plant species have to move. The seed dispersal mutualism shapes biodiversity from local to global scales and will determine whether plants keep pace with climate change. Observing how seed dispersal networks have changed, and predicting how networks will reassemble, is therefore critical to understand the fate of biodiversity and ecosystem services in future terrestrial ecosystems. We report on data syntheses aimed at gaining a macroecological understanding of recent change in seed dispersal networks and of the processes that assemble networks. Using literature data from 410 spatially or temporally distinct networks involving approximately 5,000 animal and plant species and 24,000 unique pairwise interactions, we determined the native or introduced status of species and phylogenetically imputed traits using global trait databases. First, we found that introduced species have significantly altered biogeography within the global meta-network that is comprised of interactions observed at any study location. Over the past 75 years, the prevalence of introduced interactions has increased seven-fold, and introduced interactions are on average eight times higher in the most versus least human-impacted environments. Second, we found that interactions are largely predictable at the global scale based on functional traits and abundance proxies. To test our ability to predict novel interactions, we developed machine learning models using data on interactions only with native species and then predicted interactions involving introduced taxa, achieving roughly 90% predictive accuracy. This work shows that, although monitoring of species interactions lags far behind species-level monitoring, the synthesis of interaction, phylogenetic, and trait data can offer macroecological insights into the seed dispersal mutualism and its feedbacks with biodiversity patterns at global scales.

## Farmers Don't Feel Alone: Perception Of Animals As Natural Enemies Of Pests In Cider Apple Orchards

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The relevance of biological control for crop production has been proved in scientific research; however its promotion is still insufficient in farming practices. To promote biological control it is essential to study how farmers perceive natural enemies in their farmlands. Few studies link natural enemies and biological control with social perceptions and local ecological knowledge. In this study, we examined farmers' perceptions regarding pest biological control and the organisms underpinning its provision in Asturian cider-apple orchards (N Spain). By conducting face-to-face questionnaires, we found that farmers know the importance of biological control and differently perceive how organisms provide this ecosystem service. Farmers perceived that birds, such as buzzard, robin and tit, are the most important providers of biological control, whereas arachnids and insects (excluding ladybug) were less perceived as natural enemies. In addition, we found that farmers recognized the interactions between natural enemies and pests, although they have some misconceptions and knowledge gaps. This complex knowledge about the perceived interactions also was connected to the natural enemies' importance given by farmers. All these perceptions of natural enemies as providers of biological control depended on previous local ecological knowledge, but also can be modulated by formal knowledge. Our results give insights for future management of cider-apple orchards in order to preserve natural enemies and foster biological control. Farmers could become agro-biodiversity steward and sponsor in redressing multiple aspects of current agricultural model and associated biodiversity.

## Beyond plants: Combining Remote Sensing, Tracking And Monitoring Techniques To Assess Biodiversity And Ecosystem functions Across Multiple Trophic Levels

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All life on Earth is embedded in complex resource networks, which are at risk with ongoing biodiversity loss. To keep track of Earth's biological status, various monitoring techniques are applied, ranging from ground-based methods like traditional field assessments to sophisticated air-based methods like Lidar, which in combination allow assessing plant diversity and vegetation structure at unprecedented resolution. To understand how changes in one trophic level like plants connect to other higher levels like herbivores and their predators, it is essential, though, to combine such methods in order to investigate the mechanisms underlying indirect biodiversity loss across trophic levels.

We here demonstrate how remote sensing data can effectively be combined with ground-based monitoring methods and latest animal tracking techniques to investigate anthropogenic influences on biodiversity across multiple trophic levels simultaneously. Our real-life model system comprises multiple aerial-hunting insectivorous bats and birds that co-occur and compete for food resources in a dynamic agricultural landscape in NW-Germany. These are tracked using the recently installed ATLAS Wildlife Localization System, which allows tracking large numbers of moving individuals locally at high spatial and temporal resolution employing ultra-light radio tags. Additionally, prey availability is monitored by insect trapping and drone sampling, primary producers by remote sensing and traditional field monitoring.

First results highlight that the composition and configuration of the landscape, including the distribution of plants and insects at lower trophic levels, influence the behaviour of animals at higher trophic levels with likely consequences on population and community dynamics. We further present remaining challenges in "remote sensing" of higher trophic levels, and future applications combining traditional methods, remote sensing and real-time animal tracking that could be investigated integrating latest remote sensing in our model system in the future.

## Assessing Biodiversity from Space: Functional Diversity Across Spatial Scales and Optical Sensors

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The increasing need for continuous global information on the biodiversity of Earth's vegetation calls for new approaches to exploit the potential of existing satellite time-series. Mapping functional diversity from space will provide opportunity to quantify biodiversity, ecosystem functioning and the effects of environmental changes. We adapted and tested methods to map functional diversity based on airborne imaging spectroscopy (APEX) in a temperate forest ecosystem and transferred these to spaceborne multispectral satellites (Sentinel-2). We selected four physiological traits related to forest health, stress, and potential productivity, namely chlorophyll, anthocyanin, carotenoid, and water content. We selected and applied corresponding indices to Sentinel-2 and APEX data, namely $CI_{red\text{-}edge}$, RGR, PSRI, and NDII and reproduced observations from APEX-based studies at the spectral resolution of Sentinel-2. Based on spatial scaling analysis we observed changes in two functional diversity metrics, namely richness, and divergence. Both only allow for qualitative comparisons across different spatial resolutions, as the difference in the size and number of pixels at the same unit size result in altered values of richness and divergence. However, the diversity-area relationship can still be compared. Furthermore, at coarser spatial resolution, mixed pixel effects (e.g. at forest borders) cause an increase in richness and a decrease in divergence. When comparing resampled APEX data and Sentinel-2 data, effects due to differences in solar angle and sensor specifications are visible as well. Approaches to increase the comparability (e.g. correction of solar angle) will further improve the interpretation of the datasets. The goal of this study is to quantify the change in retrievable information when upscaling from an airborne to a spaceborne platform. This will allow effective assessment of functional biodiversity from space exploiting the full potential of existing multispectral satellites. The next steps include analysis of the approach at larger scales, in different ecosystems and throughout the phenological year.

## Are Spectral Indices Only Reflecting Leaf Chlorophyll?

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Leaf chlorophyll was selected as an essential plant trait to characterize *habitat structure* (GEOBON.org). Today's technologies offer optical sensors with better resolution than few years ago, holding promise for improved monitoring of plant traits. However, the quality of the information retrieved from leaf reflectance spectra depends on the calibration. Unlike sensors, calibrated in-situ leaf content measurements do not benefit from the recent advances in analytical chemistry.

Standard analytical methods allow to determine leaf bulk chlorophyll content, but do not differentiate between individual pigments. We developed a new analytical method to describe leaf pigment composition in unprecedented detail and assess the contribution of so far ignored pigment derivatives to leaf optical properties.

We sampled leaves of a mature beech tree (*Fagus sylvatica*) located on the University of Zurich campus between May and November 2018. Published and calibrated indices for chlorophyll retrieval were applied to leaf spectra measured in-situ with a contact probe coupled with a field spectrometer. Pigment composition was characterized with both, standard and newly developed high pressure liquid chromatography methods. We compared the sensitivity of the methods using statistical approaches.

In comparison with the standard method, the new method allows us to extract 3.5 times more pigment derivatives. Interestingly, the contribution of pigment derivatives to the bulk chlorophyll signal was higher in spring and autumn (up to 9%) than in summer (1-2%) when leaves reached their full extend. Decreasing performance of published spectral indexes in spring and autumn can be partially explained by the contribution of pigment derivatives which are not considered during in-situ calibration. Additionally the full pigment composition allows identifying leaf composition heterogeneities within a single tree. We argue that our new method can increase the quality of pigment retrieval and hence optimal trait estimates. This will enable us to better monitor plant-environment response with optical sensors.

## Better Representation of the Stomatal Conductance Scheme and its Impact on Pan-Arctic Warming and Greening

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Opening and closing of stomatal pores in terrestrial plants are a key control of both photosynthetic $CO_2$ uptake and transpirational loss of water by land ecosystems. Their accurate modelling in response to variation in atmospheric conditions is important because it controls global water and carbon cycle even energy balance on the land surface. However, it is reported that simulations of transpiration by the Earth System Models (ESMs) are significantly diverse and it seems that leading uncertainty factor in future climate projections especially in terms of climate–carbon feedback. The current ESMs make use of the coupled photosynthesis-stomatal conductance models to determine the transpiration flux and gross primary productivity based on an empirical model, but

the most ESMs are composed of parameterization for constants of empirical stomatal conductance model to only distinguish $C_3$ and $C_4$ plants. In recent studies, these constants are observed based on in-situ flux towers with various values depending on Plant Function Type (PFT) such as needleleaf, broadleaf tree, arctic (cold) grass, and shrub. Here, we modified the stomatal conductance scheme based on observed constant in the Community Land Model (CLM) 4.5 as a part of the Community Earth System Model (CESM). Especially, transpiration in boreal needleleaf forest is significantly reduced by modification of stomatal conductance scheme and it directly leads temperature increase by reduced latent heat and increased sensible heat flux between land and atmosphere in the AMIP run. As a result, leaf area index (LAI) has significant increasing trend during recent 30 years in modified simulation, while the control simulation does not show increasing trend of surface temperature and LAI which is observed in pan-Arctic.

## Comparison Between Individual Tree-based And Pixel-based Functional Diversity Monitoring Of Forests

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Functional diversity (FD) is a key aspect of biodiversity, which summarizes inter- and intra-specific variations of functional traits and provides a direct link between biodiversity and ecosystem functioning. However, the spatial and temporal scales of forest functional traits and functional diversity remain largely unclear due to the complexity and costs of traditional field measurements. Remote sensing provides a consistent and efficient way to monitor traits and FD across large areas at different spatial units, typically in the form of pixels or, more recently, individual tree crowns (ITC). However, few studies compared ITC-based methods to pixel-based methods, which is important to better integrate remote sensing approaches with traditional (often tree based) ecological monitoring and to increase our understanding of the potentials and challenges of remote sensing to address related ecological questions at different scales.

We implemented two different methods to estimate FD of forests based on morphological and physiological traits of individuals and pixels from airborne LiDAR and imaging spectroscopy. After that, we compared the variability of traits at individual-level and pixel-level in terms of trait distribution (e.g. histogram). In addition, we compared the scale dependency of ITC-based and pixel-based functional diversity. Finally, we explored the correlation and difference of spatial patterns of the ITC-based and pixel-based functional diversity. We found significant differences in some traits distributions at individual tree level and pixel level, although the spatial patterns of FD for these two methods are similar. ITC-based functional richness generally has higher value than the pixel-based results, and the slope is steeper at small scales, which indicates that increased within-community diversity could be better described by the ITC-based method considering the variability between individuals.

## Genetic Structure of Fagus sylvatica Derived from Multi-annual and Multi-seasonal Airborne Spectroscopy

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Declining genetic variation within species is a key factor in biodiversity loss. Reduction of the genetic variability of a population increases its susceptibility to diseases, limits its evolutionary potential and may lead to inbreeding depression. Therefore, maintaining genetically variable populations is important for preventing species loss under changing environmental conditions. Assessment of genetic variation is commonly based on allele frequencies measurements limited by spatial extent and continuity of sampling. A promising alternative is offered by imaging spectroscopy from remote-sensing platforms. Each genetically distinct individual plant has a spectral fingerprint resulting from its particular leaf – light interaction. We used the patterns of seasonal and annual variation of this interaction to obtain such fingerprints of *Fagus sylvatica* individuals at a forest site in Switzerland. We show that repeated-time airborne spectroscopy data holds the potential to assess the genetic structure of the studied *F. sylvatica* population.

We used the imaging spectrometer APEX (Airborne Prism Experiment) to obtain a data set consisting of ten yearly images from 2009 – 2019 and nine seasonal images from 2009 for the study area (Laegern, 47°28'N, 8°21'E). We compared this data set with a genetic data set consisting of microsatellite data of 77 dominant *F. sylvatica* individuals from the site. We constructed distance matrices between individuals based on multi-annual, multi-seasonal and single-time spectral fingerprints and based on microsatellite information. We expected higher correlations between microsatellite distances and spectral distances when the latter were derived from multi-temporal than from single-time spectral data. Additionally, we expected a stronger correlation with seasonal than with annual data because the former capture phenology-specific physiological processes with genetic constrains. Based on investigated hypothesis, we will present and discuss the potential of repeated-time airborne imaging spectroscopy to assess the genetic structure of tree species at the landscape level.

## Identifying Nesting Habitats of the Critically Endangered Siberian Crane in a Changing Arctic

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Siberian cranes are critically endangered with only 3500-4000 individuals remaining in the wild. The majority of the population breeds in eastern Yakutia, Siberia every summer before migrating about 5000 km to eastern China. Siberian cranes are one of only two crane species in the Arctic, and have a significant cultural relevance to local people in the wintering and breeding regions. Habitats in the Arctic tundra are changing rapidly due to increasing temperatures and rainfall from global climate change. Therefore, it is important to understand Siberian crane nesting habitat preferences and identify where this habitat is available. We used locations of Siberian crane nesting sites in conjunction with biodiversity variables derived from remotely sensed data including land cover, topography, snowfall, land surface phenology, and surface water features to identify spatio-temporal correlates of preferred breeding sites. Based on vegetation types, visibility and climate factors, and distance to lakes and rivers, we developed a breeding habitat suitability model across the core breeding areas in eastern Siberia. The final nesting habitat map will be shared with local stakeholders and nature conservation organizations to identify areas for future protection. As climate change dynamics affect lakes and landscapes, Siberian crane breeding success can decrease, and thus this map will help us to monitor their vital habitat and support population predictions of this critically endangered species.

## Linking Modelled Species Distributions and Abundances to Local Population Processes in Greenland Shrub Communities

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A critical component of Arctic ecosystem functioning in a changing world is an improved understanding of what processes drive shrub communities, and how they respond to ongoing climate change. The most common approach to predicting how species ranges and ecological functions will shift with climate change is to construct distribution and abundance models. Another forecasting approach is to analyze the relationship between past growth and climate, and project this relationship across the landscape with future climate scenarios. However, it is unclear to what extent these predictions match local scale processes, such as growth and abundance, and which forecasting tool is best. Given the increasing and wide-spread use of these forecasting tools, it is therefore crucial to gain an improved understanding of their predictive power on local scale processes to project changes with greater confidence. We focus on Greenlandic shrub communities to examine how well modelled abundance, or magnitude of past climate change, better predict past growth and current abundance. Utilizing extensive field-based and digitalized occurrence data, we construct spatial distribution and abundance models for two woody species (Salix glauca, Betula nana) in Greenland. In a further step, we quantify the magnitude of climatic changes over the last 30 years using downscaled data from a global climatology dataset. Using an extensive dataset of shrub growth (i.e. growth rings) and abundance (i.e. % cover) across elevational gradients, we assess if spatial abundance models or magnitude of past climate change can better predict local population processes. In a final step, we project future shrub distribution, growth, and abundance with different climate change scenarios. An increased understanding of how spatial population model output and climatic changes match local processes will increase prediction accuracy of ecological responses to climate change.

## TRAIN – The Tundra Rain Experiment to Test Effects of Drought and Extreme Precipitation on Surface Energy Fluxes and Vegetation in the Arctic

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The Arctic is undergoing amplified climate change, and forecasts predict a future increase in warming and precipitation. How changes in temperature and precipitation impact the partitioning of the Arctic land surface energy budget and vegetation diversity is not clear, despite the importance of these factors for many earth system processes.

Changes in summer precipitation might significantly alter the potential carbon sink of the tundra ecosystem, particularly through influencing soil moisture and the subsequent changes in active layer thickness, nutrient availability, and plant growth strategies. Previous studies have shown Arctic shrub growth to be sensitive to soil moisture.

We set up a precipitation manipulation experiment simulating both future drought and extreme precipitation scenarios to test effects of changing summer precipitation on the partitioning of the surface energy budget and ecosystem properties, such as plant diversity and functional traits, of tundra vegetation. We constructed 30 precipitation shelters (10 control, 10 drought, and 10 extreme precipitation treatment shelters) across two study sites that harbor different tundra vegetation types – a ridge site dominated by mosses, lichens, and dwarf shrubs and a dried lakebed site dominated by wet sedge vegetation. The experiment was set up at the Kytalyk nature reserve in northeast Siberia (70.83° N, 147.49° E) in the summer of 2019 and will continue for at least two additional summer growing seasons where we will assess energy fluxes, plant community diversity, and plant functional traits for all precipitation treatments.

With our results on energy fluxes, community composition, and plant strategies under changing summer precipitation regimes, we expect to inform mechanistic and statistical modelling of species distribution, ecosystem functions, and feedbacks with climate in the Arctic tundra.

## Applying the Nature Futures Framework for Urban Areas in the Brazilian Atlantic Forest

**Andressa Vianna Mansur[1], Sheina Koffler[2], Pedro H. Albuquerque Sena[3], Caroline Picharillo[4], Cecilia Cronemberger[5], Rafael Cavalcanti Lembi[6], Jéssica Francine Felappi[7], Alice Ramos de Moraes[6], Jessie Pereira dos Santos[6], Adnan Arshad[8]**
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Despite challenging, considering distinct worldviews is essential to conciliate nature conservation, development, provision of ecosystem services, and human well-being. In such context, the Nature Futures Framework (NFF) was recently proposed by IPBES as a strategy to recognize different perspectives of nature and better inform decision-making at multiple scales, being a powerful tool for policy planning. Here we applied the NFF to the context of the Brazilian Atlantic Forest, a biodiversity hotspot which is predicted to be increasingly affected by urban growth in the next decades. Based on the Driver-Pressure-State-Impact-Response (DPSIR) framework, we presented a conceptual model to elicit and discuss the consequences of urban growth. For each NFF perspective, we estimated how drivers and pressures could impact different values: (i) Nature for Society - climate regulation, water supply, and physical and psychological experiences; (ii) Nature for Nature - connectivity, species diversity, and water quantity and quality; and (iii) Nature as Culture - people's connection to nature and supporting identities. We then proposed three positive scenarios that may be used by policymakers to plan desirable futures for cities in this biome. We discussed the impact of distinct policies on these values, identifying how the management of urban green and blue spaces inside cities, natural ecosystems, and urban density can lead to different social-ecological outcomes. Applying the NFF allowed a better understanding of the complex relationships between people and nature, as well as trade-offs and synergies regarding distinct policies for urban growth. This integrative approach could be used for better planning and problem-solving of future challenges on urban sustainability in the Brazilian Atlantic Forest, as well as in other areas in the Global South also facing accelerated urban expansion.

## IPBES goes FAIR!

**Rainer M. Krug[1], Aidin Niamir[2], Benedikt D. Aboki Omare[3]**
[1]University of Zurich, Zürich, Switzerland; [2]Senckenberg Biodiversity and Climate Research Institute, Frankfurt, Germany; [3]IPBES Secretariat, Bonn, Germany; Rainer.Krug@uzh.ch

The Multidisciplinary Expert Panel and the Bureau of the Intergovernmental Science-Policy Platform on Biodiversity and

Ecosystem Services (IPBES), at their 13th meeting in January 2020, has approved the IPBES data management policy.

This is an important step for IPBES to further improve the accessibility of its products and the transparency of the underlying procedures. The IPBES data management policy is based on the principles of Open Science and FAIR data. It provides a framework to make the products (e.g. statements, maps, and tables) traceable from the original data layers, through the processing steps, and up to the final status in the product. The IPBES data management policy also provides guidelines on long-term repositories, metadata, and file formats. Management, handling, and delivery of the materials from the indigenous people and local communities are also covered by the policy. The IPBES data management policy will pave the road towards reproducible assessments over time and scalable at the national or regional scale.

In this contribution, we aim to inform the community with the highlights of the policy and to present an outlook of projects emerging from the implementation of the policy.

Here is the link to the IPBES data management policy: https://doi.org/10.5281/zenodo.3551078

## The Thermal Acclimation Potential of The Southern Long-toed Salamander In The Face of Climate Change

**Sofia Duarte Vámos[1,2], Regina Spranger[1], Barry Sinervo[1]**

[1]University of California Santa Cruz; [2]University of Zurich, Switzerland; sofia.duartevamos@uzh.ch

A rapidly changing climate can alter an ecosystem's composition and may pose a serious threat to the survival of its populations. Ectotherms rely on their environment to perform their daily activities and maintain body temperature. The ability of an ectotherm to properly thermoregulate can thus be critical for its survival, as it supports the animal's capability to flee from predators, capture prey and mate or produce offspring. Amphibians are perhaps the most vulnerable group of vertebrates to climate change due to complex life histories and sensitive skin. Ambystomatidae is a family of salamanders which contains the Southern long-toed salamander subspecies (*Ambystoma macrodactylum sigillatum*). Because this species is found throughout different climates and elevations, they may show great plasticity for adaptation. This study aimed at answering questions regarding the thermal adaptive potential in *A. macrodactylum sigillatum* across both larval and metamorphosed life stages. We measured thermal preference using circular tracks to create a temperature gradient and their fitness by assessing their thermal performance through sprint speed. Metamorphosed animals had growth measurements taken every other week in order to investigate if temperature affects growth. We found that individuals tend to grow smaller with increasing temperatures. Sprint speed results showed that although many groups showed significant faster speeds in warmer temperatures, few were actually able to acclimate. Temperature preference trials showed that larval stages show inverse acclimation, while metamorphosed individuals showed a positive trend for acclimation. Individuals will be differently fit according to what temperature they are raised in. When they express the ability to perform well or better in warmer temperatures, their fitness is also shifted. As a highly endangered group and good ecosystem health indicator, understanding their acclimation responses to warming temperatures can help us predict their extinction risks.

## Threatened Arctic Vegetation Types: Conservation In The Face Of Climate Change

**Merin Reji Chacko[1], Ariane Goerens[1], Gabriela Schaepman-Strub[1,2]**

[1]University of Zurich, Department of Evolutionary Biology and Environmental Studies; [2]University Research Priority Programme Global Change and Biodiversity; merinreji.chacko@uzh.ch

Climate warming has led to significant shifts in the composition and distribution of Arctic vegetation. These changes may not only threaten endemic plant species but also whole endemic plant species communities — i.e. vegetation types, which are critical habitats for many endangered insect and animal species and affect the climate through the short-wave energy budget. The currently existing placements of protected areas have been the result of a focus on the conservation of single species, which may be insufficient to protect the vegetation types on which these species depend. Despite the significant role that vegetation types play in the Arctic, an understanding of the effects of climate change on present and future Arctic vegetation types and their protection status is lacking. Here, we study the present and future distributions of vegetation types in the Arctic by intersecting the Map of Arctic Protected Areas with the Circumpolar Arctic Vegetation Map, as well as the maps of vegetation distribution predictions for 2050 by Pearson et al. (2013). In general, the abundance of a vegetation type within protected areas increased with its abundance across the Arctic, therefore the least threatened vegetation types were most prominent within protected areas. Furthermore, we applied a subset of the IUCN Red List of Ecosystems criteria to evaluate the vulnerability of Arctic vegetation types. We demonstrate that five out of the eight assessed vegetation types will be threatened or critically threatened by 2050. For these threatened vegetation types, we located refugia, which are scattered principally across the northernmost edges of Canada, Greenland, Norway, Russian and the USA. This study establishes the current and potential future state of vegetation type distributions in the Arctic, provides insight into a management approach that shifts the focus from single species to whole vegetation types, and advocates for potential locations for future conservation.

## Environmental Drivers of Mangrove Biodiversity and Structure on Aldabra Atoll, a UNESCO World Heritage Site.

**Annabelle Constance[1], Nancy Bunbury[2], Gabriela Schaepman-Strub[1]**

[1]University of Zurich, Switzerland; [2]Seychelles Islands Foundation, Seychelles; annabelle.constance@ieu.uzh.ch

Mangrove trees form important transitional, intertidal forests in tropical coastal regions around the world. They are vulnerable to climate change stressors, such as sea level rise, which might push mangroves beyond their thresholds of tolerance. Because of the values of, and threats to, mangroves, description of forest composition and structure in relation to their habitat are needed to monitor status and trends in mangrove vulnerability. In this research, we investigate how local environmental factors impact the habitat structure of tide-dominated mangrove forests (1720 ha) on Aldabra Atoll, a UNESCO World Heritage Site in the Seychelles, using field survey data and drone imagery. The field survey covered 54 plots of 25m$^2$ spread across two of the largest mangrove forests on the atoll (480 ha). Measurements were made on adult trees (species identification, diameter at breast height, total height) and seedlings (species identification, density, survival, growth rate). The water level, soil nutrients and elemental concentrations, salinity fluctuations experienced by the mangroves are being recorded using established methods. Preliminary results indicate a high mangrove species richness of seven species on Aldabra Atoll when compared to the east African region. Three mangrove species are more common; the most important (considering frequency, density and dominance) were *Rhizophora mucronata*, *Ceriops tagal* and *Avicennia marina*. The tallest mangrove tree recorded was 8.10 m and the largest had a stem diameter of 47.4 cm (*A. marina*). The seedling density in the stand was 12,308 stems/ha indicating a high regeneration rate and recruitment. We expect that soil salinity fluctuations will have a strong control on mangrove forest functional and compositional diversity. The results of this study will help us to establish a baseline on mangrove responses to environmental stress in exposed tide-dominated mangrove forests and apply that concept to mangrove management

# Plenary 4: Plenary Session 4

*Time:* Tuesday, 25/Feb/2020: 2:15pm - 3:45pm · *Location:* Davos (2/3)

## Lenore Fahrig, Carleton University

## Odette Curtis, Renosterveld Conservation Trust

**2:15pm - 3:00pm**

### Small Spaces pack a big Punch for Biodiversity

**Lenore Fahrig**

Carleton University, Canada; Lenore.Fahrig@carleton.ca

Around the world, efforts to conserve biodiversity focus on preservation of large blocks of continuous habitat, such as large forests or large wetlands. Small patches of habitat usually have very little if any protection. My research shows that the combined biodiversity value of many small patches is as high as or higher than the biodiversity value of a few large patches of the same total area, whether in forested, urban, or agricultural landscapes. To effectively conserve biodiversity we need to extend protection to all habitat, including the small spaces.

**3:00pm - 3:45pm**

### Renosterveld under Siege: Securing and Managing one of the World's most threatened Ecosystems

**Odette Curtis-Scott**[1,2]

[1]Overberg Renosterveld Conservation Trust, South Africa; [2]University of Cape Town; info@overbergrenosterveld.org.za

On the southernmost region of South Africa lies one of the World's most threatened, least conserved and ecologically diverse Mediterranean ecosystems: Renosterveld. This easily-overlooked habitat forms part of the Cape Floristic Region (CRF), which is better known for its showy Fynbos habitats and less so for its superficially less interesting Renosterveld. Nonetheless, Renosterveld is renowned amongst local botanists for its extraordinary diversity, albeit the less showy kind: It is considered the richest geophyte habitat on Earth and diversity indices rival those of its Fynbos counterparts. These habitats also have the misfortune of being some of the most fertile within the CFR, thus have suffered extremely high levels of habitat loss and fragmentation, with an estimated 5% remaining in the lowlands of the Overberg. The scattered islands now exist in a matrix of monoculture, all on privately-owned, commercial farmland, where additional pressures such as pesticide drift, overgrazing, inappropriate fire management and continued unlawful ploughing work in tandem to exacerbate the impacts of fragmentation. This brings into question the severity of potential extinction debts and the potential for sufficient mitigation action to halt the functional extinction of this unique ecosystem.

The Overberg Renosterveld Conservation Trust (ORCT) is pioneering a landscape-level approach to the plight of Renosterveld in the Overberg. This essentially rests on the establishment of partnerships with landowners which take the form of voluntary 'conservation easements' or servitudes attached to the title deeds of the properties. In return the ORCT generates an Integrated Management Plan for the property and then assists with the implementation of priority management interventions (both financially and strategically). I present the outcomes of this approach and explore the impacts and constraints of the programme. Furthermore, I discuss the usefulness of the argument for preserving 'ecological infrastructure' in an environment that is 95% transformed and discuss other 'values' that are equally powerful in bringing about the paradigm mind-shifts that are required to halt this extinction spiral.

# 185S: The role of biodiversity in multi-functional landscapes

*Time:* Tuesday, 25/Feb/2020: 4:15pm - 6:15pm · *Location:* Dischma
*Session Chair:* Margot Neyret, Senckenberg Biodiversity and Climate Research Centre, Germany
*Session Chair:* Peter Manning, Senckenberg Research Institute and Natural History Museum - Frankfurt Am Main, Germany

Talks will be followed by 30 minutes in-depth discussion.

While there is considerable evidence that biodiverse ecosystems are required to provide multiple ecosystem functions and related services at small scales, the role of biodiversity in delivering landscape scale multifunctionality is poorly understood. This prevents clear estimates of the importance of biodiversity at this scale, at which multifunctionality is desired and most management actions are performed.

In this session we will present research which upscales the biodiversity-ecosystem functioning relationship and/or takes a mechanistic approach to understanding the drivers of landscape scale ecosystem services and multifunctionality. The aim of the session is to stimulate discussion regarding the best way to evaluate the role of biodiversity at large scales and mechanistically incorporate biodiversity into landscape scale ecosystem service assessment and management.

**4:15pm - 4:30pm**

## Consequences Of Biotic Homogenization For The Multifunctionality Of Landscapes

**Fons van der Plas**
Leipzig University, Germany; fonsvanderplas@gmail.com

Larger scale biodiversity loss results from either local biodiversity loss (known as alpha-diversity loss), or from increased compositional similarity among the different patches that form a landscape (known as beta-diversity loss or biotic homogenization). Compared to the consequences of alpha diversity loss, the consequences of beta-diversity loss for ecosystem functioning are hardly understood. This currently leads to great uncertainties regarding the importance of large scale biodiversity for landscape-scale functioning.

Here, I present three research lines aiming to fill this gap. First, theoretical Lotka Volterra models are developed to show how beta-diversity relates to ecosystem functioning under different scenarios of land use heterogeneity and habitat isolation. This shows that effects of beta-diversity on landscape functioning are either neutral or positive, with positive effects strongest in heterogeneous landscapes consisting of connected patches. Despite this, in some cases negative, albeit non-causal, correlations between beta-diversity and ecosystem functioning can occur.

Second, I show how beta diversity of tree communities promotes the multifunctionality of European forest landscapes. This happens both to additive processes, whereby different ecosystem functions are promoted in stands dominated by different tree species, but also due to non-additive processes, whereby forest functioning in stands surrounded by other stands with different tree species is higher than functioning in stands surrounded by plots with similar compositions.

Third, I present first results of a new grassland experiment, in which both plant alpha and beta diversity, as well as dispersal limitation, are manipulated to investigate the separate and interactive effects of these factors on multiple grassland functions.

In summary, while beta diversity has been understudied so far in biodiversity-ecosystem functioning research, emerging evidence indicates that its effects may be as important as local alpha diversity loss, and that beta diversity may be a key driver of multifunctional landscapes.

**4:30pm - 4:45pm**

## Biodiversity, Stability and Ecosystem Functioning in Agricultural Landscapes

**Daniel Montoya[1], Bart Haegeman[1], Sabrina Gaba[2,3], Claire De Mazancourt[1], Vincent Bretagnolle[3], Michel Loreau[1]**
[1]Centre for Biodiversity Theory and Modelling, Theoretical and Experimental Ecology Station, UMR 5321, CNRS, 09200 Moulis, France; [2]USC 1339, Centre d'Etudes Biologiques de Chizé, INRA, 79360 Villiers en Bois, France; [3]Centre d'Etudes Biologiques de Chizé, UMR 7372, CNRS & Université de La Rochelle, 79360 Villiers en Bois, France; daniel.montoya@sete.cnrs.fr

Agricultural systems differ from other landscapes in that, despite they are multifunctional, they prioritize one ecosystem function or service over the others – crop production – to satisfy the world's food demand. Agricultural intensification, mainly by means of land conversion and the intensive use of chemicals, increased global food production and reduced world hunger significantly for several decades. However, the benefits of this approach have started to be challenged on the basis that the yields of several major crops are no longer increasing and their response to pesticide levels start to saturate. Besides, agricultural intensification has come at a cost to biodiversity, which paradoxically is responsible of the provision of important ecosystem services that in turn influence food production, such as crop pollination.

Ensuring stable food supplies is one of the 2017 UN Sustainable Development Goals, and is a challenge that will require multiple solutions. In this session, I will talk about the role of biodiversity on the provision and stability of ecosystem services in agricultural landscapes. Despite we know that landscape composition generates trade-offs in the delivery of ecosystem services, e.g. increases in crop yields and reductions in biodiversity as land conversion proceeds, it is not clear how the stability of ecosystem services responds to such changes, and what ecological mechanisms underlie these trade-offs. To illustrate this approach, I will use a model of crop pollination services and their dependence on wild pollinator diversity, and address two questions: (i) What are the trade-offs between biodiversity and the magnitude and stability of crop yields in agricultural landscapes? (ii) How does landscape composition and crop pollination dependence influence these trade-offs? Our model reveals trade-offs and synergies imposed by land-use intensification that affect not only the magnitude but also the stability of ecosystem services. I will also discuss recent results on the effects of fragmentation on multifunctional agricultural landscapes and the stabilizing effect of biodiversity on food production. The general conclusion is that biodiversity must be a key factor to achieve food security and design sustainable, multifunctional agricultural landscapes.

**4:45pm - 5:00pm**

## Upscaling Biodiversity-Ecosystem Service Relationships In Agricultural Landscapes

**Gaëtane Le Provost, Margot Neyret, Sophie Peter, Peter Manning**
Senckenberg Biodiversity and Climate Research Centre, Germany; gaetane.le-provost@senckenberg.de

Biodiversity-ecosystem functioning research has shown consistently positive effects of species richness on ecosystem functioning. However, to date, most of these studies have focused on local-scale biodiversity-ecosystem function relationships rather than larger scale biodiversity-ecosystem service relationships. As a consequence, we know little about how the larger scale

configuration of biodiversity affects individual ecosystem services or the simultaneous supply of multiple services (i.e. ecosystem multifunctionality). In this talk we will first show how the concept of multifunctionality can be conceived in terms of ecosystem service supply and demand. Next, using a unique and comprehensive database from 150 German grasslands, we will show how ecosystem service supply is shaped by both local- and landscape-scale land use and biodiversity, and its spatial configuration. This work is complemented by investigations of ecosystem service demand by a wide range of stakeholder groups. Finally, we will show how supply and demand can be integrated in an exploration of which landscape composition minimize the trade-offs between biodiversity conservation, food production and other ecosystem services. Together, this work aims to understand biodiversity-ecosystem service relationships at the large scales relevant to ecosystem management and provide useful insights that may inform policy decisions.

**5:00pm - 5:15pm**

### Bright Spots of Biodiversity and Multifunctionality in Agricultural Landscapes

**Barbara Frei[1,2], Elena Bennett[2]**

[1]Environment and Climate Change Canada, Canada; [2]McGill University; barbara.frei@canada.ca

Agricultural landscapes are one of the principle interfaces between people and the environment. These are areas of intensive pressure and promise – supporting, at time, dense human populations, providing critical ecosystem services, and are capable of supporting rich and diverse species communities. There is an urgent need to pursue solutions on how to achieve preferred outcomes for multiple goals and stakeholders in these social-ecological systems. One way to do so is to focus on those areas and landscapes that are already achieving multiple positive outcomes. Rather than focusing on areas that may intrinsically be more diverse in their functions (multifunctionality) or species (biodiversity), so-called 'hot spots', we instead focused on areas performing better than expected, or 'bright spots'. We identified bright, dark and average spots within a complex agricultural landscape and explored the associated socioeconomic patterns. We found that areas exceeding expectations for biodiversity and landscape multifunctionality were neither spatially congruent nor in conflict. While dark spots for multifunctionality were alike in their ecosystem service composition, bright spots were bright in multiple, diverse ways. The socioeconomic attributes that characterize bright and darks spots included both farm characteristics as well as farming practices, suggesting that both have potential to be levers of change. Additionally, we found that areas becoming more multifunctional over time, were simultaneously becoming more biologically and agriculturally diverse, without large losses in overall food production. This suggests the potential for complementarity among goals of food production, multiple ecosystem service provisioning, and biological and agricultural diversity for agricultural landscapes. While we cannot distinguish whether diversity is the driver, or the consequence, of multifunctionality, we can conclude that diverse, multifunctional agricultural landscapes is an important goal for general system resilience and the future of food security.

**5:15pm - 5:30pm**

### Trade-offs Between Multifunctionality And Profit In Tropical Smallholder Landscapes

**Ingo Grass**

University of Hohenheim, Germany; ingo.grass@uni-hohenheim.de

Land-use transitions can enhance the livelihoods of smallholder farmers but potential economic-ecological trade-offs remain poorly understood. We present a multidisciplinary study of a tropical smallholder landscape and find widespread biodiversity-profit trade-offs resulting from land-use transitions from forest and agroforestry systems to rubber and oil palm monocultures, for 26,894 aboveground and belowground species and ecosystem multidiversity. Despite variation between ecosystem functions, profit gains come at the expense of ecosystem multifunctionality, indicating far-reaching ecosystem deterioration. Using a genetic algorithm we identify landscape compositions that can mitigate trade-offs under optimal land-use allocation but also show that intensive monocultures always lead to higher profits. These findings suggest that losses in biodiversity and ecosystem functioning can only be reduced if economic incentive structures are changed through well-designed policies.

**5:30pm - 5:45pm Warning: The presentations finish prior to the end of the session!**

### Spatial Disconnects In Drivers Of Ecosystem Services Vary Geographically And By Type Of Driver

**Laura J Graham, Felix Eigenbrod**

University of Southampton, United Kingdom; laurajaneegraham@gmail.com

Key to delivering multifunctional landscapes is an understanding of what drives trade-offs and synergies between ecosystem services. Trade-offs between services often arise from different responses to common drivers. As such, it is key that we understand the shape, magnitude and scale of these relationships at broad spatial extents. However, increasing the spatial extent of analysis can come at a cost of fine-resolution detail.

Here, we show where and for what drivers of ecosystem services there are disconnects between fine-resolution detail and broad-extent patterns. This information is key to understanding when we need to incorporate fine-resolution information in broad-extent modelling. We end by detailing a method to overcome the issue of spatial disconnects in the analysis of multifunctional landscapes.

# 138W-2: Interaction Diversity: From Theory to Practice

*Time:* Tuesday, 25/Feb/2020: 4:15pm - 6:15pm · *Location:* Flüela
*Session Chair:* Gianalberto Losapio, ETH Zurich, Switzerland
*Session Chair:* Jacqueline Oehri, University of Zurich, Switzerland
*Session Chair:* Jake Alexander, ETH Zurich, Switzerland

Talks are followed by 40 minutes working group discussion and wrap up.

Within natural systems, an impressive diversity of interactions links species within ecological networks composed of both mutualistic and antagonistic partners. Biologists have long recognized that these interactions shape the structure and functioning of ecological communities, as well as the evolution of biological diversity itself, and that a diversity of interactions is key to the stability of ecosystems. Yet, in contrast to species or genetic diversity, interaction diversity is an often ignored and underappreciated dimension of biodiversity. The goal of this workshop is to explore what shapes interaction diversity and its functional significance, and consider how a greater appreciation of interaction diversity might guide the conservation of biodiversity and sustainable use of ecosystems.

While the diversity of genes and species provides the building blocks of ecosystems, it is the diversity of interactions between species that determines how these functions are combined and bring ecosystems to life. It is currently well established that biodiversity increases ecosystem functioning. Specifically, the diversity of genes and species increases the productivity of ecosystems and stabilizes multiple ecosystem processes. Yet, the exact mechanisms behind positive effects of biodiversity on ecosystem functioning are still poorly understood and the role of interaction diversity in mediating these effects remains unclear. Indeed, ecological communities with the same number of genes or species can function differently, likely due to variation in species interactions and the organization of the ecological networks.Furthermore, ecological theory predicts that biodiversity decreases the rates of species invasions and species extinctions and facilitates community recovery after environmental perturbations, in such a way that communities hosting a higher number of species are more resilient than species-poor communities. The specific architecture of ecological (interaction) networks affects their resilience to perturbations, with most natural communities displaying architectures that maximize resilience and reduce species loss by limiting extinction cascades. However, how interaction and network diversity mediate the response of species to environmental change, mitigate species loss or facilitates the recovery of ecosystems after perturbations remains poorly understood.Whilst causing species to be lost from ecological networks, environmental changes are also forcing new interactions between species. This arises as new species become integrated into ecological communities following distribution shifts, for example, as species migrate in response to changing climate or through biological invasions. New interactions can exacerbate some of the negative impacts of environmental change on communities, but can also compensate for lost interactions and contribute to biodiversity maintenance. A key goal of current research is therefore to predict which interactions will arise when environments change, and what their outcomes will be. Such an understanding may help guiding efforts to anticipate and manage new and changing species interactions to meet management and conservation goals. The interactive workshop (4-hour) will bring together researchers with theoretical, empirical and applied perspectives on interaction diversity. The expected outcome of the workshop is a perspective publication synthesizing knowledge about the drivers and functional significance of interaction diversity, and paving the way for new studies addressing the role of interaction diversity in natural and anthropogenic ecosystems.

**4:15pm - 4:40pm**

## Global Change And Species Interaction Diversity: Perspectives For Conservation And Restoration

**Matthias Albrecht**
Agroscope, Switzerland; matthias.albrecht@agroscope.admin.ch

Species interaction networks shape the structure and functioning of ecological communities. How key properties of such networks are affected by drivers of global environmental change, such as land use change or alien species invasions, as well as the consequences on ecosystem functioning and stability, is still poorly understood. Yet, to develop effective measures to mitigate negative impacts, and to restore healthy ecosystems, we need to identify the critical architectural features of interaction networks driving their resilience to and recovery from perturbations, their robustness against cascading species extinctions and their role in promoting ecosystem functioning. Here, different dimensions of interaction diversity may play a key role. I will present perspectives about the potential relevance of considering interaction diversity to better understand and predict impacts and consequences of global environmental change on ecological communities, and how such knowledge could support conservation and restoration management.

**4:40pm - 5:05pm**

## Geodiversity – Biodiversity Interactions

**Franziska Schrodt**
University of Nottingham, United Kingdom; lgzfs@nottingham.ac.uk

We increasingly recognize the diversity of biological systems, in terms of taxonomy, phylogeny and function, as well as the importance of biotic interactions in shaping them. However, the diversity of abiotic factors and interactions between biotic and abiotic diversity are still understudied.

In the face of accelerated anthropogenic and natural change of abiotic aspects, appreciation of the interaction diversity between all spheres of the Earth is urgently needed. Yet, to date, the vast majority of studies only account for the effect of climate and, potentially, soils on biodiversity, ignoring interactions (e.g. the effect of biodiversity on soils) and other aspects of geodiversity (the range, value and dynamics of geological, geomorphological, pedological and hydrological aspects and features of the Earth's surface and subsurface).

I will give a brief introduction on the state-of-the-art in geodiversity – biodiversity interaction research, discuss the importance of incorporating the diversity of abiotic factors in biodiversity and conservation studies and indicate promising avenues for further research. This includes theoretical advancements, such as the recently introduced Essential Geodiversity Variables framework (Schrodt et al. 2019), as well as practical matters, including remote sensing (Lausch et al. 2019) and modelling approaches suitable for expanding the geo- biodiversity interaction approach across the relevant spatial and temporal scales.

Lausch, A. et al. (2019) Linking Remote Sensing and Geodiversity and Their Traits Relevant to Biodiversity—Part I: Soil Characteristics. Remote Sensing 11: 2356

Schrodt, F. et al. (2019) To advance sustainable stewardship, we must document not only biodiversity but geodiversity. PNAS 116 (33): 16155 - 16158

**5:05pm - 5:30pm Warning: The presentations finish prior to the end of the session!**

## Changing ecological interactions in the Anthropocene

**Rodolfo Dirzo**
Stanfrod University, United States of America; rdirzo@stanford.edu

While the main focus of conservation science and practice has been the maintenance of species, populations and genetic diversity, the deterioration –or even local extinction– of ecological interactions is an increasingly evident feature of the Anthropocene. Here I wish to discuss how anthropogenic disturbances such as land use change, over-exploitation, invasive organisms and climate change—as well as the interactions among these drivers of change, unleash cascading consequences on ecosystem structure, functioning and services of direct significance to humans (e.g., disease risk regulation), mostly in diversity-rich tropical ecosystems. Given the complexity of biotic interactions and the interplay of them within the disrupted abiotic environment, our adequate understanding and capacity to predict the trajectories and outcomes remains extremely limited. Here I will try to illustrate some examples of such complexities, with hopes of stimulating discussion that may lead to identify some of the promising avenues to address these critical features of the Anthropocene.

# 166S-2: Illuminating the black box

*Time:* Tuesday, 25/Feb/2020: 4:15pm - 6:15pm · *Location:* Sertig
*Session Chair:* Helen Phillips, iDiv, Germany
*Session Chair:* Léa Beaumelle, iDiv, Germany

Soils harbour some of the highest biodiversity. Yet, soil organisms are understudied in terms of their taxonomy, global distributions and the threats they face. It is important we understand life in the soil, as these organisms provide a variety of ecosystem functions that are vital for human wellbeing, such as decomposition, plant growth, and climate regulation, amongst many others. Despite their importance, soil biodiversity is often overlooked in large-scale and global biodiversity assessments, as well as in policy directives and conservation planning.

This session aims to shed light on the most recent advances in soil biodiversity research, with emphasis on three facets. The latest advances on methods to assess where soil organisms are, and which processes or drivers are shaping their distribution. How anthropogenic impacts are affecting soil biodiversity, in terms of their distribution and their diversity. And finally, what changes in distribution and diversity of soil organisms may mean for our wellbeing, given the importance of soil biodiversity in the provisioning of many ecosystem functions.We will consider a variety of soil organisms, from micro-organisms to soil invertebrates, all of which play important roles for ecosystems by their interactions with each other and with plants. As well as a variety of scales, from the mechanistic approaches using experiments to unravel the complexity of soil communities and foodwebs all the way to macroecological approaches that are key to highlight current and future global biodiversity trends.

By bringing together this soil biodiversity research, we hope to advance the field in terms of conservation of the soil organisms. As well as highlight the importance of integrating soil organisms into policy-making and targets, and large-scale assessments.

**4:15pm - 4:35pm**

## #GlobalCollembola Initiative: Global Assessment of Springtail Diversity and Abundance

**Anton M Potapov**
University of Goettingen, Germany; potapov.msu@gmail.com

Springtails are basal insect relatives that are found virtually in all terrestrial habitats and play keystone role in food webs as biotic filters of microbial communities and prey for invertebrate predators. Increasing recognition of importance of soil biota for ecosystem functioning and warning findings of global insect diversity decline urges us to compile existing knowledge on springtail abundance and diversity, which has never been done on a global scale. To achieve this goal, a group of 97 researchers across 41 countries joined their efforts to bring together existing digital data on springtail communities. Over last decades, springtail communities were recorder all over the globe, from tropical rainforests to Antarctica. Unlike many aboveground groups, springtails show the highest diversity and abundance in temperate, rather than tropical, regions. High springtail densities and their high metabolic activities suggest that springtails is one of the key groups, supporting invertebrate predators across majority of terrestrial habitats. Documenting the abundance and diversity of springtails will allow us to understand drivers shaping the global soil biodiversity and predict its potential responses to the global change with consequences to ecosystem functioning.

**4:35pm - 4:55pm**

## Comprehensive Database Of Functional Traits Of Soil Invertebrates (BETSI) To Illuminate The Black Box

**Pierre Ganault[1], Sophie Joimel[2], Apolline Auclerc[3], Lea Beaumelle[4], Jonathan Bonfanti[1], Jérome Cortet[1], Mickaël Hedde[5], Florence Manoury-Danger[6], Johanne Nahmani[1], Benjamin Pey[7]**
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Soils host a quarter of our planet's biodiversity and provide a variety of ecosystem services that are vital for human wellbeing. Even though we know more and more about soil organisms, there are still many gaps on the roles of soil organisms in ecosystem functioning and how environmental drivers shape soil communities.

To illuminate this black box, molecular techniques have rapidly emerged, but are often impracticable and give only few information about functional roles of soil organisms. Consequently, many studies in the last years worked on expanding the trait-based conceptual framework to soil organisms. This approach provides quantitative and generic predictions in order to understand and predict how soil organisms interact, respond and affect their environment.

The challenge is now to standardise semantics and methods. The Biological and Ecological Traits of Soil Invertebrates database (BETSI, https://portail.betsi.cnrs.fr/), is a European database dedicated specifically to soil organisms' traits, linked to a thesaurus defining those traits. This open database gathers to date 129 185 entries on 44 413 species and 56 traits coming from ca. 2000 literature reference. It allowed the publication of more than 20 articles, four PhD thesis conducted on various taxonomic groups and land uses/soil types, and collaborative projects e.g. on soil invertebrates feeding preferences or earthworm distribution in France.

BETSI has been evolving over the years thanks to its support by the TEBIS network of soil biodiversity researchers. Everyone is welcome to join us and contribute to our discussions and projects!

In this presentation, we give you an introduction on BETSI database, an overview of the related published works and the on-going collaborative projects. Finally, we talk about perspectives on functional traits in order to help the monitoring and conservation of soil biodiversity in the on-going European COST Action EUdaphobase.

**4:55pm - 5:15pm**

## Patterns and Drivers of Soil Respiration Across European Land-Cover Types

**Linnea Smith[1], Alfred Lochner[1], Alberto Orgiazzi[2], Simone Cesarz[1], Nico Eisenhauer[1], Carlos Guerra[1]**
[1]German Centre for Integrative Biodiversity Research (iDiv); [2]European Commission, Joint Research Center, Institute for Environment and Sustainability; linnea.smith@idiv.de

Soil ecosystem functions play a key role in supporting biodiversity and vice versa, making it important to quantify these functions

and to understand the mechanisms behind them. To this end, we measured soil microbial basal respiration and microbial biomass in 851 soil samples from the Land Use/Cover Area frame statistical Survey. These samples come from across Europe and represent a variety of land cover types including agriculture, forest, and grasslands. We investigate the differences in soil microbial properties across land cover types in order to distinguish between various mechanistic and functional processes associated with different land cover types over the European environmental gradient. We show that natural ecosystems have higher microbial biomass, diversity, and basal respiration than agricultural systems. We also show that soil properties such as water content will be significant drivers of soil ecosystem functions in all land-cover types. However, climatic variables such as precipitation appear to be less significant in managed than in natural ecosystems, due to the influence of anthropogenic inputs (e.g. artificial irrigation). This Europe-wide survey provides both a baseline for the current state of soil microbial properties and allows wide-scale investigation of their driving mechanisms.

**5:15pm - 5:35pm**

## Global Biogeography of Soil Biota

**Johan van den Hoogen[1], Stefan Geisen[2], Devin Routh[1], Thomas Crowther[1]**

[1]Global Ecosystem Ecology, Institute of Integrative Biology, Department of Ecosystems Science, ETH Zürich, Switzerland; [2]Department of Terrestrial Ecology, Netherlands Institute of Ecology, Wageningen, The Netherlands.; johan.vandenhoogen@usys.ethz.ch

Soil organisms are a crucial part of the terrestrial biosphere. Despite their importance for ecosystem functioning, we still have a limited understanding of the global distribution and composition of the belowground community. Quantifying these spatial patterns is imperative to gain insight in global nutrient cycling, carbon fluxes and responses to changing climates. In particular, nematodes, the most abundant animals on Earth, fill all trophic levels in the soil food web and are a strong indicator of biological activity in soils. Here, we present the results from a global initiative of over 70 nematologists, encompassing 6,579 georeferenced soils samples used to generate a mechanistic understanding of the patterns of global soil nematode abundance and functional group composition. The resulting spatial distributions show that $4.4 \pm 0.64 \times 10^{20}$ nematodes (total biomass ~0.3 Gt) inhabit surface soils across the world, with higher abundances in sub-arctic regions (38% of total), than in temperate (24%), or tropical regions (21%). Using the latest developments in machine learning, we aim to provide insight into the global diversity and functioning of soil ecosystems.

**5:35pm - 5:55pm Warning: The presentations finish prior to the end of the session!**

## Microbial Biogeography In Alpine Soils

**Lucie Anne Malard[1], Heidi Mod[2], Sometalp Consortium[3], Antoine Guisan[1]**

[1]University of Lausanne, Switzerland; [2]University of Helsinki, Finland; [3]Aalborg University, Denmark; University of Neuchatel, Switzerland; University of Lausanne, Switzerland; Spanish National Research Council, Spain; The Arctic University of Norway, Norway; lucie.malard@unil.ch

Soil microorganisms are central to ecological processes such as decomposition or nutrient cycling, yet, identifying the factors influencing their distribution remains challenging, especially in fast changing, environmentally heterogeneous ecosystems such as the Alps. Here, we characterized microbial communities of Alpine soils using 230 sites covering 700 $km^2$ across the western Swiss Alps and representing a wide range of environmental gradients. The aim was to identify biogeographical patterns as well as key environmental and climatic factors influencing the spatial distribution of different groups of soil microorganisms.

Using amplicon sequencing along with 39 edaphic, 5 topographic and 26 climatic variables, key factors influencing microbial distribution were identified. As seen elsewhere, pH and TOC were found to drive microbial community structure. However, we showed that topographic and climatic variables also have to be taken into account for comprehensive understanding and realistic predictions of spatial patterns of soil microbiota.

This study brings a deeper understanding of Alpine microbial community assemblages and forms the basis for predictive studies investigating the influence of environmental changes on soil microbial communities in mountain regions.

# 129S: The role of biodiversity and ecosystem services in adapting to global change

*Time:* Tuesday, 25/Feb/2020: 4:15pm - 6:15pm · *Location:* Schwarzhorn
*Session Chair:* Adrienne Grêt-Regamey, ETH Zürich, Switzerland
*Session Chair:* Aino Kulonen, Mountain Research Initiative, Switzerland
*Session Chair:* Andreas Heinimann, CDE, University of Bern, Switzerland

Mountain ecosystems contribute critically to ecosystem services for people living inside and outside these areas. Their compressed topography, vertical gradients, and isolation make them particularly vulnerable to global change, calling for effective coping mechanisms. While there are many perspectives on what a desirable future should be, focusing on the pathways to adapt to global change helps highlighting trade-offs between the ecosystem services provided at various sequenced decision points along the adaptation pathway.

Taking into consideration the mentioned challenges for defining adaptation pathways the following questions arise:

- Which characteristics of the ecosystems and which ecosystem services are essential to allow adaptation?
- What are the main path dependencies in the ecosystems and the socio-ecological systems limiting future adaptation options?
- What are the main trade-offs in biodiversity and ecosystem services along the pathways?

Objectives: Guided by these questions, the session is dedicated to diagnose adaptation pathway challenges across mountain ecosystems and socio-ecological systems. The focus will be on both challenges resulting from changes in the ecosystems along the pathways to opportunities emerging from learning and co-creating solutions along the pathways. Showing some international practice-oriented examples, we will discuss and synthesize ecological and socio-economic principles in enabling adaptation pathways

**4:15pm - 4:35pm**

## Linking Ecological And Social Changes For Identifying Adaption Pathways In Mountain Landscapes

**Ulrike Tappeiner[1,2], Uta Schirpke[1,2]**

[1]University of Innsbruck, Austria; [2]Eurac Research, Italy; ulrike.tappeiner@uibk.ac.at

Mountain landscapes, which have been shaped by human activities over centuries, are facing great transformations in the European Alps, mainly due to the abandonment of alpine grassland. To improve the understanding of interactions between human activities and ecological processes as well as to identify adaption pathways in socio-ecological systems, we focused our analyses on the Central Alps in Austria. We used the concept of social-ecological resilience as a framework for understanding complex interlinkages on multiple scales and from different disciplines and for identifying key drivers influencing farmers' management decisions, such as socio-economic development of the community, farm management, and political interventions (e.g. subsidies and regulations). Results of different narratives obtained from a participatory approach point to that pluri-activity can support various sources of income and may avoid great land-use changes, whereas reductions in subsidies and changes in consumer behaviour may lead to further abandonment of mountain grassland. Spatially explicit and quantitative analyses of the changes in land use and ecosystem services indicate that climate change leads to a higher vulnerability of forage production, requiring an adapted and more flexible management. In particular, the abandonment of mountain grassland and subsequent reforestation causes a shift in ecosystem services, i.e. the decline of typical grassland ecosystem services such as forage production and an increase in forest-related ecosystem services, in particular, of regulating services. Here, unmanaged forests seem to be more efficient in providing climate regulation and erosion regulation compared to managed systems, while management can positively influence water regulation. However, the ability of management to control ecosystem service supply decreases sharply with the severity of future climate change, if no decisive actions to mitigate climate change are taken. Hence, climate change may severely hamper the management of mountain ecosystems, but value-based visions of local communities may help defining appropriate adaption pathways.

**4:35pm - 4:55pm**

## Mountain Forest Ecosystem Services – Maintaining Resilience in the Face of Disturbances

**Ana Stritih[1,2], Peter Bebi[2], Adrienne Grêt-Regamey[1]**

[1]ETH Zürich, Switzerland; [2]WSL Institute for Snow and Avalanche Research SLF; ASTRITIH@ETHZ.CH

For centuries, mountain forests in the Alps have provided essential ecosystem services such as wood production and protection from natural hazards (e.g. avalanches and landslides), enabling mountain societies to thrive in these marginal environments. In addition, they provide services valued by a wider society, such as places for recreation, habitats for rare species, and carbon sequestration. These ecosystem services are affected by climate and land use change, as well as changes in societal demand and management regimes. In recent years, the management of mountain forests has been increasingly driven by forest disturbances, such as windthrow, bark beetle outbreaks, and forest fires. The increasing rate of disturbances has the potential to convert forests from carbon sinks to carbon sources, and may also affect the provision of other ecosystem services, such as avalanche protection. The vulnerability of forests to disturbances and their capacity to maintain service provision after a disturbance are affected by their structure, where forests with a more heterogeneous structure and species composition are expected to be more resilient.

Information on ecosystem structure and its link to functions and services is available from a variety of sources, from Earth Observation and in-situ data, existing process-based models, to local expert knowledge. We use Bayesian Networks to integrate these different types of information and model ecosystem services in two case study areas in the Swiss Alps, the strictly protected Swiss National Park and the more tourism-oriented region of Davos. This probabilistic modelling approach allows us to identify knowledge gaps and explore uncertainties in the future provision of ecosystem services. We model carbon sequestration and wood production, and investigate how different management scenarios can reduce the vulnerability of these services and facilitate adaptation. Furthermore, we discuss the potential trade-offs and synergies with other ecosystem services, such as protection from natural hazards, recreation, and biodiversity.

**4:55pm - 5:15pm**

## People Working With Nature To Co-produce Adaptation In The French Alps

**Enora Bruley[1], Sandra Lavorel[1], Bruno Locatelli[2]**

[1]Laboratoire d'Ecologie Alpine, CNRS – UGA, 38000 Grenoble, France; [2]Cirad, University of Montpellier, Montpellier 34398, France; enora.bruley@univ-grenoble-alpes.fr

Mountain biodiversity and ecosystems contribute significantly to quality of life locally and globally. As global changes impact

mountain social-ecological systems (SES), adaptation is critical to sustain future community's livelihoods. Biodiversity and ecosystems can play an important role in adaptation through the provision of nature's contribution to people's adaptation (NCA) but this role still remains a research gap. Through a participatory process involving a wide diversity of stakeholders of a mountain SES in the central French Alps, we co-constructed adaptation pathways towards a desired future. With a normative scenario approach, we first defined with stakeholders a desirable vision for the area in 2040, allowing us to assess adaptation options and future demand for NCA. Pathways were then constructed using a serious game, in which participants played with the future trajectory of the SES and discussed how to achieve their vision. From the game, we identified different adaptation strategies defined by particular sets of actions. Through the analysis of the co-production of NCAs along adaptation pathways, we assessed the natural and anthropogenic capitals required to implement adaptation strategies. Here, natural capital did not appear to be a limiting factor for adaptation and for the achievement of the vision, even under the effects of climate change. Barriers to adaptation come from the challenges in mobilizing human, physical, financial and social capital for the co-production of NCAs, rather than from ecological limits related to ecosystems functions and biodiversity. Power relations, access rights, participation in decision-making regarding common goods, mental path-dependency and resistance to change restrict the co-production of NCAs. These barriers can lead to pathways that move the SES away from the vision, thus perceived as undesirable. For example, a shift towards over-exploitation of natural resources or, conversely, the abandonment of human activities in the SES. This analysis highlights the need to consider all drivers involved in the co-production of NCAs when studying adaptation pathways.

**5:15pm - 5:35pm**

## Managing Livestock And Wild Herbivores For Nature And Climate In Mountain Areas

**Gunnar Austrheim[1], James Speed[1], Hilde Bjørkhaug[1], Anders Kolstad[1], Vegard Martinsen[2], Jan Mulder[2]**

[1]Norwegian University of Science and Technology, Norway; [2]Norwegian University of Life Sciences, Norway;
gunnar.austrheim@ntnu.no

Large herbivores affect a wide range of services provided by socio-ecological systems in mountains globally. Both livestock and wild herbivores provide material as well as non-material services and are often the backbone in rural economies. However, socio-economic developments, such as structural changes in these economies, might challenge the sustainable use of biodiversity and regulating services, and limit the ability of the system to facilitate climate change mitigation and adaptation. In this study, we examined socio-economic and ecological changes in Norwegian mountain rangelands. The study included spatial and temporal dynamics of human population, farms, large herbivores as well as other land-uses (e.g. conservation, tourism) and how indirect drivers affect land-use. We especially focused on how grazing affected biodiversity and ecosystem services and interacted with climate using experimental designs with different densities of sheep. Intermediate grazing intensities favored regulating services, such as soil carbon storage in grassland habitats. Several services were traded-off at reduced grazing and high grazing intensities. Studies of carbon storage along the forest-tundra ecotone showed the importance of soil carbon for climate change mitigation above the forest line. Comparative "space for time" studies demonstrated long-term effects of sheep grazing, and the slow recovery of both below and aboveground rangelands. Mountain socio-ecosystems are currently experiencing strong changes in both land-use and climate with impacts on biodiversity and ecosystem services. Changes in density and distribution of livestock and wild herbivores is a key land-use change that also interacts with climate. Visioning exercises involving a broad range of stakeholders recommended alpine rangeland to be used for grazing. However, both over and undergrazing should be prevented to optimize ecosystem services. This study suggests that more targeted regulations of large herbivore grazing in mountain rangelands can be important tools for optimizing nature and climate in mountains for a long-term sustainable socio-economic and ecological management.

# 115S-2: Socio-economic and ecological implications and challenges of conserving biodiversity

*Time:* Tuesday, 25/Feb/2020: 4:15pm - 6:15pm · *Location:* Seehorn
*Session Chair:* Sergio Rasmann, University of Neuchâtel, Switzerland
*Session Chair:* Marco Moretti, Swiss Federal Research Institute WSL, Switzerland

Most of the basic needs of society depend on biodiversity, nonetheless the anthropocene is characterized by the dramatic and fast disappearance of species diversity worldwide. The causes of biodiversity erosion are multiple, including habitat fragmentation, pollution or climate change, and its impact are multiple, including particularly, the loss of genetic diversity, and with that, proper ecosystem functioning and services provision for the society. To counteract biodiversity loss, conservation programs have been put in place, but with mitigated, or only local, success.

The scope of this symposium is to bring together world-renowned experts in conservation biology and socio-economic sciences for discussing future venues for better conserving biodiversity and ecosystem functioning. Particularly, we aim to discuss whether to conserve species that deliver services or, rather to conserve biodiversity per se. What shall the society focus on? What is the responsibility of research, people, society, economy and policy? How can we bring biodiversity to the top ranks of the society and political agenda?

**4:15pm - 4:30pm**

## Social-Ecological Drivers And Outcomes Of Biodiversity In Urban Gardens: Lessons From The BetterGardens Project

**David Frey[1], Christopher Young[1], Simon Tresch[1,2], Robert Home[2], Nicole Bauer[1], Marco Moretti[1]**
[1]Swiss Federal Research Institute WSL; [2]Research Institute of Organic Agriculture (FiBL); david.frey@wsl.ch

In the context of increasing urbanization, gardens as a form of urban greenspace may underpin urban biodiversity and deliver a variety of ecosystem services such as food production or psychological restoration of urban dwellers. Despite increasing recognition of their social and ecological importance, and the considerable proportion of urban land used for horticulture, there has been insufficient study of urban gardens. Moreover, they are under threat in many Swiss cities, as well as in most European urbanized areas, as cities become denser and green spaces become attractive targets for development. Arguments for the preservation of urban green spaces need to be strengthened, which should include how to maintain or enhance the sustainability of green space management so that biodiversity and soil quality are secured. The main goal of the interdisciplinary study BetterGardens was to contribute to the development of such arguments, by investigating the social-ecological drivers and outcomes of biodiversity in two different garden types in the City of Zurich: allotment and home gardens. We found that i) both home and allotment gardens can contain diverse and heterogenous communities of invertebrates and plants, that ii) diversity levels of plants and invertebrates are controlled by direct and indirect relationships between the gardener's biodiversity preference, gardening concept and garden environmental heterogeneity, and that iii) both domestic - but even more allotment - gardeners experience their gardens as highly restorative; with potentially additional positive effects of plant diversity on restoration. In the face of shrinking urban greenspace in many cities, our study provides arguments for a more resolute protection of urban gardens and suggests that urban planning could better utilize the synergies offered by gardens to address issues of public health and urban biodiversity conservation.

**4:30pm - 4:45pm**

## Social-Ecological Networks For Biodiversity

**Manuel Fischer**
Eawag, Switzerland; manuel.fischer@eawag.ch

Biodiversity management and governance are challenged by complex social-ecological interdependencies: human action impacts the quality or quantity of ecosystems and related services. This can then again affect humans and other species and result in a complex causality chain and provoke feedback loops. To account for these complexities, scholars have emphasized the importance of social-ecological fit, i.e. an alignment of the governance system (i.e., institutional arrangements addressing environmental problems or resource uses) with the characteristics of the respective ecosystem (Berkes et al. 2003, Ostrom 2005). In other words, reducing the misfit between the societal system and the ecosystem is fundamental to enhance effective biodiversity governance (Young 2002). Collaboration among actors can reduce such misfit and lead to improved environmental problem solving (Bodin et al. 2014).

**4:45pm - 5:00pm**

## The Influence Of Coordination And Social Norms On Farmers' Willingness To Accept Agro-environmental Schemes Across Europe

**Roland Olschewski[1], Julian Sagebiel[2], Sergio Villamayor Tomas[3]**
[1]WSL Swiss Federal Research Institute, Switzerland; [2]Department of Landscape Architecture and Environmental Planning, Technical University of Berlin, Germany; [3]ICTA Autonomous University of Barcelona, Spain; roland.olschewski@wsl.ch

This presentation aims to shed light on the challenges and opportunities of promoting farmers' participation in agro-environmental programs in intensively used agricultural landscapes. On the one hand, the study assesses the costs of coordinating farmers for the implementation of such programs, as a complement or alternative to increasing the amount of land set aside for said programs. On the other hand, the paper responds to recent calls about the need to identify incentives other than monetary payments to promote farmers participation. Methodologically, the study consists of a choice experiment exploring the willingness of farmers in Germany, Switzerland, and Spain to participate in a tree planting measure. According to our findings, the resistance of farmers to participate in coordinated programs is not insurmountable and has to do with transaction costs as well as beliefs about other farmers' behavior. Similarly, having conservation programs recommended by farmers can encourage other farmers to participate. Finally, different conservation framings can affect the resistance of farmers to participate depending on the emphasis made on the environmental benefits that farmers obtain from the programs. Overall, the findings illustrate the interest of further integrating farmers in the design of agro-environmental schemes, and further testing the feasibility of coordinated schemes in light of the influence of both monetary and social incentives.

**5:00pm - 5:15pm**

## Public Subsidies Harmful To Biodiversity – An example for tackling Aichi Target 3

**Lena Gubler[1], Sascha Ismail[2], Werner Müller[3], Daniela Pauli[2], Friedrich Wulf[4], Irmi Seidl[1]**

[1]WSL, Switzerland; [2]Swiss Biodiversity Forum; [3]Swiss BirdLife; [4]Pro Natura; lena.gubler@wsl.ch

In most countries, more subsidies promote harmful than beneficial activities for biodiversity. At the same time abolishing harmful subsidies for biodiversity, as envisaged in Aichi target 3, has not been followed up, neither at the international nor at the national level. For grasping the extent of this issue, this study compiles all relevant subsidies in Switzerland harmful to biodiversity and proposes ways to transform them. The screening process is based on the identification of the stressors in all habitats and the underlying drivers. Building on this all, subsidies and incentives for sectors involved in harmful activities are collected based on publicly available sources, expert knowledge and a crowd-sourcing element to obtain examples on a community level. Thereby, the study aims for maximum completeness and includes on-budget subsidies (such as direct cash transfer, low interest loans or the government provision of goods and services), off-budget subsidies (such as tax exemptions and rebates or preferential market access) as well as indirect subsidies (such as non-internalized external costs). While the results will be directly relevant for Switzerland, public incentives to harm biodiversity are ubiquitous and the methodology for identifying these incentives can motivate similar investigations in other countries.

**5:15pm - 5:45pm Warning: The presentations finish prior to the end of the session!**

## Socioeconomic Diversity, Norms And Adaptive Management

**Jon Norberg**

Stockholm Resilience Centre, Stockholm University, Sweden; jon.norberg@ecology.su.se

How does human socio-economic diversity affect natural resource management? By incorporating both diversity in the economic opportunity of actors as well as how actors relate to each other's behavior I investigate how inequality is dynamically shaped by resource use and actors interactions through social norms. As expected we find that inequality has a detrimental effect on resource use exacerbated by the number of actors. We investigate four different types of norms on resource use scenarios. Norms can both increase and decrease the misuse of resources but do not create sustainable attractors for the socio-ecological system. I then will elaborate on how social networks can potentially provide a way to create an attractor for sustainability.

# Plenary 5: Plenary Session 5

*Time:* Wednesday, 26/Feb/2020: 8:30am - 10:00am · *Location:* Davos (2/3)

## Emma Archer, University of Pretoria

## Eduardo Brondizio, Indiana University Bloomington

**The maximum number of 0 presentations has been exceeded! There are now 2 presentations in this session.**

**8:30am - 9:15am**

### Future Biodiversity and Ecosystem Change in Africa

**Emma Archer**

University of Pretoria, South Africa; emma.archer@up.ac.za

Throughout the world, biodiversity and nature's contributions to people are under threat, with clear changes evident. Biodiversity and ecosystem services have particular value in Africa– yet they are negatively impacted by a range of drivers, including land use and climate change. Here, we show evidence of changing biodiversity and ecosystem services in Africa, as well as the current most significant drivers of change. We then consider five plausible futures for the African continent, each underlain by differing assumptions. In three out of the five futures under consideration, negative impacts on biodiversity and ecosystem services are likely to persist. Those two plausible futures prioritizing environment and sustainability, however, are shown as the most likely paths to achieving long term development objectives without compromising the continent's biodiversity and ecosystem services. Such a finding shows clearly that achievement of such objectives cannot be separated from full recognition of the value of such services.

**9:15am - 10:00am**

### Science and Indigenous and Local Knowledge have complemented and enriched each other in the IPBES Global Assessment.

**Eduardo Sonnewend Brondizio**

Indiana University-Bloomington, United States of America; ebrondiz@indiana.edu

It was clear that fulfilling the mandate of the IPBES Global Assessment on Biodiversity and Ecosystem Services (GA) would require a comprehensive, multi-faceted approach to incorporate, synthesize and scale-up the contributions of Indigenous and Local Knowledge (ILK), practices, and innovations and issues concerning Indigenous Peoples and Local Communities (IPLCs), from local to global levels. An operationalization strategy dedicated to ILK and engaging IPLCs was developed at the onset, discussed and reviewed by multiple constituencies within IPBES, particularly the ILK Task Force, and in dialogues with experts and IPLC representatives. This guiding strategy included several components, including overarching and chapter specific questions, synthesis of multiple types of evidence, online and face-to-face consultation and dialogue workshops, and compilation of social-ecological indicators, all of which carried out by a dedicated group of assessment authors. This presentation reflects on the operationalization strategy dedicated to ILK and engaging IPLCs as it was implemented in the Global Assessment. It also reflects on lessons learned and identify gaps and areas that can be further advanced during the next work program of IPBES.

# 176S-1: Ethics and Biodiversity Conservation

*Time:* Wednesday, 26/Feb/2020: 10:30am - 12:30pm · *Location:* Dischma
*Session Chair:* Anna Deplazes Zemp, University of Zurich, Switzerland
*Session Chair:* Anna Wienhues, University of Zurich, Switzerland

In this session we welcome contributions that discuss different types of ethical conflicts in biodiversity conservation. Amongst other things, such conflicts could concern the aims, methods, costs or policies of biodiversity conservation.

Potential topics include the conflicts between social justice and conservation goals in certain conservation areas or questions about whether (or to what extent) biodiversity should be conserved by 'unnatural' means such as biotechnology or assisted migration or. The session will consist three to five presentations selected from submitted abstracts. We encourage submissions from different disciplinary backgrounds, but we want to highlight that the presentations should focus on ethical conflicts involving different principles, values, normative theories or similar.

**10:30am - 11:00am**

## Seeking an Ethical Grounding for Risk-based Decision-making in Managed Relocation

**Mark Schwartz[1], Allison Simler[2], Matthew Williamson[3], David Rizzo[1], Aviv Karasov-Olson[1]**
[1]University of California, Davis, United States of America; [2]United States Geological Survey, Boise,; [3]Boise State University, United States of America; mwschwartz@ucdavis.edu

A suite of emerging technologies offer hope, and caution, for the conservation of biodiversity. From assisted migration to gene insertions to confer disease resistance, conservation practitioners are now faced with difficult choices on whether to engage, or not in emerging tools for protecting species through manipulation of nature from genomes to distributions. Using managed relocation (assisted migration) as a case study, we discuss scientific uncertainties that generate risk of creating harm while trying to achieve a conservation goal. Beyond technical risk uncertainties, actors are faced with the sociological dilemma of whether or not the use of managed relocation is socially acceptable. Lacking clear guidance from society, plans are drawn based on ecological assessments of risk and feasibility. Lacking clear guidance from society, resource managers are then faced with the ethical dilemma of making management decisions based on levels of acceptable risk for causing ecological harm through management actions. Making these decisions would be aided by ethical guidance on the nature of harm and the acceptability of causing harm through unintended consequences of a recognized risk. Actors often avoid ethical arguments for or against an action and revert to the use of a precautionary principle in prioritizing actions. However, in the case of preventing extinction through assisted migration, both sides claim to be following precautionary approaches. A case study using the U.S. National Park Service is used to illustrate the need for further engagement from social scientists and ethicists in navigating these troubled waters.

**11:00am - 11:30am**

## The Ethical Dimension of Lethal Specimen Collection in Ornithology

**Frances Heather Fairbairn, Vanya Rohwer**
Cornell University, United States of America; fhf22@cornell.edu

Ornithologists and researchers routinely kill and collect bird specimens for research, education, and conservation. Many object to this on ethical grounds, arguing it endangers the very species that researchers claim to protect, or that the killing in the name of research is never justified. The researchers in question then respond by citing data on populations to prove their work in no way endangers species or arguing that conservation and (hence) ethical considerations should be made at the species (rather than individual) level.

We investigate this literature, especially as it pertains to ornithology. Rather than assessing individual arguments, we identify problematic inferences made in the literature as a whole using the notion of *inference webs[1]* to argue that there problematic assumptions in the background of this literature that i) are faulty and ii) would be rejected by the people who make them if asked *directly*.

For example, many arguments in favor of collection assume that cost-benefit analyses are the most poignant way to assess research even though, in another context, researchers would *deny* the relevant considerations reduce to mere costs and benefits. Firstly, they all undoubtedly think the benefits derived from collecting go far beyond preserving biological diversity. It's clear that conservation efforts aim at a huge variety of ends over-and-above protection of individual species (for example, preserving information for further scientific study of ecological and evolutionary forces or preserving features of nature important for human enjoyment). Thus, arguing that collection is ethical on the basis of costs and benefits misses the most important concerns in favor of collection. Second, most researchers would acknowledge the prevailing problems with the concept of 'species' and the extensive literature suggesting biodiversity is not best measured by the number of species conserved.

Our aim is not simply to reject arguments but to improve on them. On our account, the inference webs that pervade this literature foreclose discussion of more productive views. Once we clear the ground of these problematic arguments, we can set the stage for more productive debates.

[1]These are *structured collections of claims and inferences that frame our reasoning in a given area.*

**11:30am - 12:00pm**

## Donkeys, Deer, and Death around the Swiss National Park: Developing a Relational Values Approach to Align Environmental Values in Sustainable Development

**Mollie Chapman[1,2], Anna Deplazes Zemp[1,3], Norman Backhaus[1,2]**
[1]University Research Priority Program on Global Change and Biodiversity, University of Zurich; [2]Department of Geography, University of Zurich; [3]Ethics Research Institute, University of Zurich; mollie.chapman@geo.uzh.ch

Environmental values are important for many biodiversity conservation and sustainability transformation contexts—particularly in participatory decision making or ecosystem services assessments and implicitly in policies and programs for sustainable development. When values are included in biodiversity conservation efforts, usually one of two approaches are used: instrumental values focus on the benefits from nature for people whereas intrinsic values reflect the idea of nature's value for its own sake.

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 sustainable development with a focus on Swiss alpine agro-ecosystems. Relational values include values such as stewardship and care,

kinship and connection towards nature, concepts such as ‘eudaemonia’ which refers to living a good life in harmony with nature, as well as values around responsibility towards nature (Chan et al., 2016, *PNAS*).

Interviews with farmers in the vicinity of the Swiss National Park along with analytical philosophy serve to elaborate an approach to relational values and develop the conceptual foundations of this emerging research area. We present preliminary results from 32 interviews conducted in March 2019 with farmers in Val Müstair and the Lower Engadine. We show how our framework, elaborated via interdisciplinary collaboration between philosophy and social science, can facilitate elicitation and analysis of relational value data. We also discuss the broader implications of a relational values approach for biodiversity conservation efforts.

**12:00pm - 12:30pm**

## Different Concepts of 'Naturalness’ as a Source of Conservation Conflicts

**Anna Deplazes Zemp**
University of Zurich, Switzerland; deplazes@ethik.uzh.ch

It is recognized that differences in philosophical positions can be a source of disagreement in environmental conservation. Examples include different assessments of the aim of culling individuals of invasive animal species to protect an ecosystem. While animal ethicists classically reject such an approach, holistic environmental ethicists are inclined to support it.

However, there are other theoretical sources of disagreement in environmental conservation, for instance, the underlying concepts of ‘nature’ and ‘naturalness’ themselves. I will discuss these concepts in the context of the suggestion to apply biotechnology to protect endangered birds. Whether it is considered to be contradictory to apply such *technological*interventions to protect *nature*depends on what is meant by ‘nature’ or ‘naturalness’.

I will start from Dieter Birnbacher’s distinction between genetic and qualitative naturalness. For Birnbacher something is natural in the *genetic*sense if it has a natural origin and underwent a natural ‘genesis’. In contrast, something has qualitative naturalness if it appears natural meaning that no human agency is observable. While *genetic*naturalness is past-oriented, *qualitative*naturalness is present-oriented. I will suggest a third type: ‘prospective naturalness’, which is future-oriented. The more an object is ‘left to nature’ and natural forces shape its future, the more natural it is in this sense.

The biotechnological intervention to protect bird species is an interruption of natural processes and thus an interference with *genetic*naturalness. However, if the endangered bird species survive, nobody would recognise a human intervention. *Qualitative* naturalness would thus be protected. If the ecosystem is ‘left to nature’ after the invention *prospective*naturalness could also be strengthened.

However, while these conclusions can be relevant to assess the aims and potential success of a conservation project, the observation that naturalness *can*be protected by biotechnological intervention does not yet imply that it *should*be protected by these means.

# 120S-1: Aquatic Biodiversity - State and Challenges ahead

*Time:* Wednesday, 26/Feb/2020: 10:30am - 12:30pm · *Location:* Flüela
*Session Chair:* Rosetta Blackman, Eawag, Switzerland
*Session Chair:* Ole Seehausen, Eawag and Institute of Ecology & Evolution, University of Bern, Switzerland
*Session Chair:* Florian Altermatt, University of Zurich, Switzerland

The earth's surface is made up of over 70% water, and these aquatic ecosystems are among the most biodiverse worldwide. Key examples of ecological and evolutionary dynamics have been established in aquatic ecosystems, including work on adaptive radiation, spatial ecology and invasive species biology. These ecosystems are also used as an essential resource by humans, ranging from freshwater drinking supplies, fisheries, and transportation.

These uses often negatively affect aquatic ecosystems, their biodiversity and eventually also their ecosystem functions. Consequently, aquatic ecosystems are globally among the most threatened ecosystems. To reverse these rapid declines in biodiversity, concerted and interdisciplinary actions are needed. In this session, we combine talks that give an overview on the state and threats to aquatic biodiversity, discuss the underlying drivers and outline how this affects the ecological and evolutionary integrity of these systems. We want to discuss advancements in the detection and assessment of aquatic biodiversity baseline data, link aquatic biodiversity and ecosystem functioning, and outline socio-economic strategies needed to change the trajectory of aquatic biodiversity.

**10:30am - 11:15am**

## Biodiversity In The Face Of Adversity: 'Temporary' Streams As Aquatic–Terrestrial Ecosystems Responding To Global Change

**Rachel Stubbington**
Nottingham Trent University, UK; rachel.stubbington@ntu.ac.uk

Temporary streams sometimes stop flowing and many lose most or all surface water, creating mosaics of flowing, ponded and dry habitats that shift in space and time. These dynamic ecosystems dominate lotic networks in drylands, and are also common in regions with cool, humid climates. Across regions, the biodiversity of these aquatic–terrestrial ecosystems has received unprecedented research attention in recent years. In particular, biodiversity assessments have focused on the α diversity of lotic aquatic species, and compared to perennial streams, temporary streams typically support impoverished communities. However, when holistic assessments document the lotic, lentic and terrestrial species that inhabit heterogeneous, shifting habitat mosaics, temporary stream networks are shown to support high β diversity in both space and time. Their species interact with each other and their environment to perform ecological processes that deliver regulating, provisioning and cultural ecosystem services. However, human activities that alter flow regimes place the biodiversity of natural temporary streams at risk, altering their ecological functions and thus service delivery to people. Discharges and land use changes can cause profound shifts from temporary to perennial flow – but more commonly, water resource use increases dry phase durations, threatening freshwater biodiversity. Advances in biomonitoring are underway to recognize temporary streams as ecosystems which support unique communities that differ from those in perennial streams. Nonetheless, more research is needed to inform the development of effective biodiversity assessments, using innovative tools that recognize the considerable habitat heterogeneity within temporary stream subtypes. As temporary streams become increasing features in our changing landscapes, academics and stakeholders need to initiate collaborative, interdisciplinary projects designed to protect the ecological resilience of temporary streams as dynamic ecosystems that support high aquatic–terrestrial biodiversity.

**11:15am - 11:30am**

## Environmental DNA Shaping A New Era of Ecotoxicological Research

**Xiaowei Zhang**
State Key Laboratory of Pollution Control & Resource Reuse, School of the Environment, Nanjing University, Nanjing 210023, China; zhangxw@nju.edu.cn

Aquatic ecosystems, such as rivers and lakes, are exposed to multiple stressors from anthropogenic activity and changes in climate, which have resulted in a general decrease in biodiversity, alteration of community structures, and can ultimately result in reduction of resources provided by natural ecosystems. Adverse outcomes caused by pollutants to ecosystems are determined not only by toxic properties, but also ecological contexts of ecosystems, including indigenous biodiversity and community composition. It is therefore important to identify key factors, such as diversity of species and traits that determine the vulnerability of structures and functions of ecosystems in response to toxic substances. Detection and quantification of biodiversity and its activities using environmental DNA (eDNA) is arguably one of the most important technical advances in ecology in recent years.

A huge opportunity has appeared to allow more relevant approaches for assessments of risks posed to ecosystems by toxic substances. eDNA approaches provide effective and efficient tools to evaluate the effects of chemical pollutants on 1) the occurrences and population of wildlife, 2) communities, and 3) the function of ecosystem in the field. Here a conceptual framework of adverse outcome pathways to relate molecular initiating events to apical ecosystem-level responses is proposed to connecting laboratory-based prediction to observations under field conditions. Particularly, future research opportunity on effects on biodiversity, community structure, and ecosystem function by toxic substances will be discussed.

**11:30am - 11:45am**

## Tropical Water Research Alliance - An International Network for Biodiversity Conservation and Sustainable Development in Tropical Watersheds

**Marcelo da Silva Moretti[1], José Francisco Gonçalves Jr.[2], Stuart Bunn[3]**
[1]University of Vila Velha, Brazil; [2]University of Brasília, Brazil; [3]Griffith University, Australia; msmoretti@gmail.com

The general aim of the Tropical Water Research Alliance - TWRA is to develop environmental technologies and methodological supports for the development of integrated and sustainable management of tropical watersheds, through staff training and mitigation of the effects of environmental degradation and climate change. Specific aims to be pursued in the medium and short term include to: (i) apply integrated scientific protocols (case studies) between research groups from Brazil and Australia; (ii) Develop integrated management tools (Governance) of tropical watersheds bringing together academia, public and private organizations and different sectors of society with a view to sustainable development (e.g. smart cities, agro-forests, water reuse, payment for environmental services); (iii) Develop a technical start-up incubation program to respond to different social and governmental demands, including disasters (e.g. Mariana and Brumadinho), environmental crises (e.g. lack of water), pollution,

resource depletion through building, analysis and organization of databases internationally wide; (iv) Advance in a program of capacity building to public and private sectors in the environmental problems and challenges to water, social technologies, application of scientific knowledge and production of sustainable income at the watershed level (Science-Society Bridge). This project will target the quantitative and qualitative advance in scientific knowledge, strengthening strategies for reforestation, recuperation, and restoration hydro-environmental systems, and sustainable development in the watersheds of both countries. In addition, the future expectation is to assist and subsidize public policies aimed at strategies for conservation and management of water resources in river basins, through river basin committees and agencies, public managers and decision makers.

**11:45am - 12:00pm**

## The Freshwater Biodiversity Observation Network (FWBON): Current State And Development Goals

**Andreas Bruder[1], Eren Turak[2,3]**

[1]SUPSI, Switzerland; [2]NSW Department of Planning, Industry and Environment. Parramatta, Australia; [3]The Australian Museum, Sydney, Australia; andreas.bruder@supsi.ch

Freshwater ecosystems are hotspots of biodiversity, and these ecosystems and their biotic communities provide numerous crucial services for human societies around the globe. Yet freshwater ecosystems are losing biodiversity faster than most other ecosystem types due to a multitude of anthropogenic pressures and often insufficient protection status. Effective action to counter this loss requires good information on the condition of freshwater biodiversity across the world. Standardization of methodologies and datasets, and making these publicly available are two of the critical steps needed to address current information gaps. This need has led to the formation of the Freshwater Biodiversity Observation Network (FWBON), a thematic BON of the Group on Earth Observations Biodiversity Observation Network (GEOBON). FWBON aims to involve scientists, environmental managers, policy makers, and citizen scientists working in all ecoregions worldwide in action towards the following goals: (i) to coordinate the development of standardized observations and methodologies for biodiversity monitoring based on freshwater Essential Biodiversity Variables (EBV); (ii) to facilitate compilation and sharing of datasets, (iii) to expand biodiversity assessments to understudied regions and taxonomic groups, and (iv) to develop syntheses and products to support decision making by managers, administrators and politicians. In its initial phase, FWBON focused on building the network, coordinating it with other initiatives on freshwater biodiversity and with the various GEOBON working groups, and initiating developments towards standardized assessments of fish and macroinvertebrate diversity and ecosystem services. As FWBON approaches the end of the beginning, we are assessing the achievements and challenges and work towards identifying the goals for the next phase of its activities. These will focus on developments of EBV in the classes of genetic composition of communities, species traits and ecosystem function in addition to refinements of EBV in classes that are already further advanced (i.e. species populations, community composition, and ecosystem structure).

**12:00pm - 12:15pm**

## Open Data Sharing Opportunities for Conservation of Freshwater Biodiversity: Lessons from Biodiversity Informatics Projects across Sub-Saharan Africa

**Vianny Natugonza**

National Fisheries Resources Research Institute (NaFIRRI), Jinja, Uganda; viannynatugonza@yahoo.com

Freshwater biodiversity is more threatened in Africa than anywhere else in the world apart from Asia. Apparently, the threats are intensifying because freshwater biodiverity and dependent ecosystem services are overlooked in policies, partly due to limited awareness by the public and decision makers. The limited awareness is associated with inacessiblity to user-friendly freshwater biodiversity data and information. Elsewhere, increased access to freshwater biodiversity information has been shown to faciliate conservation planning, thereby mitigating threats to aquatic biodiversity and ecosystem services. Here, I seek to share (i) experiences on biodiversity informatics projects in the sub-sharan Africa, involving mobilisizing existing freshwater biodiversity data and making it publicly available through online data repositories, including how to change perceptions of data holders to embrace open data sharing, and (ii) opportunities that the mobilised user-friendly data could offer for freshwater biodverity conservation. I will also show that besides increasing access to data in user-friendly formats, baseline data can be obtained on aquatic ecosytems previously thought to have no baseline information. Equally, areas that are in urgent need for baseline data collection can easily be identified. Data are needed to improve on the knowledge of localities with threatened species, designating key biodiverity areas, and assessing conservation status of data deficient and unevaluated taxa. These applications were previously limited in Africa due to inadquate data; presently, there is positive progress but the effort will need support from both data holders and data users across the continent. I believe the lessons learnt to date can inspire scientists and research, especially within the African Great Lakes region, to upscale the data mobilisation efforts, and to raise awareness among the public and decision makers to support decision making.

**12:15pm - 12:30pm**

## Living Water: A Research Agenda on Freshwater Biodiversity

**Sonja C. Jähnig[1], Daniel Hering[2], Ralf B. Schäfer[3], Jonathan Jeschke[1,4], Michael T. Monaghan[1]**

[1]Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB); [2]University of Duisburg-Essen; [3]University of Koblenz-Landau; [4]Freie Universität Berlin; sonja.jaehnig@igb-berlin.de

Fresh waters including their floodplains and adjacent coastal waters represent a global hotspot of biological diversity, which e.g. harbour approximately 40% of all fish species within 0.3% of global water. They are also among the most threatened ecosystems on Earth, yet receive much less attention than terrestrial and marine ecosystems. In many places, fundamental alterations of freshwater biodiversity have occurred due to human interventions which subsequently compromised key ecosystem functions and services. Legislative and other measures to preserve and promote freshwater biodiversity so far have proven to be insufficient, even though major challenges have been regionally solved in the past, such as the organic pollution and acidification of streams. Due to the multitude of human pressures, more comprehensive approaches to protect freshwater biodiversity must be urgently developed and implemented.

Bearing this in mind, biodiversity research is called upon to provide workable approaches, appropriate methods and detailed information supporting more efficient conservation. As a first step, a large number of scientists engaged in aquatic biodiversity research have jointly prepared the ‘Living Water Research Agenda on Freshwater Biodiversity’. We have identified the following overarching research needs: (1) data infrastructure: acquisition, mobilization, integration and provision of data; (2) monitoring: documenting the status and development of freshwater biodiversity; (3) ecological research: achieving a mechanistic understanding of influencing factors, and especially of anthropogenic pressures; (4) socio-ecological research: the role of society; and (5) management: developing approaches, strategies and measures for sustainable biodiversity management for achieving national, European and global biodiversity targets.

We present the Research Agenda and discuss how challenges and priorities in freshwater biodiversity research vary regionally within all bioclimatic zones of the world. Further comments will be collected to foster discussions and international collaborations that may help to spread the idea. We invite interested colleagues to further contribute to the agenda and thus to generate additional momentum to propel freshwater biodiversity to the forefront of global and regional research agendas, which constitutes a prerequisite to counter the ongoing global biodiversity crisis.

# 178S-1: Using Earth Observations to understand changes in biodiversity and ecosystem function

*Time:* Wednesday, 26/Feb/2020: 10:30am - 12:30pm · *Location:* Sertig
*Session Chair:* Jeannine Cavender-Bares, University of Minnesota, United States of America

Earth observation is an essential complementary component to in situ observations and experiments designed to observe and understand changes in biodiversity, forcing mechanisms, and changes in ecosystem function across a range of spatial and temporal scales. NASA is a recognized a leader in satellite technologies for earth observation and the scientific understanding that underlies global ecological processes and forces of change. In recent years, the NASA Biodiversity and Ecological Forecasting program has pushed the research community to explore new methods to monitor biodiversity.

We introduce NASA supported state-of-the-art work, with keynote presentations illustrating the response of biodiversity and ecosystem function to environmental change, and exploring the impacts of (anthropogenic) drivers of change and their interactions and feedbacks with ecosystems. This session is linked to session 155S The future of remote sensing of biodiversity, where we will identify future research directions in assessing biodiversity (change) with remote sensing technologies.

**10:30am - 11:00am**

## Unlocking the Functional Biogeography of Forests: Lessons Learned From Spectranomics

**Roberta Enders Martin**
Arizona State University, United States of America; roberta.martin@asu.edu

Biological diversity is under threat from human activities and a rapidly changing climate; yet, we lack critically important information at spatial scales commensurate with much needed management and conservation action. There is an urgent need for better quantification and monitoring of biodiversity and its relationship to ecosystem function at multiple scales. Remote sensing and trait-based ecological approaches are huge steps forward but how do we bridge the gap between coarse measurements of plant function derived from satellites and detailed measurements from field plots to understand forest function in a spatially explicit manner? My answer is through a combination of foliar chemical traits, spectroscopy and phylogenetic information that comprise what we call Spectranomics. The Spectranomics approach was developed to link plant canopy functional traits to their spectral properties with the objective of providing time-varying, scalable methods for remote sensing of forest biodiversity. In this talk, I will explain key components of Spectranomics and highlight how this approach allows us to elicit biogeographical patterns of forest biodiversity that will help us understand its role in ecosystem function particularly in the face of environmental and anthropogenic change.

**11:00am - 11:30am**

## Functional Diversity at the Continental Scale

**Philip A. Townsend[1], Zhihui Wang[1], Adam Chlus[1], Ting Zheng[1], Fabian Schneider[2], Ryan P. Pavlick[2], David Schimel[2], Eric L. Kruger[1]**
[1]University of Wisconsin-Madison, United States of America; [2]Jet Propulsion Laboratory, California Institute of Technology; ptownsend@wisc.edu

We lack essential baseline data to characterize biological diversity in the context of a rapidly changing planet. Imaging spectroscopy offers the potential not only to fill these knowledge gaps, but to provide new insights into the roles of species and environment as drivers of plant functional diversity at broad scales. Notably, spectroscopy enables measurements of a larger suite of traits over a greater spatial extent than traditional approaches. Using data from NASA airborne missions and the U.S. National Ecological Observatory Network (NEON), I will illustrate how spectroscopic data are reshaping our understanding of core ecological concepts such as the leaf economics spectrum (LES) and trait plasticity. Using millions of measurements (rather than hundreds or thousands), I show that the core relationships stand up, but also that the interesting patterns of functional diversity extend beyond traditional relationships addressed by the LES. Moreover, the data reveal broad deviations in relationships among traits that suggest a variety of modes in which phenotypic plasticity is expressed across biomes. While estimates of functional diversity from remote sensing cannot fully replace inventories as a basis for cataloguing global taxonomic diversity, they depict other aspects of diversity important to understanding ecosystem function and the responses or ecosystems to global change at large scales. Ultimately, this provides a foundation to better address impacts of future change.

**11:30am - 11:50am**

## Mapping Plant Functional Diversity Within and Among Forest Canopies

**Kyla Marie Dahlin[1], Aaron G. Kamoske[1], Shawn P. Serbin[2], Scott C. Stark[3]**
[1]Department of Geography, Environment, and Spatial Sciences, Michigan State University, USA; [2]Brookhaven National Lab, USA; [3]Department of Forestry, Michigan State University, USA; kdahlin@msu.edu

Within a forest canopy, plant productivity depends on two suites of factors: 1) the functional diversity of plants and 2) the physical structure or canopy architecture, and therefore the within-canopy light environment, of the forest. Predictive models of plant productivity, from ‘green slime’ to ‘big leaf’ to multi-layer, assume that photosynthetic rates can be lumped into generalized classes (‘plant functional types’) and that explicit handling of the three-dimensional structure of the forest is not essential to estimating its productivity. Yet we know these assumptions are inadequate – important plant functional traits like foliar nitrogen concentrations ([N]L) and leaf mass per area (LMA) can vary significantly within a single species and through a canopy, where the radiation regime and the amount of light a leaf receives is not due to its general canopy position but is due to the locations of the leaves and branches that surround it. Here we use hyperspectral imagery (HSI) and LiDAR data from the National Ecological Observatory Network’s (NEON’s) Airborne Observation Platform to model the three dimensional distribution of [N]L and LMA through the forest canopy. We show that LiDAR-derived metrics of forest canopy structure can be used to predict LMA and within canopy nitrogen content. When we compare landscape patterns of top of canopy and total canopy nitrogen, we show that total canopy nitrogen is less variable across the landscape than top of canopy nitrogen, suggesting that diverse groups of plants optimize whole plant nitrogen content, as has been suggested by ground based research. Over time, at the landscape scale these observations may reveal that some patches may be more stable and resilient, while others may be at risk or nearing a tipping point.

**11:50am - 12:10pm Warning: The presentations finish prior to the end of the session!**

## Ecosystem Resilience to Global Environmental Change in a Biodiversity Hotspot

**Adam M Wilson[1], Jasper Slingsby[2], Glenn Moncrieff[2]**

[1]University at Buffalo, United States of America; [2]South African Environmental Observation Network; adamw@buffalo.edu

Integrated research across biological scales is vital to understand and anticipate the ecological implications of global environmental change. In particular, the feedbacks between climate, biodiversity, and ecosystem function/services are not well understood. These feedbacks are especially important in fire-prone biomes which cover approximately 40% of Earth's land surface. There is now a plethora of ecological, natural history, climate, and remotely sensed data available to address this important issue. I explore the potential for climate-biodiversity-ecosystem function feedbacks in the Cape Floristic Region (CFR), a biodiversity hotspot in South Africa. Firstly, I describe an analysis of multi-decadal satellite and field observations. We found that post-fire recovery rate has strong gradients, associated with climate, resulting in faster recovery in regions with higher soil fertility, winter temperature, and summer precipitation. Secondly, we conducted an analysis of the longest-running permanent vegetation plots in the region (44 years) and relate observed changes in diversity and composition to fire history, extreme weather in the first summer after fire, and alien plant species invasion. We found a significant decline in plant diversity over time which was associated with increasingly severe post-fire summer weather events (number of consecutive days with high temperatures and no rain) and alien plant invasion. We also observed a 1˚C increase in maximum temperature tolerance of the species sets unique to each survey, which suggests there has been selection for species adapted to warmer conditions. Observed differences in the response of major growth forms and fire-response types could drive major shifts in ecosystem structure and function such as altered fire behavior, hydrology, and carbon storage. This is the first example of climate change impacts on biodiversity in this hyperdiverse region and demonstrates an important interaction between extreme weather and disturbance by fire that suggests flammable ecosystems are particularly sensitive to climate change.

# 101S: Understanding cultural, ecosystem and environmental diversity across the world's mountains

*Time:* Wednesday, 26/Feb/2020: 10:30am - 12:30pm · *Location:* Schwarzhorn
*Session Chair:* Robert Marchant, University of York, United Kingdom
*Session Chair:* Ricardo Grau, Instituto de Ecología Regional, CONICET-National University of Tucumán, CC 34 (4107) Yerba Buena, Tucumán, Argentine Republic
*Session Chair:* Julia Klein, Colorado State University, Dept. Ecosystem Science & Sustainability, Campus Delivery 1476, Fort Collins, CO 80523 USA
*Session Chair:* Aida Cuni-Sanchez, University fo York, United Kingdom
*Session Chair:* Christine Schmitt, Center for Development Research, University of Bonn, Genscherallee 3, D-53113 Bonn, Germany

Mountains provide an ideal natural laboratory to investigate the evolution of social-ecological systems, and to assess the current challenges and opportunities that this past evolution has created. Mountains have been centres of past development and conduits for the spread of crops, populations and technologies. They were and remain a locus for cultural interaction, as manifested recently in many parts of the world at the local level through pastoral-agricultural-urban interactions over access to space and resources, particularly water.

Drivers such as climate change, high population growth, over-exploitation of resources, poor and ineffective governance and rapid land-use change are all combining to compromise the potential of the world's mountains to continue sustaining the flow of Ecosystem Services, including food, timber, water, carbon storage, dry-season pastures, nutrient cycling, soil formation, among many others. The growing evidence for elevation-dependent warming has important implications for the mass balance of winter snow accumulation and associated runoff; critical in a future characterized by greater water-scarcity. The ecosystem services provided by mountains thus extend downstream, affecting farming communities, urban centres, ecosystems and biodiversity in general, including the species that reside in these highland biodiversity hotspots.

**10:30am - 10:45am**

## Assessing And Aggregating Knowledge Across Diverse Mountain Contexts - Experiences With IPCC

**Carolina Adler**
Mountain Research Initiative, Switzerland; carolina.adler@giub.unibe.ch

Global scientific assessment efforts, such as those conducted by the Intergovernmental Panel on Climate Change (IPCC), seek to synthesise and assess the large scientific body of evidence on the effects and responses to phenomena such as climate change and present these results in narratives, figures and key messages that inform the knowledge needs of policy makers. Mountain environments, as geographically distributed and fragmented regions across the world, and each with unique socio-economic and cultural aspects that define their context in place, pose certain methodological challenges to the aspired goal of synthesis and generalisability at the global scale that global assessments aim at. This presentation will offer reflections on some of the key challenges and experiences in bringing knowledge on coupled social-ecological knowledge on mountains to the IPCC Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC), in particular in its chapter on High Mountain Areas. As the IPCC assessment effort continues in the main assessment reports of this 6th assessment cycle (AR6), further reflections are offered on what is needed to present scientific evidence and information that is relevant in the understanding of mountain social-ecological systems under climate change in order to inform policies that are fit-for-purpose in diverse mountain contexts. Reflections on the role of global mountain research networks such as the Mountain Research Initiative (MRI) and the Group on Earth Observations Global Network on Observations and Information in Mountain Environments (GEO-GNOME) are also offered for discussion.

**10:45am - 11:00am**

## Landscapes in Motion: Human Migration and Mobility Shaping Landscapes in Mountainous Regions in Central Asia and Africa

**Houria Djoudi[1], Bruno Locatelli[2], Christopher Martius[1], Zulfiya Bakhtibekova[3]**
[1]CIFOR; [2]CIFOR/CIRAD; [3]UCA; h.djoudi@cgiar.org

Human migration and mobility have always been an important feature of how people interact with their environment and, in recent years, there has been an increased interest in understanding mobility drivers and effects. In many regions of the world, mountains have been at the heart of human mobility, including transhumance, nomadism and human migration. The field of ecosystem services research has been opening to include broader human and social dimensions toward an interdisciplinary understanding of landscape processes and changes. Yet links between mobility, migration, and landscape changes have been largely overlooked in the landscape-related literature including in the landscape ecology body of literature. Vice versa the environmental impacts of human mobility are missing in the migration research field. By capturing and analyzing the diversity of linkages between human mobility or migration and landscape dynamics, this paper aims to fill those gaps and to illustrate with concrete examples, how integrating human mobility thinking and research can trigger new perspectives in the field of landscape ecology. These linkages can be farmed in different ways. Mobility and migration induce significant changes in rural and urban areas, by direct demographic and social changes or indirectly through the investment of remittances in the landscape of origin. Using a pathways analysis approach, we examined different migration trajectories and their impact on the use and the management of ecosystems in several cases studies in drylands. We explored the impacts of remittances on various human activities and ecosystem use or management. We also analyzed how knowledge, values and rules evolved along the migratory pathways and affect ecosystem management. The results highlight different types of feedbacks between human migration and social and ecological processes in the landscape of origin. They also show various feedback loops between migration and landscape recovery or degradation. Migration can induce adaptive or maladaptive pathways, which have profound consequences on landscape sustainable or unsustainable trajectories. Rather than conceptualizing mobility and landscape dynamics separately, development and landscape conservation policies need to better integrate mobility and migration in their analytical frames in order to achieve long term, desired, landscape conservation and development outcomes.

**11:00am - 11:15am**

## Tree Diversity, Structure And Biomass Of 35 Tropical Montane Forests In Africa

**Aida Cuni-Sanchez[1], Martin Sullivan[2], Christine Schmitt[3], Rob Marchant[1]**

[1]University fo York, United Kingdom; [2]University of Leeds, United Kingdom; [3]University of Bonn, Germany;
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Tropical montane forests are biodiversity rich ecosystems, which also store important quantities of carbon. Despite their potential to store and sequester substantial amounts of carbon, little is known about the above ground biomass (AGB) and the factors affecting it in these ecosystems, especially in Africa. We investigated height-diameter allometry, structure, tree diversity and AGB, and analysed relationships with environmental attributes in 35 mountain sites across Africa. We assembled over 400 plots of varying sizes, where all trees ≥10cm had been measured for diameter and the majority of stems identified to species. About 60 % of the plots also had field measurements of tree height.

We identified the importance of accounting for variation in height-diameter allometry between sites, with a general equation for all plots under/over estimating AGB in some sites. We found marked variation in structural and taxonomic attributes and AGB. The latter ranged from 20 to 800 Mg $ha^{-1}$, and was more closely related to structural than taxonomic attributes. With regard to environmental parameters, mean annual temperature, rainfall seasonality and cloud cover were the main drivers of AGB. Although we focused on closed-canopy, non-logged and non-managed forests, the effects of historical disturbance, large mammals and landslides should be further investigated. We note that some forests contained comparable AGB to lowland rainforests, highlighting the importance of tropical montane forests as large carbon stock, which could be released if converted to another land cover type. We also discuss the need to foster research in plant identification in some sites, where numerous stems were identified to genus only given the lack of reference material for those regions.

**11:15am - 11:30am**

## Different Aspects Of Global Change Govern Responses Of Vegetation And Soil In The European Alps

**Aline Buri, Sabine Rumpf, Sébastien Tesson, Carmen Cianfrani, Stéphanie Grand, Antoine Guisan**
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Climate change has major impacts on ecosystems worldwide and mountains areas are warming at an even faster rate than other terrestrial environments. In addition, land use changes have profound impacts on biodiversity and soil properties. Yet, the interface of vegetation and soil is related to many ecosystem services provided by mountain areas, understanding its response to global change is thus crucial. Although many studies demonstrated the impacts of global change on plant species and communities, responses of soil properties are far more uncertain, and it still remains largely unknown whether vegetation and soil respond to the same aspects of global change. Here, we analysed changes of vegetation and soil composition after more than 40 years in 88 re-surveyed semi-permanent plots in the Swiss Alps. Both plant species and soil composition changed significantly over time. Plant species from lower elevations and those adapted to moist habitats, forests and fertilized meadows increased in the study area, while species adapted to dry conditions and unfertilized meadows declined. Organic carbon, nitrogen, organic matter content, and pH increased in the soil. Yet, changes of species and soil composition were unrelated and driven by different aspects of global change. The expansion of human settlements was the most important driver of vegetation changes, while changes of agricultural management were most important for changes of soil composition. Notably, land use changes and their interactions with topography were more important than climate warming for both species and soil composition. Our findings thus suggest that global change has a major impact on both mountain vegetation and soil but that they are governed by different aspects of it. In the decades to come, this might lead to asymmetrical responses of vegetation and soil, with important consequences for the conservation of mountain ecosystems and our capacity to predict their future trajectory.

**11:30am - 11:45am**

## Integrating Nature's Value Within Spatial Conservation Prioritization

**Cindy Ramel[1], Pierre-Louis Rey[2], Rui Fernandes[1], Antoine Guisan[1,2]**
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As anthropogenic degradation of ecosystems increases, so does the potential threat to the supply of ecosystem services (ES), a key contribution of nature to people. For ES to be fully considered as a solution for the decision making, it should be integrated within conservation planning. Here, we selected ten ES that were economically evaluated and mapped in the Vaud Alps area (Switzerland), and integrated with distributions species models into a spatial conservation prioritization (SCP) scheme. Different weighting scenarios for biodiversity and ES were used to simulate alternative actions of makers and evaluate the effectiveness of different conservation networks (which does not directly include the specific richness or quality of a landscape). The solutions were compared to existing protected areas and to the SCP analysis focused solely on biodiversity (diversity and species richness). Our results reveal that putting too much weight on ES could be detrimental for biodiversity, and that the best priority area compromising biodiversity conservation and ES are not located in the current protected areas, questioning the effectiveness of the present reserve network which were not conveived in this way when they were created. The approach proposed is a powerful tool to increase the communication between scientists and decision-makers, and has the potential to further integrate many other socio-economic and ecological drivers, and ultimately fuel the development of more informed, evidence-based conservation decisions.

**Keywords**

Ecosystem services, conservation planning, economic valuation, Human-Biodiversity tradeoff, spatial prioritization, Decision support tool, Zonation software, Evidence-based conservation.

**12:00pm - 12:15pm**

## Long-term Dynamics and Spatial Interactions of Multiple Ecosystem Services in the European Alps

**Uta Schirpke[1,2], Erich Tasser[1], Lukas Egarter Vigl[1], Ulrike Tappeiner[1,2]**
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Human activities have shaped cultural landscapes in the European Alps over centuries. During the last decade, massive land-use changes, in particular the abandonment of mountain grassland, are responsible for ongoing landscape changes and related shifts in the supply of ecosystem services (ES) with huge consequences for the local populations as well as the people living in the surrounding lowlands. Here, we focus on three major aspects that characterize recent trends in the European Alps: (1) land-use/cover changes over the past 150 years, (2) trajectories in multiple ES supply and future trends, and (3) spatial mismatches between ES supply and demand across different landscapes. Our results show that forested areas have increased mainly at the cost of mountain grassland, while agricultural use of easily accessible sites and fertile valley floors have been intensified. Consequently, ES supply shifted in many regions from provisioning services towards predominantly regulating services. Three major trajectories could be identified: regions developing from single to multifunctional sites, sites reducing their service capacities

and sites with rather stationary patterns over long periods. Future scenarios indicate that legacy effects of past land-use changes together with accelerating climate change will increase the vulnerability of managed ecosystems and constrain management options. Moreover, we found important supply-demand mismatches across landscapes, i.e. mountain regions were generally hotspots of ES supply, whereas highly urbanized areas or intensively used agricultural areas in the lowlands were related to high demand. For most ES, the spatial flow was directed from mountain regions towards lowland areas, including areas far beyond the regional level, and will become even more important in the future. Our findings contribute to an enhanced understanding of ES in the European Alps and in mountain regions in general, which can provide valuable information for decision-making and developing sustainable management strategies at different levels.

**12:15pm - 12:30pm**

## Climate And Land Use Change Lead To Marked Changes In Swiss Breeding Bird Abundance

**Thomas Sattler, Sylvain Antoniazza, Samuel Wechsler, Jerome Guelat, Marc Kery, Nicolas Strebel, Peter Knaus**

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The climate in Switzerland has become much warmer in the past 40 years, most pronounced in the Alps with an increase of about 2°C. In addition, the abandonment of traditional grazing practices has led to substantial forest expansion as well as agricultural intensification to loss of habitat diversity in open areas. Hence, rapid climate change and land use change may act in concert to change breeding bird species distribution and abundance in the region. While the populations of agricultural species have halved, forest birds have increased by app. one million breeding pairs between the two periods 1993–1996 and 2013–2016 in which field work for the last two breeding bird atlases took place. Thanks to the unique quantitative data from these atlases, we obtained marked changes in average altitudinal distribution and changes in abundance of climate-sensitive species: the altitudinal distribution of 71 common breeding birds shifted upwards by 24m on average between 1993–1996 and 2013–2016. Almost two thirds of all species have shown an upward shift in average altitudinal distribution, 22 of them by more than 50m. In contrast, only four species experienced a downward range shift of 50m or more. A common pattern has emerged for 20 species with very different habitat requirements that highlights the potential influence of climate change: their populations are decreasing at lower altitudes while increasing in the upper reaches of the range. Between 1993–1996 and 2013–2016, 20 species predicted to be climate winners increased together by around 7,700 territories (from 25,400 to 33,100), while 20 predicted climate losers have declined by about 91,000 territories (from 453,000 to 362,000). The combined effects of climate and land use change are expected to exert even more pronounced effects on breeding birds in the Alps in the future.

# 190S: Integrated Pathways for Sustainable Biodiversity Futures

*Time:* Wednesday, 26/Feb/2020: 10:30am - 12:30pm · *Location:* Seehorn
*Session Chair:* Eva Spehn, Swiss Biodiversity Forum, Switzerland
*Session Chair:* Andreas Obrecht, SDSN Switzerland, Switzerland
*Session Chair:* Davnah Payne, Global Mountain Biodiversity Assessment, Switzerland
*Session Chair:* Ariane Carole de Bremond, Global Land Programme, Switzerland
*Session Chair:* Hannah Moersberger, Future Earth, France
*Session Chair:* Gabriela Wuelser, SCNAT Sustainability Research Initiative, Switzerland

This session explores existing knowledge on the linkages between biodiversity and the SDGs and discuss challenges associated with collecting, providing, and implementing knowledge on this linkage to support social and political transformation. Short presentations are followed by a moderated fishbowl discussion, inputs will be summarised in a policy brief which will be shared with participants and beyond upon finalisation.

Co-designing biodiversity futures with relevant actors across sectors, backgrounds, values, and communities requires a highly integrated approach taking into account trade-offs and synergies with other development goals. The 'wedding cake' (EAT 2016) illustrates how the SDGs on life on land (SDG 15), life below water (SDG 14), clean water and sanitation (SDG 6), and climate action (SDG 13) are fundamental for achieving the 2030 Agenda of the United Nations. Life on land and below water both pertain to biodiversity, which through various conventions (Convention for Biological Diversity, CBD), platforms (Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services, IPBES), initiatives (e.g., Group on Earth Observations Biodiversity Observation Network, GEO BON), and projects (e.g., Half-Earth Project) has recently attracted immense attention. Accordingly, it is commonly assumed that the conservation and sustainable use of biodiversity is essential for achieving the Sustainable Development Agenda. The underlying evidence is however scattered and not readily available for decision makers. How can we best operationalize this knowledge for more sustainable, integrated biodiversity protection and management?

## Producing useable Knowledge for Sustainable Governance of Land and Biodiversity: Potential Contributions from Land Systems Science

**Ariane Carole de Bremond**
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Land systems lie at the intersection of diverse interests and claims concerning societies' needs for sustainable development. Thus, implementation of the Agenda 2030 Sustainable Development Goals (SDGs) may ultimately translate, in many contexts, into competing claims on scarce land resources. Land system scientists are not oblivious to this: since 2015, the scientific community of Future Earth's Global Land Programme (GLP) has produced over 5000 scientific publications (data from Scopus), many of which address aspects that are relevant to governance of land and biodiversity. This presentation first provides an overview of results of research published by Ehrensperger et al., 2019, that sought to understand the ways in which knowledge being produced by the land systems science community represented by the Global Land Programme (GLP) of Future Earth maps to different SDG targets, and more specifically, to interactions between different SDG targets, assuming that the latter are representative of the competing development claims placed on land (for example between biodiversity protection and agricultural production).

Knowledge that helps addressing complex interactions between multiple claims on land is particularly useful for supporting sustainable land governance, because it may provide clues on how to navigate trade-offs and to maximise synergies between these different claims. However, while land systems science is producing knowledge that could be relevant to sustainable development, it is an open question whether the knowledge contained in these publications is accessible and useful to societal partners and practitioners concerned with the promotion of sustainable governance of biodiversity and land around the world. Taking the land systems science community of the Global Land Programme as an example, we will also reflect on the means and options to enhance practitioners' access to relevant scientific knowledge of land systems as complex integrated socio-ecological systems such that this science can better contribute to identification of win-lose questions and socio-ecological trade-offs associated with different development pathways.

## Indigenous And Local Knowledge Matters For Biocultural Diversity and Sustainability

**Berta Martín-López[1], Carla Bank[2], David Lam[3]**
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In the realm of local sustainable initiatives, research shows that the inclusion of Indigenous and Local Knowledge (ILK) can contribute to preserve biocultural diversity and to achieve SDGs. In this study, we determine to what extent ILK-inclusive projects can offer leverage points for achieving biocultural diversity conservation in Latin America. We understand the role of ILK in the development and outputs of local initiatives that aim to preserve biocultural diversity. We used a "bright spots" lens, in which we identified 100 initiatives that have achieved conservation of biocultural diversity in in Ecuador and Peru. We characterized these initiatives based on (i) distribution and ecosystems range, (ii) main challenge to address, (iii) type of funding and funders, (iv) stakeholders with whom the indigenous peoples and local communities have networked, (v) governance of the project (i.e. bottom-up or top-down), (vi) inclusion of ILK during the project, and (vii) main outputs and outcomes achieved. We performed a multiple correspondence analysis and hierarchical cluster analysis, followed by Kruskal-Wallis tests, to characterize thematic clusters. Our results show that there were four main clusters of projects. The first cluster aims to foster agrobiodiversity and climate change resilience through ILK. These projects were led by ILK-holders who networked with other local actors, such as local organizations and were governed through bottom-up processes. In this cluster, ILK was included throughout the development of the projects through co-design. The main outcome of projects belonging to this cluster was to empower indigenous peoples and local communities, while preserving biocultural diversity and improving people's livelihoods. The second cluster was comprised by projects that bring economic opportunities to indigenous and local communities. The third cluster was comprised by projects that protect nature through legal support. These projects network with national NGOs and the main achievements relate with raising awareness and scientific outputs. The last cluster aims to protecting biodiversity through the active engagement of indigenous peoples and local communities. These results highlight the benefits of engaging indigenous communities and their ILK in the design and development of biocultural diversity projects to conserve biodiversity while enhancing people's quality of life.

## Mountain Biodiversity for Sustainable Development

**Graham William Prescott[1], Davnah Payne[2], Mark Snethlage[2], Jonas Geschke[1], Eva Spehn[2], Markus Fischer[1,2]**
[1]University of Bern, Switzerland; [2]Global Mountain Biodiversity Assessment; grahamprescott@gmail.com

Billions of people worldwide depend on services provided by healthy and biodiverse mountain ecosystems for their livelihoods, water, food, and protection from natural disasters. Conserving mountain biodiversity (SDG 15.4) is therefore key to providing a sustainable future for nature and people in mountains and beyond. At the Global Mountain Biodiversity Assessment, we apply various approaches to develop policy-relevant knowledge on the role of mountain biodiversity in supporting human wellbeing and in achieving transformations towards sustainability. With this focus, we align our conceptualization of mountain social-ecological systems to the nature-and-people framework of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). Here we present knowledge gained with different approaches. We discuss how these results and approaches can be applied from the local to the global scale in process of co-design, adoption, and implementation of science-based biodiversity-explicit pathways. Our current approaches include:

a) the application of the IPBES framework in an online survey to 140 mountain experts worldwide to assess the status of, trends in, and relationship between biodiversity, ecosystem services, human wellbeing, and their drivers;

b) its application for the analysis of 631 abstracts pertaining to four mountain systems to refine our understanding of the commonalities and singularities between mountain regions – including in the importance of individual SDGs;

c) its application in a participatory workshop with five different stakeholder groups from the Mount Kilimanjaro area to reveal fine-grained differences in perceptions and priorities, as well as in the types of actions deemed useful for long-term nature conservation;

d) comparison of direct SDG interaction scoring and intercorrelations of both expert-assessed SDG trends and World Bank indicator time series for African ecosystems;

e) comparison of SDG trends at local, regional, and national scales in mountains of Nepal, Tanzania, and Bolivia, using literature review, expert surveys, and field questionnaires.

## Multi-stakeholder Workshops to Design Transformative Pathways for Biodiversity in France: Update on an Ongoing Process

**Paul Leadley[1], Vincent Virat[2]**

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Achieving the Sustainable Development Goals (SDGs) urges the design and implementation of innovative sustainability pathways, involving a large range of stakeholders and their knowledge, prompting Future Earth to launch the Science-Based Pathways for Sustainability initiative. Its first phase focuses on designing national sustainability pathways in a series of pilot countries employing transdisciplinary approaches to engage multiple stakeholders (scientists, policy makers, civil society & the private sector). An ongoing pilot process was initiated in France in 2019, exploring novel ways to co-design a qualitative scenario and its pathway to reach the overarching objective for France “bending the curve of biodiversity loss by 2030” (“objective for 2030”). The designed scenario seeks to account for possible synergies and tradeoffs between the stated objective for 2030 and the others SDGs, including with Agriculture and Food (SDG 2), Freshwater (SDG 6), Energy (SDG 7), Inequalities (SDG 10), Cities (SDG 11) and Ocean (SDG 14). Furthermore, interactions with other scales were also explored to identify possible implications of the national pathway for other countries and regions. In the end, three key transformations were identified as part of the pathway to reach the objective for 2030 and analysed using the Transformative Adaptation Research Alliance framework: ‘halting land take for infrastructure and housing’, ‘finding new modes of sobriety in the consumption of phytosanitary products and synthetic fertilisers’ and ‘reconnecting people with nature’.

# 141S-1: Phylogenetic and genetic diversity

*Time:* Wednesday, 26/Feb/2020: 10:30am - 12:30pm · *Location:* Wisshorn
*Session Chair:* Luc De Meester, KU Leuven, Belgium
*Session Chair:* Felix Forest, Royal Botanic Gardens, Kew, United Kingdom

Evolution is the fundamental biological process that is the underlying driver of biodiversity. Past evolution has led to the tree of life with millions of species, each with their own unique characteristics and adaptations to specific environmental conditions. This phylogenetic diversity fosters resilience of ecosystems to environmental change and provides insurance and options for the future.

Genetic diversity is key to the potential of populations and species to evolve and adapt to novel conditions. In the last decade, it has become increasingly clear that evolutionary dynamics can strongly impact the response trajectories of populations to global change. Yet, at the same time, global change impacts the distribution and amount of genetic diversity that fosters evolutionary potential. In this session, we will highlight and discuss the important links of evolution to sustainability. Both phylogenetic diversity and contemporaneous evolution (genetic diversity and eco-evolutionary dynamics) are key drivers of ecological responses to global change and of resilience of ecosystems in the face of anthropogenic disturbance. Concepts and tools rooted in evolutionary biology can be used to enhance sustainability of food production, reduce the incidence of antibiotic and pesticide resistance, reduce the spread of disease and inform health decisions. In this session, we will discuss how past and contemporary evolution, evolutionary applications in agriculture and health, and the evolutionary toolbox can contribute to the sustainable developmental goals.

**10:30am - 11:00am**

## Introduction To The Session: Linking Evolution To Sustainability Science

**Luc De Meester**
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Evolution is the fundamental biological process underlying the origin of all biodiversity. Past evolution has led to the tree of life with millions of species, each with their own unique characteristics and adaptations to specific environmental conditions. This phylogenetic diversity fosters resilience of ecosystems to environmental change and provides insurance and options for the future. Genetic diversity within and among populations is key to the potential of populations and species to evolve and adapt to environmental change. In the last decade, it has become increasingly clear that evolutionary dynamics can strongly impact the response trajectories of populations to global change. Yet, at the same time, global change impacts the distribution and amount of genetic diversity that fosters evolutionary potential. Evolutionary insights and tools can in many ways contribute to sustainability. Both phylogenetic diversity and contemporary evolution are key drivers of ecological responses to global change and of resilience of ecosystems in the face of anthropogenic disturbance. Concepts and tools rooted in evolutionary biology can also be used to enhance the protection of biodiversity, sustainability of forestry and food production, mitigation of the incidence of antibiotic and pesticide resistance, reduction of the spread of invasive species and disease, and to inform health decisions. In this introduction to the session, we highlight how evolutionary insights can contribute to sustainability science, and provide an introduction and examples on how past and contemporary evolution, evolutionary applications in agriculture, health and conservation, and the evolutionary toolbox can provide important contributions to reaching the UN Sustainable Developmental Goals. We will also briefly introduce bioGENESIS, the Global Research Project of Future Earth that aims to strengthen the contribution of evolutionary insights to sustainability science.

**11:00am - 11:15am**

## Phylogenetic Diversity Metrics, Option Values And Sustainability

**Felix Forest**
Royal Botanic Gardens, Kew, United Kingdom; f.forest@kew.org

Phylogenetic diversity is a biodiversity metric based on the evolutionary relationships between taxa and is thus often refer to as evolutionary diversity. While it is often used to refer to the range of measures based on evolutionary relationships, it was originally defined as the sum of all branches connecting a set of taxa on a phylogenetic tree. Spatial patterns of phylogenetic diversity have been used to identify regions of greater biodiversity value (i.e. hotspots) that should in principle be prioritised for conservation. Phylogenetic diversity has also been advocated as a surrogate for evolutionary potential and can be considered as a good indicator of the capacity of an ecological system to respond to environmental changes, particularly its resilience in the face of anthropogenic pressures. In this contribution, I will outline briefly the most commonly used biodiversity metrics based on phylogenetic information. I will also outline how these approaches are important to maintain a great diversity of features required to provide the potential future uses and benefits for humans and nature, i.e. option values, and how the information they provide is essential for increasing the sustainable uses of biodiversity by human societies.

**11:15am - 11:30am**

## Evolution, Biodiversity, and Human Health

**Rees Kassen**
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Natural communities of microbes are often highly diverse. Why and how this diversity evolves and is maintained remain the central problems – one might more accurately say obsessions – in biology. The answer also has important implications for environmental and human health, especially when diversification occurs in pathogenic microbes that cause disease. Diversity in pathogen populations can make it harder to treat infections in the clinic and design effective public health interventions to reduce the prevalence of, say, antimicrobial resistance in the community. My presentation will show how the principles of evolutionary diversification that generate the incredible diversity of life around us also underpin the development of chronic infections in the lungs of patients living with cystic fibrosis and provide a way forward for managing antimicrobial resistance.

**11:30am - 11:45am**

## The Evolution Of Life In Cities And Its Importance For Sustainability

**Marc T. J. Johnson**
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Cities are the fastest growing ecosystem on Earth, and more than half of the world's human population now live within urban areas.

The effects of urbanization on the ecology of organisms and functioning of ecosystems is increasingly appreciated, but the impacts of urban areas for the evolution of life and its applied importance for sustainability are poorly understand. In this talk I will discuss current evidence that the development of cities, towns and villages affect the evolution of organisms as diverse as viruses, plants and mammals by altering their mutation, dispersal, stochastic evolution (genetic drift) and adaptations due to natural seleciton. I will then discuss how this altered evolution can affect the conservation of biodiversity, the spread of disease, and the health and well-being of humans and other organisms that coinhabit urban areas with us. I wlll conclude the topic by identifying gaps in our knowledge that relate to understanding the importance of urban evolution for the sustinability of life.

**11:45am - 12:00pm**

## Human Impacts On Wildlife Genetic Diversity

**Ella Vázquez-Domínguez**

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Long before the recent recognition that humanity's impact on the Earth is so profound that a new geological epoch –the Anthropocene– needs to be declared, we already knew and documented a myriad of examples worldwide on how human activities had, and still do, negatively impacted biodiversity. Indeed, anthropogenic activities have produced unprecedented and vast habitat transformations and land use changes including, but not limited to, deforestation, urbanization, pollution, and introduction of exotic species that, together with global climate change, are defining the sixth mass extinction event on Earth. Some estimates even indicate that 15% to 40% of species will potentially become extinct by 2050. Importantly, it is now recognized that the threat of extinction is more severe at the population and genetic levels –in contrast to only considering the species. Genetic diversity is the evolutionary foundation for adaptation to environmental change, thus the loss of genetic diversity compromises the evolutionary potential of species. Hence, in order to predict the fate of populations and establish management and conservation practices that ensure their viability, we need to understand the genetic and demographic consequences of these anthropogenic actions. I briefly review some of the main current changes in genetic diversity of key animal species and address their major drivers, with the aim of summarizing some of the ways that genetic data have contributed to our understanding of these threats and their evolutionary consequences, as well as motivating insights for potential solutions for the conservation of biodiversity. I

**12:00pm - 12:15pm**

## Evolution Under Domestication: Implications For Sustainable Agriculture and Food Systems

**Mauricio Rafael Bellon**

Comision Nacional para el Conocimiento y Uso de la Biodiversidad, United States of America; mbellon@conabio.gob.mx

Crop evolution under domestication is a process that continues today in many parts of the world for numerous crops, particularly in their centers of diversity, that often coincide with the crop´s center of domestication. This process is driven by smallholder farmers growing native varieties of crops with a long history of cultivation, multiple uses, and strong cultural significance in their communities, who save and share seeds, producing mostly, but not exclusively, for self-consumption, and in different production environments. These farmers provide a service to society by sustaining crop evolution that generates the broad and novel genetic variation necessary for crops to adapt to change, i.e. an evolutionary service or evoservice of global relevance. The capacity of crops to adapt to diverse, new and unforeseen circumstances is fundamental to achieve sustainable agricultural and food systems. However, current agricultural development strategies and related policies in the developing world—and thus in many of the centers of domestication and/or diversity of numerous crops—are implicitly based on discouraging crop evolution since key elements in them are: (a) to promote the replacement of native varieties by "improved" varieties predicated on the superior productivity of the latter relative to the former; (b) fostering an increased reliance by farmers on purchasing commercial seed from the "formal" seed sector; and (c) discontinuing farmers´ traditional seed management practices of saving and sharing seed. These strategies and related policies are followed by governments, and intensely promoted by international and national development and research organizations, as well as private companies. There is a need to rethink the agricultural development strategies and policies for smallholder farmers who maintain crop evolution under domestication in areas of high agrobiodiversity based on maintaining and rewarding this process and linking it explicitly to the development of food systems that deliver healthy diets for all, while keeping the health of the planet's life support systems for today and future generations.

**12:15pm - 12:30pm**

## Livestock Biodiversity: An Evolutionary Asset For Sustainable Agriculture

**Licia Colli**[1,2]

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Livestock domestication represented a key step in the development of human societies during the agricultural transition of the Neolithic. Over the following thousands of years of their evolution, farm animals followed the expanding human populations, thus colonizing and adapting to a large variety of environments, sometimes with extreme or particularly harsh conditions.

Despite farm animal species today account for billions of heads worldwide, many locally adapted livestock populations are at risk of extinction due to factors as small population sizes, crossbreeding or replacement with more productive industrial breeds, changes in traditional agricultural practices, abandonment of rural lands and climate change. According to FAO estimates, 7% of livestock breeds have become extinct during the last century and 17% are endangered.

The adaptive traits developed by local breeds during the course of livestock evolution represent an invaluable resource to guarantee an adequate food production to sustain the growing human population in the next decades.

Conservation and breeding strategies, biobanking and reproductive technologies, together with new techniques for genome analysis and editing represent important tools to characterize and preserve farm animal genomic resources, and to develop a climate-smart agriculture for a sustainable intensification of food production.

# Posters 2: Poster Session 2

*Time:* Wednesday, 26/Feb/2020: 1:30pm - 3:30pm · *Location:* Hallway

## How Does The Choice Of Different Fixed Temporal Baselines For Restoration Alternatively Affect Different Regions Of The World?

**Sophie Monsarrat, Jens-Christian Svenning**

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Large mammal restoration and rewilding initiatives often use information on species' indigenous range for identifying candidates for (re)introductions and to measure success towards recovery. Most global biodiversity initiatives currently use a fixed temporal baseline as a benchmark for the delineation of these historical ranges. However, these baselines are often chosen with a Eurocentric perspective that overlooks variations in the timing of human impacts across the world. We explore how the choice of different fixed temporal baselines potentially creates inconsistencies in the identification of 'states of reference' for restoration throughout the globe. We investigate this question from the angle of large mammal restoration and introduce the concept of restoration burden, a spatially-explicit measure of the level of effort needed to restore 'natural' communities in a given area. We compare different scenarios based on fixed temporal baselines ranging from the early Holocene to the present and relate it to the history of human impacts and current geopolitical context in different regions of the world. The results highlight inconsistencies raised by the use of fixed temporal baselines that lead to arbitrary and potentially unfair decisions in setting restoration targets in certain parts of the world.

## Cryptic Diversity In The Enteromius Anoplus (Weber, 1897) Complex

**Manda Kambikambi[1], Albert Chakona[2], Wilbert Kadye[1]**

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*Enteromius anoplus*, as currently described, is one of the most widely distributed freshwater fish in South Africa. DNA-based studies have, however, revealed substantial genetic structuring within *E. anoplus*, raising the possibility that this species may harbour undocumented taxonomic diversity. *Enteromius anoplus* was first described based on specimens that were collected from the Gouritz River system in the CFE. Three previously described species, *E. cernuus* from the Olifants-Doring River system, *E. oraniensis* from the Orange River system and *E. karkensis* from the uMngeni River system were put into synonymy with *E. anoplus*, but no adequate justification was provided for these decisions.

Molecular, morphometric and meristic data used for the present study were generated from both historical collections and fresh specimens. Principal Component Analysis was performed on meristic variables and to identify the variables that contribute the most to differences among groups. DNA isolation, extraction and amplification using a fragment of the mitochondrial cytochrome b gene was carried out.

Mitochondrial cytochrome *b* sequence data of individuals from populations formerly assigned to *Enteromius anoplus* across the species' distribution range revealed the existence of three species: (i) *Enteromius anoplus* endemic to the Gouritz River system in the Western Cape Province, (ii) *Enteromius cernuus* endemic to the Olifants River system in the Western Cape Province, (iii) *Enteromius oraniensis* endemic to the Orange River. Overall, this investigation contributes to the taxonomic and biogeographic information on small sized minnow species.

The species' exhibit subtle morphological differences, which may explain why they were previously considered to represent a single variable and widespread species. Overall, this investigation contributes to the taxonomic and biogeographic information on small sized minnow species, in addition to addressing the erroneous assumptions that the currently recognized distribution range represents a single species.

## Environmental DNA Allows Upscaling of Spatial Patterns of Biodiversity in Freshwater Ecosystems

**Luca Carraro[1,2], Elvira Mächler[1,2], Remo Wüthrich[1,2,3], Florian Altermatt[1,2]**

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Global biodiversity, and freshwater biodiversity in particular, are declining at large, unprecedented rates with potentially devastating effects on ecosystems' state and function and, subsequently, deleterious consequences for human well-being. To mitigate these threats, effective management and policy making are pivotal, thereby calling for accurate and highly resolved biodiversity data. However, current practices are still based on localized point-estimates of biodiversity, which prevents an adequate upscaling at spatially fine scales. Here we show that combining environmental DNA (eDNA) extracted from local stream water samples with mathematical models based on hydrological first principles allows an upscaling of biodiversity estimates for aquatic insects at an unprecedented spatial resolution. Our model decoupled the diverse upstream contributions to the genetic signal embedded in the eDNA data, ultimately enabling the reconstruction of spatial distributions of taxa belonging to orders *Ephemeroptera*, *Plecoptera* and *Trichoptera*. Across a whole 760-km$^2$ Swiss prealpine basin, we thus obtained a space-filling biodiversity prediction at a grain size resolution of 1-km long stream sections. The accuracy of the model in matching direct observations of local occurrence of aquatic insects ranged between 57–100 %. Our results demonstrate how eDNA can be used for large-scale and high-resolution biodiversity assessments in riverine ecosystems with minimal prior knowledge of the system. Our approach allows identification of biodiversity hotspots that could be otherwise overlooked, enabling implementation of focused conservation strategies.

## Microbial diversity in Arctic Siberian ponds and possible implication for C turnover

**Alizée Le Moigne[1], Maciej Bartosiewicz[2], Gabriela Schaepman-Strub[1], Jakob Pernthaler[1]**

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Shallow ponds are a conspicuous landscape element of the Arctic Siberian tundra. They differ in origin and display high variability in features such as carbon content. This variability will likely influence the assembly processes of microbial communities and possibly their functional properties. The Siberian Arctic is rich in carbon (C) and its remineralisation is mainly carried out by heterotrophic bacteria. Thus, variability in microbial community structure might have important implication for the C budget at a landscape scale. We investigated dissolved organic C (DOC), $CO_2$ and $CH_4$ content in 20 ponds located in Kytalyk in the context of the structure and assembly processes of their respective microbial communities. The ponds were categorized into 2 groups according to their supposed origin (polygonal vs. thermokarst). Bacterial abundances varied between 4 and 29 × $10^6$ cells mL$^{-1}$, with a taxonomic richness between 48 and 436 operational taxonomic units (OTUs). While richness of the pro- and eukaryotic microbial assemblages was as variable within as between the two pond types, they were nevertheless clearly separated with

respect to community composition. Bacterial communities showed low similarity (34-35%) within each pond type. Null model analysis pointed to an important role of stochastic microbial community assembly within sets of ponds, but also indicated selection of communities according to pond type. Pronounced functional variability of the ponds was suggested by the large range of concentrations of dissolved $CO_2$ and $CH_4$, especially in the thermokarst ponds. Moreover, the variability of the methane $\delta^{13}C$ isotopic signal (from -69‰ to -16‰) in the ponds, indicative of C oxidation, suggested pronounced differences in gas flux from individual ponds to the atmosphere.

## River Intellectuals: Connecting Scientists and Conservationists For Free and Wild Rivers in the Balkans

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The Balkan Peninsula is home to many of the last free-flowing rivers in Europe. The planned construction of more than 3000 dams in the region threatens the survival of these rivers that support hotspots of aquatic biodiversity at the European scale, provide a wide variety of ecosystem services, and are essential to the identity and life of local communities.

The “River Intellectuals” are a network of conservationists, activists and researchers that share the concern of river conservation. The network brings together students and researchers from natural sciences, technology, the humanities and law with those who do conservation work in their home countries. It also connects communities across the Balkan Peninsula, from those who have already felt the effects of hydropower and dam constructions, to those that are fighting to keep their still free-flowing rivers untouched. The network aims to accelerate innovative and interdisciplinary research regarding threatened watersheds and communicate science effectively to the public, NGOs and decision-makers, to facilitate evidence-based decision-making that takes into account the variety of values that rivers provide. Furthermore, it aims to promote the Balkans as an exciting region for research, as it constitutes a major biodiversity hotspot in Europe and is severely underrepresented in research.

One of the main activities of the organization is the “Students for Rivers” camp, a week-long summer school, where lectures on the hydromorphology, biochemistry and ecology of natural and dammed rivers, the politics and economics of energy production in the Balkans are combined with outdoor experiences and student projects tackling concrete challenges at the science-conservation interface. The next camp will be held in September 2020, on the Tara River in Montenegro. In May 2020, the network will also initiate a set of citizen science activities along the Sava catchment as a next step in bringing together local communities and scientists.

## Perceptions About Meat Reducers And Implications For Social Norms Interventions To Reduce Meat Consumption.

**Vibhuti Patel[1,2], Nicola Buckland[2], Helen Kennedy[2]**

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High meat intake poses a significant threat to human and planetary health (Willett et al., 2019) and is a primary cause of global biodiversity loss (Machovina, Feeley, & Ripple, 2015; Steinfeld et al., 2006). Alongside technological innovation, individual behavioural changes are crucial to reduce these threats (Hedenus et al., 2014). As such, ways to reduce consumer demand for meat products, whilst encouraging a transition to more sustainable sources of protein, must be identified. Social norms are an untapped yet promising tool for promoting widespread meat reduction, given their demonstrated influence in adjusting pro-environmental and eating behaviours (Cruwys et al., 2015; Farrow et al., 2017). Research has shown that dynamic (changing) norms about meat consumption have been effective in reducing the purchase of meat-based meals (Sparkmann & Walton, 2017). However there is, to date, no empirical robust evidence on the role of descriptive norms (perceptions of how others currently behave) in reducing meat consumption. The first part of the research presented in this paper (registered on Open Science Framework, osf.io/ke7sd/; osf.io/c2bt7/) paves the way for such investigation by exploring perceptions of the norm referent group – meat reducers. This is important because conformity to social norms is affected by perceptions of the norm referent group; normative messages may be rejected if they reflect a group that is undesirable or non-aspirational (e.g. Berger & Rand, 2008). For this research, perceptions about meat reducers (compared to vegetarians and habitual meat consumers) among UK-based adults, university staff, and students were explored using a free association task (n = 366, $M_{age}$ = 42.6) and short descriptions (vignettes) about hypothetical peers following these diets (targeted n = 360). The results of these two studies inform the development of social norm-based interventions to reduce meat intake, that will be investigated in a future trial.

## Non-Native Palms (Arecaceae) As Agents Of Novel Ecosystems

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Humans facilitate the emergence of ecosystems without historical precedent, novel ecosystems, by moving species around the world. However, it is unclear whether species differ in their propensity to generate novel ecosystems. To quantify this, we used the palm family, which has a pantropical distribution, high ecological importance in native ecosystems, is sensitive to global warming, and has been introduced extensively by humans for horticulture.

Using a literature review, we provide a quantitative assessment of the geographic distribution, climate, habitat type, insularity, functional traits and reported effects of non-native palm species on different organism groups, ecosystem functions, and human society.

Of the 2557 recognised palm species, 3.4% (85 species) were recorded as naturalised and 1.1% as invasive, which is more than the average for woody plants. Naturalised palms are present in most of the tropical and subtropical regions around the world and usually occur within or close to urbanised areas, reflecting strong effects of human agency through palm dispersal for horticulture. Many naturalised palms are tall, originate from open habitats or dry forest, and thus are likely adapted to disturbed areas. The literature on ecological effects of palm invasion is sparse, but strong cases exist, where palm invasions result in complete ecosystem changes and even in biome shifts.

We found strong evidence that palms can generate novel ecosystems and drivers of palm invasions are changing in a way that will promote the future involvement of non-native palms in novel ecosystems. However, there are substantial knowledge gaps, especially on the ecological impacts of palm invasion. This suggests that palm range and population dynamics in response to global change and the impacts on ecosystems should be closely monitored and studied, to better understand drivers, functioning and services of novel ecosystems in general, on which humans existence is increasingly depending on.

## "Impacts of Climate Change and Ecosystem Services Loss on Disabled Populations: a Systematic Map"

**Aleksandra {Sasha} Kosanic[1], Jan Petzold[2], Amy E. Dunham[3], Berta Martín-López[4], Mialy Razanajatovo[1]**

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Climate change and the loss of ecosystem services are likely to disproportionately affect the world's disabled populations by accentuating inequalities and increasing marginalization of the most vulnerable members of society. The latest IPCC and IPBES assessment reports do take into account other vulnerable groups (e.g. indigenous and local communities) in order to understand links between environmental change, human livelihoods and wellbeing. However, more research is needed to understand challenges for disabled populations which remain neglected in the current international discussions. Here we aim to show a systematic map of the available evidence and gaps in current knowledge on risks from climate change and the loss of ecosystem services. We argue that it is critical to understand better the linkages between global environmental change and ecosystem services loss, posing stress on vulnerable communities. This is an essential step to achieve a sustainable future for everyone, and 'leave no one' behind. In particular, we need to pay attention to the most vulnerable among the disabled populations, intersecting form of repression and neglect in current adaptation strategies (e.g. children with disabilities and women with disabilities). It is urgently needed to increase research on this topic and include disabled populations in the conversation to create appropriate and equitable climate policies.

## Developing a New Paradigm in Climate Education in Vulnerable Areas for Enhanced Climate Literacy: A Case Study of Bloom's Taxonomy of Educational Learning Objectives

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Climate projections indicate increase and frequency and intensity with impacts across all facets of human endeavour globally especially vulnerable areas like mountain communities which are biodiversity hotspots crucial to the socio-economy and human wellbeing. Education is a crucial component of the global responses to climate change. Moreover, education is an effective vehicle for understanding and appreciating the role of biodiversity and ecosystem services in adapting to global change. Furthermore, effective climate education is vital for all stakeholders from children to the elderly, to understand and address the effects of global warming, facilitating behavioural change and facilitating adaptation to climate change-related events. However, environmental education is often fraught with several conceptual challenges that compromise its effectiveness. This makes it necessary to interrogate essential attributes and elements for an enhanced "climate literacy". The Bloom's taxonomy is globally regarded as a powerful tool to help develop learning objectives because it explains the process of learning. In this study, we use a qualitative methodology involving discussions with environmental awareness organisations, teachers, community members, policy makers, teachers and lecturers to explore pathways for effective environmental education using the Bloom's taxonomy across its six domains. This study contributes to the debate to make climate change education a more central and visible part of the international response to climate change. This comes with implications for the Sustainable Development Goals (SDGs) and the related Leave No One Behind Agenda. As global response to climate action gains further traction, the study proposes pragmatic steps that will aid in layman's understanding of the implications of climate fluctuations and increase "climate literacy" among vulnerable groups such as young people whilst providing knowledge to inform policy. Furthermore, it will help enhance capacity building of vulnerable communities such as those in mountain communities and facilitate novel interventions to an integrated climate change education.

## Impact of Drought and Desertification on the Livelihood and Health of the Wayúu Indigenous People of La Guajira, Colombia.

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**Background:** It is well acknowledged that indigenous groups suffer high rates of poverty due to isolation and marginalization, low levels of education and high rates of disease. Addressing such gaps is part of the UN Sustainable Development Goals. This empirical research focuses on the Wayúu people living in La Guajira, Colombia, where reports show high levels of childhood mortality, and that food, water, sanitation and health securities are lacking due to drought, desertification and economic isolation of the region.

**Methods:** A mixed methods approached is used for this research. It consists of a set of surveys with factual and perception types of questions to assess the livelihood and opinions of the Wayúu people living in areas that experience different levels of desertification: low, medium and high desertification areas, as defined by Colombia's Institute for Environmental Studies. Perception data are gauged against factual data.

**Results:** Socio-economic and health disparities have been found among Wayúu people living in regions with different desertification levels. Individuals living in regions experiencing high desertification have the lowest accessibility to income ($F_{(2,128)}$=21.3, p<0.00001), lowest levels of education ($F_{(2,85)}$=14.35, p<0.00001), highest levels of food insecurities ($F_{(2,290)}$=82.17, p<0.00001) and water scarcity ($X^2$=24.057, df=2, p<0.00001), as well as a higher incidence of malnutrition ($X^2$=49.291, df=2, p<0.00001) and childhood mortality ($F_{(2,29)}$=6.766, p=0.003), in comparison to individuals living in regions experiencing medium or low levels of desertification.

**Conclusions:** Wayúu people living in areas with the highest levels of desertification are at an increased risk for extreme poverty, food and water insecurities and childhood mortality. This research is a call for government and private entities to be aware of this humanitarian crisis and hopes to motivate such institutions to establish effective policies and interventions in order to reduce poverty, food and water insecurities, malnutrition and childhood disease and mortality among Wayúu people.

## Superhighway Development Threatens Tropical Forest Conservation and SDGs in Equatorial Africa

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This African case study shows how re-routing poorly planned highways can reduce negative environmental impacts. The proposed 260 km superhighway in Cross River State (CRS), south-eastern Nigeria illustrates how linear infrastructure threatens biodiversity and wildlife conservation in equatorial Africa. The CRS Government in Nigeria proposed an ~115 km intersection of the highway through intact tropical rainforest or protected areas, costing ~ US$2.5 billion. Two alternative routes were proposed and evaluated

as causing less damage to the Cross River National Park, unprotected forests, and biodiversity habitats. Although, slightly longer (~290 and ~353 km), the alternative routes cost less to construct (~ US$0.9 billion), with the first proposed alternative avoiding intact forest as well as providing benefits to farmers and settlers. In the context of achieving Sustainable Development Goals (SDG), smart infrastructure provisioning and sustainable land-use management suggestions from research outcomes should be incorporated as strategic tools for developing an informed conservation economy policy and decision-making in Africa. If optimised, conservation, reduced environmental impacts and maximal socioeconomic benefits can be achieved. Africa-wide, lessons, trade-offs and synergies from the illustrated African case study on road planning and forest landscape management should be promoted and integrated with the spatial infrastructure and land-use planning process towards attaining local-scale SDGs.

## Drivers of Phytoplankton Biodiversity and Harmful Algae Blooms in Finnish Lakes

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The combined effects of eutrophication and climate change are major threats to aquatic ecosystems, their biodiversity and integrity in sustaining ecosystem functioning. More than 10 % of Finland's surface area is covered by freshwater systems, comprising well over 150 000 lakes, highlighting its fundamental importance for human well being as well as socio-economic developments under the umbrella of striving blue growth. Here we use phytoplankton community data of the national Finnish lake monitoring, including 574 sites and spanning four decades, to quantify the long-term environmental and lake topographical drivers of phytoplankton biodiversity as well as the formation and intensity of harmful algae blooms. Additionally, we focus on the changes in functional characteristics stemming from community changes using a trait-based approach. Taking advantage of Hierarchical Modelling of Species Communities (HMSC), we fit a joint species distribution model to the phytoplankton community data, that simultaneously combines information on species traits, environmental covariates and phylogenetic constraints in a single model. Our results demonstrate a major change in community composition over time and across Finland, pointing towards a homogenization of phytoplankton communities in response to nutrient loadings as well as to specific lake topographical attributes and temperature, while the absolute species richness remained relatively stable. A strong phylogenetic signal in the species responses to the environment indicates that groups of related species tend to respond in similar ways. While the included species traits could explain ~ 6 % of the variation that was not attributed to environmental covariates, the strong phylogenetic signal also indicates the existence of specific traits that are correlated with phylogeny that were not included in our analysis. To inform management and conservation policies in the future, we aim to predict possible community developments and expose tipping points of harmful algae bloom formations under different socio-economic and climate scenarios.

## Temperature-mediated Size Structure In Ecological Communities

**Mikael Pontarp[1,2], Florian Altermatt[1,3], John DeLong[5], Mathew Seymour[6], Jason Griffiths[7], Pravin Ganesanandamorthy[3], Aurélie Garnier[8], Suzanne Greene[4], Yves Choffat[1], Gian Marco Palamara[9], Thomas Massie[1], Owen Petchey[1], Frank Pennekamp[1]**

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A challenge in community ecology and climate change research is to understand and predict community responses to warming. Reduced body size with increasing temperature has been identified as a common ecological response, with important consequences for community dynamics, structure and function. Yet, a detailed understanding of such temperature effects on size is limited as the relative importance of direct physiological effects on individuals and indirect effects mediated through population or community level biotic interactions remains elusive. Here we show experimental results from a large-scale experiment on aquatic ciliate communities and compare the results with predictions of the supply-demand model. We find that size-temperature relationships in monocultures are mediated through increased metabolic rates and decreased accessible supply due to loss of species adaptation to temperature. Combining experimental community data and an extended supply-demand model in multispecies communities, we advance our understanding of temperature responses on size in the community context. On average species show a negative size-temperature relationship across the community but the size-temperature-richness relationship is contingent on the proportion of competitive and facilitative interactions in the community. Our results provide novel perspectives on community response to warming, emphasizing the important mediating role of the biotic context in a warming world.

## A General Framework To Integrate Stochasticity In Models Of Aquatic Populations.

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Populations and communities in aquatic ecosystems can be described by different modelling approaches with diverse mathematical structures. Stochastic models are particularly relevant in describing critical dynamics of threatened populations, such as invasions and extinctions. Moreover, stochasticity has a fundamental role in determining ecological and evolutionary dynamics at different spatiotemporal scales. Despite its key importance in shaping ecological communities, stochasticity is often neglected in ecological models or treated as an external source of unpredictability. Here, we present a mathematical framework providing a complete characterization of stochastic population models and show how to identify relevant model classes, based on the available data and the specific system to study. These models play an important role in understanding the functioning of aquatic ecosystems under different sources of stochasticty. We apply our framework to replicated time series data from an experiment with clonal populations of *Daphnia galeata,* a common freshwater zooplankton species, feeding on the green alga *Scenedesmus obliquus*. We show how to identify the relevant ecological mechanisms affecting Daphnia's fecundity and mortality, despite the presence of high demographic noise. Our findings stress the importance of using a multi-model approach to better understand the mechanisms affecting the dynamics of ecological populations. Our modelling framework merges different theoretical perspectives on population ecology and can be further generalized to include models from community ecology, at both ecological and evolutionary time scale.

## Forest Loss and its Potential Effect on the Mammal Community Inside Protected Areas of Northeast India

**André P. Silva[1,2], Filip Thörn[1], Gonçalo Curveira-Santos[2], Surabhi Nadig[3], Navya R[3], Carlos Fernandes[2], Shomita**

**Mukherjee[4], Uma Ramakrishnan[3], Mats Björklund[1]**

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Northeast India is a biodiversity rich area connecting the Indo-Burma, the Himalayas and South Western China biodiversity hotspots. Biodiversity protection is implemented through protected areas (PAs) but knowledge on its effectiveness is unavailable. We look at remotely sensed forest loss (2000 - 2017) data to investigate human disturbance within 56 PAs (1km2 resolution sampling units) and used generalized linear mixed models to understand underlying causes. In addition, we assessed potential ecological consequences of disturbance by testing (multispecies occupancy models) for an effect of forest loss on mammal occupancy using data from camera-trap surveys (144 stations) in five lowland protected areas. We found a forest loss peak at low elevation (<1000 m) and another at high elevation (>3100 m). At lower elevation sampling units, forest loss (7.63%, 0-100%) is mainly explained by increasing percentage of cropland (main effect). However, at higher elevation forest loss (1.94%, 0-100%) is not so clearly explained as several variables had similar effect size. We discuss a potential negative influence of forest loss on mammal occupancy and importance of forest loss patch size. We conclude that PAs in Northeast India are unable to completely stop forest conversion into cropland with potential influence on mammal occupancy. We speculate that cropland suitability might be influenced by climatic changes highlighting potential complex interactions between global change drivers.

## Social Preferences for Biodiversity and Ecosystem Services of Mountain Agriculture across Policy Scenarios

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Mountain agroecosystems are the result of complex adaptive interactions between humans and nature where trade-offs between food production and other ecosystem services are key. The objective of this research was to explore the social preferences for biodiversity and ecosystem services, and the associated willingness to pay, in three multifunctional mountain agroecosystems in Europe (Mediterranean-Spain, Atlantic-Norway, Alpine-Italy) under alternative agrienvironmental policy scenarios. We used a choice experiment including equivalent attributes and levels across locations to rank and estimate the economic value of biodiversity and provisioning, regulating, and cultural ecosystem services. These ecosystem services were identified in previous socio-cultural analyses in each mountain agroecosystem. We defined the policy scenarios (current situation, abandonment and enhanced management) in biophysical terms to elucidate changing relations between the social perception and the level of delivery of biodiversity and ecosystem services. We derived some lessons. i) Value of biodiversity and ecosystem services: biodiversity and regulating ecosystem services always produced welfare gains; people, however, perceived trade-offs between delivery of agricultural landscapes and quality food products. However, preferences were heterogeneous and varied across regions, scenarios and ecosystem services. ii) Policymaking: society's willingness to pay for the delivery of ecosystem service exceeded largely the current levels of public support in each location. Moreover, further abandonment and intensification of agriculture was clearly rejected by the public. iii) Methodological: monetary valuation was context dependent and extrapolation of economic values could be misleading.

## The Impact of Changing Climate on the Indigenous Sherpa Community on the Mountain Foothills of Nepal

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The impacts of changing climate range from the bigger landscapes to the smaller niche and communities. Nepal is highly vulnerable to the impacts of climate change due to its natural differences and livelihood dependent on it. Also, it is a least developed country with lack of many resources to combat with the changing climate. The Sherpa community live on the foothill of the Mount Everest and are often involved in portering and agriculture. The difficult mountainous terrain has been utilized by the knowledge of the indigenous people and the natural and cultural landscape is a result of their interaction since decades. As such, the changing climate and increasing temperature is now causing threat to the glaciers, mountain, wildlife and livelihood of the indigenous people here and the study aims to look at the impacts climate change is having to the community, their adaptation strategies and its relation with the sustainable livelihood outcome.

## Perceptions About Meat Reducers And Implications For Social Norms Interventions To Reduce Meat Consumption.

**Vibhuti Patel[1,2], Nicola Buckland[2], Helen Kennedy[2]**

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High meat intake poses a significant threat to human and planetary health (Willett et al., 2019) and is a primary cause of global biodiversity loss (Machovina, Feeley, & Ripple, 2015; Steinfeld et al., 2006). Alongside technological innovation, individual behavioural changes are crucial to reduce these threats (Hedenus et al., 2014). As such, ways to reduce consumer demand for meat products, whilst encouraging a transition to more sustainable sources of protein, must be identified. Social norms are an untapped yet promising tool for promoting widespread meat reduction, given their demonstrated influence in adjusting pro-environmental and eating behaviours (Cruwys et al., 2015; Farrow et al., 2017). Research has shown that dynamic (changing) norms about meat consumption have been effective in reducing the purchase of meat-based meals (Sparkmann & Walton, 2017). However there is, to date, no empirical robust evidence on the role of descriptive norms (perceptions of how others currently behave) in reducing meat consumption. The first part of the research presented in this paper (registered on Open Science Framework, osf.io/ke7sd/; osf.io/c2bt7/) paves the way for such investigation by exploring perceptions of the norm referent group – meat reducers. This is important because conformity to social norms is affected by perceptions of the norm referent group; normative messages may be rejected if they reflect a group that is undesirable or non-aspirational (e.g. Berger & Rand, 2008). For this research, perceptions about meat reducers (compared to vegetarians and habitual meat consumers) among UK-based adults, university staff, and students were explored using a free association task (n = 366, $M_{age}$ = 42.6) and short descriptions (vignettes) about hypothetical peers following these diets (n = 420, $M_{age}$ = 30.8). The results of these two studies inform the development of social norm-based interventions to reduce meat intake, that will be investigated in a future trial.

## Phenotypic Ability to Persist in a Changing Environment

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Environmental change is ubiquitous and acts on entire communities simultaneously. Species can respond to such environmental changes by shifting their geographic range or by shifting their phenotypic distribution. A shift in phenotypic distribution can occur due to an environmental (plastic) response, a genetic response, or a combination of both. Here, we use microcosm experiments to determine a phenotypic shift in the trait distribution of microbe communities along an environmental gradient. We measured key traits (such as size and shape of the cell, and swimming behavior), covering ecological, physiological and behavioral processes. We found strong shifts in the phenotypic distribution, which also depended on the ecological history of the microbe populations.

## Interaction Networks of Reef Fishes Under Scenarios of Climate Warming

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Climate-driven range shifts will result in the formation of novel assemblages of interacting species. Unforeseen feeding interactions are challenging to anticipate in these future assemblages. Network stability is related to structure, so spatial patterns in network structure are essential to quantify to identify regions of stability in a warmer world. To examine spatial patterns in the future of feeding interactions, we modelled changes in species distributions over the next 100 years under RCP 2.6 and RCP 8.5 warming scenarios for >6000 coral-reef and shallow-water fishes. Next, we applied a size-based model to predict future interactions within assemblages. Preliminary results suggest widespread warming-related shifts in interaction networks that vary regionally in magnitude and direction. Tropical and polar systems had reduced number of links between species in future interaction networks, whereas sub-tropics and temperate systems had an increased number of links. The modularity and connectance of networks also showed high regional variability suggesting stability of these future networks may be compromised in some locations. We further find signals of biogeographic boundaries effect on future network structure, for example, the link density of the Mediterranean increases due to tropical migrants whereas there is a loss of links where longitudinal geographic barriers to dispersal exist (e.g. south coast of Australia). Future work to identify 'hub' species that exhibit shifted ranges and high connectivity in trophic networks would benefit future conservation efforts.

## Temperature-Related Biodiversity Change Across Temperate Marine And Terrestrial Systems

**Laura H. Antão[1,2], Amanda E. Bates[3], Shane A. Blowes[4], Conor Waldock[5,6], Sarah R. Supp[7], Anne E. Magurran[2], Maria Dornelas[2], Aafke M. Schipper[8,9]**

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Climate change is reshaping global biodiversity as species respond to changing temperatures. However, the net effects of climate-driven species redistribution on local assemblage diversity remain unknown. Here, we relate trends in species richness and abundance from 21,500 terrestrial and marine assemblage time series across temperate regions (23.5-60.0°) to changes in air or sea surface temperature. Specifically, we test two predictions for the effects of temperature change on assemblage-level diversity: (1) species richness and total abundance will increase with warming, and such increases will be greatest across relatively warm regions that border the species-rich tropics; and (2) the coupling of assemblage and temperature change will be tighter in the ocean than on land. We find a strong coupling between biodiversity and temperature changes in the marine realm, which is conditional on the baseline climate. We detect increases in species richness with increasing temperature that is twice as pronounced in warmer locations, while abundance declines with warming in the warmest marine locations. In contrast, we did not detect systematic temperature-related richness or abundance trends on land, despite a greater magnitude of warming. We also found no evidence for an interaction between biodiversity change and latitude, further emphasizing the importance of baseline climate in structuring assemblages. As the world is committed to further warming, significant challenges remain in maintaining local biodiversity amongst the non-uniform inflow and outflow of “climate migrants” across distinct regions, especially in the ocean.

## The Democratization of Conservation Science: Clarifying the Project and Identifying Challenges

**Kinley Gillette**

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There is an emerging consensus that conservation management and science need to be evaluated, at least in part, according to social justice criteria. For example, many professional conservationists now agree that achieving conservation goals should not come at the price of harming the world’s poor. Another example of a social justice criterion—and the one that will be my focus here—is adherence to democratic norms. In the case of conservation *management*, adherence to democratic norms is relatively easy to conceptualize and assess, at least compared to the case of conservation *science*. Partly for this reason, many calls for the democratization of conservation *science* are vague or incomplete. One specific problem is that a crucial democratic norm is largely absent from the discussion. This missing norm is the “all affected interests” principle, which requires people who are affected by a collective decision (i.e., the decision’s stakeholders) to have a degree of influence over that decision. When decision-making is fully or partially delegated to authorities—including, in the case of conservation management and science, particular expert authorities—the “all affected interests” principle requires those authorities to be accountable within their respective spheres to stakeholders. To be sure, currently proposed strategies for the democratization of conservation science—such as empowering citizen scientists to collect data, facilitating dialogue between local or traditional ecological knowledge and conservation science, and better integrating the social and ecological sciences—do sometimes facilitate a degree of accountability. However, the accountability that these strategies facilitate is typically only ever horizontal, insofar as accountability relations remain justified on the basis of claims to relevant (often complementary) expertise rather than potential affectedness. The result is, among other things, the undemocratic exclusion of stakeholders who lack relevant expertise. Other proposed strategies for democratization allow stakeholders to participate in research design by, for example, selecting research questions. This strategy allows stakeholders to influence the scope of initial authorization. However, it does not address the problem of accountability *after* authorization.

## Grasping the Nettle: Neural Taxa Recognition for Scientific and Vernacular Plant Names

**Isabel Meraner**
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The recognition of taxonomic entities plays a key role in natural language processing and understanding in biodiversity contexts. Automating entity and knowledge extraction is hence a core endeavour in order to enrich international ontologies and digitally interlink scientific and ethnobotanical plant knowledge. We present a semi-supervised approach to automatically detect and disambiguate plant names in their Latin and vernacular variants in German and English texts. Besides tailoring linguistic pre-processing for biodiversity literature, we use dictionary-based annotations to automatically label a low-effort silver training set using nine hierarchical entity classes. To assess the domain adaptation potential, we train and cross-evaluate the bi-LSTM-CRF models on text genres differing in terms of formality (scientific/non-scientific), writing style (blogs/Wikipedia), and period (historical/recent). By incorporating both token-level and character-level pre-trained word embeddings, we additionally leverage contextual semantic information. An evaluation of the neural tagger on a representative, manually corrected gold test set shows F1-scores of >89% and >94% for the English and German combined-dataset models. In comparison to the dictionary-based baseline, we observed a promising boost in recall (≈ +10p.p.) leading to the identification of further multilingual vernacular names. Including a capitalisation feature dimension, as well as fine-tuning the dropout rate during training, led to more accurate tagging of unseen entities in related sub-domains, e.g. mycology. These positive results for cross-corpus applications to lower-resourced domains highlight the potential of state-of-the-art deep learning approaches in hitherto under-represented biodiversity contexts. Finally, the entity candidates are disambiguated and mapped to currently accepted taxonomic concepts in the Catalogue of Life knowledge base. To overcome the ontological gaps and further boost the linking coverage, we integrate a lookup table to pre-disambiguate the vernacular names. Our approach aims to make the potential of deep learning-based text mining for biodiversity more visible and to computationally explore lower-resourced genres for knowledge preservation purposes.

## Nature Sound Box: A smart sensor for automated acoustic monitoring of wildlife

**Julien Ricard**
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Biodiversity is a key indicator of the sustainability of an ecosystem, and a critical factor in our own health. Preserving this biodiversity requires to better understand the complex relationships between the species, but also to increase public awareness on the ecological impact of human activity.

Current state of technology allows to build tools that could help gaining insights about these relationships. It is possible today to continuously collect a large variety of data from an ecosystem and automatically extract useful information from it thanks to recent progress in the field of machine learning. More specifically, it has been shown that sound is a good proxy to monitor wildlife, and automatic detection and identification of species through their vocalisations, referred to as Passive Acoustic Monitoring (PAM), is improving quickly.

Cross-analysis, over long periods of time, of environmental data and biodiversity-related data, would help better understand their interdependencies, predict the impact of human activities both on the local (e.g. industry, tourism…) and the global (global warming) levels, and to implement effective conservation strategies to minimize it. This ambition is supported by Europe through its EU Biodiversity Strategy, which commits its members to measurable improvement in this field, which requires to develop tools to measure biodiversity.

By combining technological advances in the fields of Internet of Things (IoT) and Artificial Intelligence (IA), Securaxis addresses this issue by proposing its Nature Sound Box (NSB), a smart sensor dedicated to detecting and identifying species from their vocalisations.

Collecting huge amount of data, as commonly done in remote sensing, is not enough to understand it. The NSB dashboard is a web application designed by Securaxis, including ergonomic tools to explore, visualise, summarize or further analyse the detection data, allowing an optimal exploitation of the data in different application contexts.

## Viral exposure in rural dogs around Batanghari protected Forest, West Sumatra Indonesia: The potential pathogen spillover to Sumatran Tiger.

**Erlinda C. Kartika[1,2], Nasir Uddin[3], Syerlly Octarini[4], Nuarti S. Ramadhani[5], Kurt A. Johnson[6], Herbert H.T. Prins[1], Ignas M.A. Heitkonig[1]**

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Domestic dogs can be a threat to wild carnivore populations due to the transmission of infectious diseases. Canine distemper virus (CDV) and rabies virus (RABV), commonly found in domestic dogs, have been recognized to cause population declines of carnivores. The chance of transmission may increase through wildlife hunting traditions using dogs near the border of protected areas. Understanding the potential of disease, dog management, and dog-wildlife interactions are key factors to prevent the spillover of diseases from domestic dogs to wildlife. Our objectives are to understand: (1) the exposure and environment factors associated with risk factors for CDV and RABV in domestic dogs (2) dog management practices, including people's perception of vaccination, and (3) factors determining dog-wildlife interactions. Through a cross-sectional viral-serological approach and questionnaire survey, we assessed these issues in the Batanghari protected forest, West Sumatra, Indonesia. We collected blood from 115 domestic dogs and interviewed 160 people from eight villages within 5 km from the protected area where tigers are known to be present. Using the One-Step Reverse Transcriptase PCR Method, CDV was detected in 64 % of sampled dogs. Using indirect ELISA for testing antibody against RABV, we found that 97% of sampled dogs had an antibody titer lower than protective level of immunity (<0.5 EU/ml), both for vaccinated and unvaccinated dogs. The risk of getting the CDV is higher in hunting dogs, in juvenile dogs and higher if the owners do not know about the CDV. Only one respondent vaccinated his dog against CDV, whereas 52% of the respondents vaccinated their dogs against Rabies. Knowledge about the diseases was considered important, but only <5% of respondents were familiar with CDV, against 75% with Rabies. Dogs were commonly and traditionally used for hunting, also within the Batanghari protected area. The high CDV and RABV infection levels in domestic dogs facilitate a spillover to carnivores such as the tiger. To prevent the spread of diseases to wild carnivores, effective vaccination in combination with strict hunting regulations and education about the disease and vaccination is needed.

## From Aichi to Kunming: Contributions from biodiversity research to the CBD's Post-2020 biodiversity

## framework

**Andrea Perino**
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The Convention on Biological Diversity (CBD) is currently preparing the post-2020 biodiversity framework that will define global biodiversity goals for the next decade. In late 2020, the 196 signatory countries will decide upon this framework during the 15th Convention of the Parties. Since the Aichi targets of the current target have been decided ten years ago, biodiversity research has overcome knowledge boundaries and has brought about new evidence and scientific insights that are critical to understanding causes and patterns of biodiversity change. This knowledge will be instrumental in reaching the CBD vision that "By 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people." Here we present the outcomes of a workshop where European biodiversity scientists from a brought range of expertise discussed the major topics that have emerged from biodiversity research in the last decade. We suggest how those advances should be captured by the CBD Post-2020 framework and how current targets should be revised to account for new frontiers in biodiversity research.

# 155S: The Future of Remote Sensing of Biodiversity

*Time:* Wednesday, 26/Feb/2020: 3:00pm - 6:00pm · *Location:* Sertig
*Session Chair:* Susan L. Ustin, University of California Davis, United States of America
*Session Chair:* Margarita Huesca, University of California Davis, United States of America
*Session Chair:* Maria Santos, University of Zurich, Switzerland

Talks followed by panel discussion

The Earth is undergoing a rapid decline in global biodiversity due to habit loss, changes in land use, and climate change, among others. There is significant need to increase our understanding of the spatial and temporal scales of biodiversity and its organization to address questions about sustainability of ecosystem functionality and the ecosystem services they provide.

Ground-based data cannot provide the reliable and consistently collected global data that is needed to understand the biological and ecological consequences of these losses. Combining remote sensing data with ground-based strategies offers a way to acquire this information, and todays technologies are increasingly diverse, measuring wavelengths from the ultraviolet to radar with accurate and robust capabilities. Many of these hold promise for contributing to measurement and monitoring of global biodiversity patterns, however full utilization of these capabilities for biodiversity applications have lagged and more research is needed. Generally, current use of remote sensing data to map or monitor plant biodiversity has been limited to applications of spatial variation based on simple spectral indexes. The use of individual sensor technologies like hyperspectral, lidar, and thermal imagery and measurements of steady-state fluorescence are now available on the International Space Station or will soon be flown as free-flyers. Individually or a combination of these technologies hold promise to measure a wide range of plant chemical, physiological, and structural properties that relate to ecosystem functionality and plant biodiversity.

**3:00pm - 3:30pm**

## Applying Remote Sensing to Biodiversity Science

**Jeannine Cavender-Bares**
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Biodiversity science—by virtue of its nature and its importance for humanity—intersects evolution, ecology, conservation biology, economics, and sustainability science. Its future requires remote sensing technology. In an era of rapid global change, classic approaches to understanding and assessing the origins, distribution, maintenance and consequences of biodiversity cannot keep pace with the large-scale changes in our biosphere. At the same time, advances in technology, alone, cannot address the challenge of risk assessment and monitoring of our global ecosystems. Without full integration of remote sensing capabilities with ecological and evolutionary understanding of biological processes, remote sensing technologies will fail to decipher ongoing biodiversity trends and to deliver the information required by conservation efforts for efficient and effective focus. Here I consider fundamental issues in ecology and evolution (with a bias towards plants) that lie at the heart of biodiversity science and require continued integration—across spatial, temporal and biological scales—with technologies, including spectroscopy and LiDAR among others. In particular, the talk will examine advances and challenges in 1) detecting and differentiating multiple stress factors within ecosystems, 2) detecting plant functional-phylogenetic groups and plant traits in the leaf economic spectrum for ecosystem modeling, 3) linking plant genomes to trait variation, 4) integrating biodiversity records with spectral fingerprints, 5) biodiversity discovery and change detection, 6) detection of large-scale patterns of biodiversity, 7) detecting consequences of biodiversity for ecosystem function at large spatial extents, and 8) predicting changes in species composition for conservation and management. It has long been recognized that risk assessment and monitoring are critical steps in managing global environmental risks and sustaining a habitable planet. New possibilities and approaches for applying remote sensing technologies to the urgent needs of biodiversity science in the realm of monitoring and risk assessment provide a path forward—a path that depends on transdisciplinary collaboration.

**3:30pm - 4:00pm**

## The Future of Remote Sensing of Biodiversity

**Susan L. Ustin[1], Margarita Huesca-Martinez[1], Shruti Khanna[1], Maria Santos[2]**
[1]University of California Davis, United States of America; [2]University of Zurich, Switzerland; slustin@ucdavis.edu

Environmental factors forcing losses of biodiversity include climate change, human population growth, severe weather, acceleration of biogeochemical cycles, overexploitation of resources, degraded landscapes, and avenues of global transport facilitating invasive species, among other disturbances. The rate of global biodiversity loss has been estimated to be at or approaching those of the previous mass extinction events. Thus there is an urgent and significant need for improved methods to monitor biodiversity. Remote sensing has been a potential tool but past satellites have been too coarse, spatially and spectrally to provide detailed maps. Satellite technologies have been rapidly evolving and there has been a significant expansion of new remote sensing capabilities recently and into the next several years, which have potential to provide new and improved information about global vegetation patterns and changes of biodiversity. I will provide a review of these technologies, their capabilities and examples of types of information they produce (or are expected to produce). These technologies fall into the following groups: high spatial resolution sensors of various types, including multispectral sensors, high resolution imaging spectrometers (hyperspectral imagers), multiband and hyperspectral thermal infrared imagers, and lidar and radar systems. The presentation will provide an introduction into next generation remote sensing capabilities for the panel discussion to follow.

**4:00pm - 4:07pm**

## The Role of Imaging Spectroscopy Data to Assess Plant Diversity in Dry Tropical Forest

**Margarita Huesca[1], Maria J. Santos[2], Ting Zheng[3], Raman Sukumar[4], Susan L. Ustin[1]**
[1]University of California Davis, United States of America; [2]University of Zurich, Switzerland; [3]University of Wisconsin-Madison, United States of America; [4]Center for Ecological Sciences, Indian Institute of Science, Bengaluru, India; mhuescamartinez@ucdavis.edu

Global loss of biodiversity is one of the rise and we lack a capacity to monitor this process to inform actions to reverse or halt its effects. To address this, we need to develop methods for assessing and monitoring biodiversity and remote sensing seems to be the only efficient tool to achieve this goal at a regional to global scale. Imaging spectroscopy is an established technology which provides information useful to identifying important physiological traits and discriminate plant species, combined this information is likely to provide a way forward to monitoring biodiversity from space. This is because imaging spectroscopy provides very detailed measurements of the spectral responses of species and by defining how many different spectral profiles are found in an area we

can approximate species diversity, the hypothesis that spectral diversity should be related to species diversity.

Here we aim to understand how remote sensing can be used to monitoring biodiversity specifically the role of imaging spectroscopy data. We present the results of our research using AVIRIS-NG data in a tropical forest within the biodiversity hotspot of the Western Ghats in India. We test the usefulness of imaging spectroscopy data to assess biodiversity and we compare our results with biodiversity estimated based on functional diversity approach. We find that both approaches are useful to estimate biodiversity. More specifically we find spectral diversity is more related to species richness than species abundance. We also evaluated the effect of varying plot size and we found the best plot size is 100x100 m. Furthermore, we tested the effects of vegetation-background cover. We find the spectral diversity approach tends to overestimate biodiversity in areas with incomplete canopy cover. In conclusion, our results desmostrate the capability of imaging spectorscopy data to assess and monitor biodiversity althought there are still many issues that require improvements.

**4:07pm - 4:15pm**

### Spooky Action at a Distance: The Power of Remote Sensing to Infer Diversity

**Duccio Rocchini**
University of Bologna, Italy; duccio.rocchini@unibo.it

Biodiversity includes multiscalar and multitemporal structures and processes, with different levels of functional organization, from genetic to ecosystemic levels. One of the mostly used methods to infer biodiversity is based on taxonomic approaches and community ecology theories. However, gathering extensive data in the field is difficult due to logistic problems, especially when aiming at modelling biodiversity changes in space and time, which assumes statistically sound sampling schemes. In this context, airborne or satellite remote sensing allows information to be gathered
over wide areas in a reasonable time.
Extending on previous work, in this talk, I will propose novel techniques to
measure diversity from airborne or satellite remote sensing, mainly based on:
(1) multivariate statistical analysis, (2) the spectral species concept, (3) self-organizing feature maps, (4) multidimensional distance matrices, and the (5) Rao's Q diversity. Each of these measures addresses one or several issues related to diversity measurement. I will encompass most of the available methods for estimating diversity from remotely sensed imagery and potentially relating them to species diversity in the field.

**4:15pm - 4:22pm**

### A New Era of Remote Sensing Instruments to Monitor Biodiversity from Space

**Fabian Daniel Schneider**
California Institute of Technology, Jet Propulsion Laboratory; fabian.schneider@jpl.nasa.gov

Biodiversity is under pressure by anthropogenic and climate change, but it is incredibly difficult to measure, monitor and predict across the globe. We face large knowledge gaps in terms of the spatial distribution and temporal dynamics of biodiversity and related ecosystem functions. A new suite of current and upcoming remote sensing instruments is providing large-scale measurements of plant functional traits, functional diversity and ecosystem functioning from space and could help to change this. We can, for the first time, get spatially continuous measurements of three-dimensional plant canopy structure in horizontal space from high-resolution radar and vertical characteristics from spaceborne laser scanning. New measurements of evapotranspiration and solar-induced fluorescence offer the opportunity to monitor water stress and productivity of plants, and new imaging spectroscopy methods will allow to monitor leaf biochemical and biophysical traits from space. Combining these new measurements with ground-based data will help to better understand biodiversity patterns and change over time, as well as the link between biodiversity and ecosystem functioning. Today’s methods and models, developed for moderate-resolution remote sensing, are inadequate to this task and present a challenge as these new measures are integrated for a global picture of biodiversity change.

**4:22pm - 4:30pm Warning: The presentations finish prior to the end of the session!**

### Monitoring Tropical Biodiversity From Space: From Multispectral To Hypersepctral Information

**Jean-Baptiste Féret**
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The accelerated erosion of biodiversity is a critical environmental challenge and tropical ecosystems are particularly threatened due to multiple factors. Remote sensing is identified as a particularly relevant data source for operational biodiversity monitoring systems. Optical sensors provide information about canopy chemistry and show interesting potential for the discrimination among forest types, the estimation of taxonomic and functional diversity, and the monitoring of ecosystem changes at regional scale. The potential and limitations of current multispectral sensors such as Sentinel-2 now needs to be investigated and standard methodologies are required to build operational applications for ecologists and decision-makers. Future hyperspectral missions open new perspectives to potentially push the limitations of multispectral sensors and expand capacity in terms of monitoring of vegetation chemistry, changes in taxonomic and functional diversity and adaptation to climate change. This presentation will introduce recent methodological advances for biodiversity monitoring using optical images and their applicability to multispectral and hyperspectral data.

# 003GS-1: Strategies for conservation of biodversity and ecosytem services

*Time:* Wednesday, 26/Feb/2020: 4:00pm - 6:00pm · *Location:* Studio

**4:00pm - 4:15pm**

## Prognosis for Amphibians and Reptiles in World's Largest Restoration Project

**Christopher A Searcy[1], Hunter J Howell[1], Joel C Trexler[2]**

[1]University of Miami, United States of America; [2]Florida International University, United States of America; casearcy@bio.miami.edu

The Everglades are a Natural World Heritage Site and a Ramsar Wetland of International Importance. However, they have suffered severely from anthropogenic impacts, including system-wide declines in wading birds, small mammals, and native fish. Here, we provide the first analysis of amphibian populations in the Everglades using a 22-year dataset (1996-2018) collected from 24 sites. We find that amphibian abundance has decreased by 58% over this period. Most of this time period coincides with implementation of the Comprehensive Everglades Restoration Plan, which was launched in 2000 and is now the largest restoration project ever undertaken. In order to examine how restoration practices affect reptile and amphibian populations in the Everglades, we employed landscape-scale experimental manipulations at the Loxahatchee Impoundment Landscape Assessment. The four 8-ha impoundments at this site provide replicate landscapes that include all major Everglades microhabitats (alligator holes, deep and shallow sloughs, ridges, tree islands) and that can be experimentally manipulated. Starting in 2018, we used these impoundments to compare hydrological restoration treatments that have been proposed for the Everglades as a whole. These include a constrained hydrology that limits maximum water depth during the wet season and a variable hydrology that follows precipitation patterns. Over the first year during which these treatments were imposed, the herpetological communities of the two impoundment types diverged significantly. In particular, the constrained hydrology favored proliferation of invasive reptile and amphibian species. Most notably, the two species with the strongest positive response to the constrained hydrology were the Brown Anole (*Anolis sagrei*) and Cuban Treefrog (*Osteopilus septentrionalis*), the two most abundant invasive species at the site. This suggests that a drier future for the Everglades, whether driven by direct human management of water flow or indirectly through anthropogenic climate change, will favor invasive herpetofauna.

**4:15pm - 4:30pm**

## Stability and Disturbance in Regulated Alpine Streams: Lessons from a Large-scale and Long-term Flow Manipulation Experiment

**Gabriele Consoli, Christopher T. Robinson**

Department of Aquatic Ecology, Eawag; gabriele.consoli@eawag.ch

Freshwater ecosystems across the world are facing the pressure of multiple stressors, undergoing alarming ecological degradation. The exploitation of hydropower potential of rivers has substantially altered natural flow and sediment regimes, considerably contributing to habitat degradation and biodiversity loss in fluvial networks .These alterations modify the physical habitat template of a river downstream of a dam by reducing flow-generated disturbance. Pulse disturbance by natural floods is a key driver of temporal change in freshwater ecological communities, adjusting the equilibrium between physical habitat, resources and biota. Aquatic and riparian organisms have evolved flood-adaptation strategies, and frequency and magnitude of floods shape community organization. Adaptive dam management can make use of experimental floods to restore seasonal peak flows and reintroduce elements of natural disturbance associated with discharge variability. This is what happened on the Spöl River, (Graubünden, Switzerland), where an unprecedented, two-decadal large scale flow manipulation experiment took place. This study will present results from the continuous monitoring of ecosystem responses to repeated experimental floods in the Spöl. These regular flow releases allowed a gradual shift from disturbance-prone to alpine-like macroinvertebrate assemblage by introducing disturbance and enhancing physical habitat conditions, increasing ecosystem resilience to disturbance. Some events occurred in the years (i.e. fine sediments spill, 3 years of flood discontinuation) allow us to elucidate the importance of floods for maintaining the integrity of the river, and to estimate patterns and rates of ecological transition driven by flow disturbance or by flow stability.

**4:30pm - 4:45pm**

## Size-dependent Loss Of Aboveground Animals Differentially Affects Grassland Ecosystem Coupling And Functions

**Anita Christina Risch[1], Raul Ochoa-Hueso[2], Wim H. van der Putten[3], Joseph K. Bump[4], Matt D. Busse[5], Beat Frey[1], Dariusz J. Gwiazdowicz[6], Debbie S. Page-Dumroese[7], Martijn L. Vandegehuchte[8], Stephan Zimmermann[1], Martin Schütz[1]**

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Increasing evidence suggests that community-level responses to human-induced biodiversity loss start with a decrease of interactions among communities and between them and their abiotic environment. The structural and functional consequences of such interaction losses are poorly understood and have rarely been tested in real-world systems. Here, we analysed how five years of progressive, size-selective exclusion of large, medium, and small vertebrates and invertebrates – a realistic scenario of human-induced defaunation – impacts the strength of relationships between above- and belowground communities and their abiotic environment (hereafter ecosystem coupling) and how this relates to ecosystem functionality in grasslands. Exclusion of all vertebrates results in the greatest level of ecosystem coupling, while the additional loss of invertebrates leads to poorly coupled ecosystems. Consumer-driven changes in ecosystem functionality are positively related to changes in ecosystem coupling. Our results highlight the importance of invertebrate communities for maintaining ecological coupling and functioning in an increasingly defaunated world.

**4:45pm - 5:00pm**

## Mapping Green Infrastructure for the Canton of Geneva : Testing the Added Value of Including Ecosystem Services to Biodiversity-based Protected Areas

**Erica Honeck[1], Benjamin Guinaudeau[1], Nicolas Wyler[2], Martin Schlaepfer[1], Pascal Martin[2], Arthur Sanguet[1,2], Bertrand von Arx[3], Joëlle Massy[3], Loreto Urbina[4], Claude Fischer[4], Anthony Lehmann[1]**

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The concept of Green Infrastructure (GI) seeks to identify and prioritize areas of high ecological value for wildlife and people, in order to improve the integration of natural values in landscape management planning decisions. In Switzerland, establishing a functional GI network by 2040 is one of the central objectives of the Swiss Biodiversity Strategy adopted as a law in 2017. In 2018, the canton of Geneva also established a roadmap for biodiversity conservation, which includes the operationalization of a GI framework to conserve 30% of the territory.

Our objective is to demonstrate the implementation of a GI mapping framework based on biodiversity, ecosystem services and connectivity to identify priority conservation areas in the canton of Geneva. Our approach is based on the separate assessment of three pillars, namely species distribution, landscape structure and connectivity, and ecosystem services to optimize the allocation of conservation actions. The pillars are then integrated into the final map using spatial prioritization methods with the Zonation software. The relative weight of each pillar varied under different scenarios.

We investigated the relative influence of GI inputs on the distribution of priority areas and on red list species, as well as the overlap of existing natural reserves with the proposed G.I. and its feasibility. Geneva's GI map will support local decision-makers in spatial planning to help minimize potential conflicts between environmental preservation and other land use interests.

**5:00pm - 5:15pm**

## The Right to Ecological Space | In the City. Operationalising Green Infrastructure as Strategic Urban Planning Concept ensuring a Just Access to its Functionings for both Human Beings and Other Species?

**Sonja Gantioler**

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To address biodiversity conservation beyond high value areas, Green Infrastructure (GI) enhancement has been introduced as an objective in various EU policies. More importantly, GI has been brought forward as a concept that can ensure a wider availability and access to green spaces and their benefits – via conserving and restoring a network of natural and semi-natural elements and environmental features, and supporting a multitude of functions. However, what the concept actually means in practice is subject of on-going discussions between researchers and practitioners.

Arguing that the operationalisation as a strategic planning concept is crucial, a conceptual and action model has been developed, which first of all bases GI implementation on the dedicated principle of the right to ecological space. The presentation will argue how the resulting enlarged value basis not only can help guiding GI's functional and physical shaping, but also framing choices on governance entitlements, linked to property rights, and political, economic and articulation powers. This shall lead to the application of an adequate mix of policy interventions, going beyond a technical rendering and addressing the justice of both outcomes and processes. The presentation will provide conclusions on the study of normative notions such as inequality or justice, and to the extent it helps define clear concepts that can support coherency of action. It will also provide results of the case studies, the cities of Vienna and Munich, which aimed at testing the model by comparing it to existing approaches based on document analysis, questionnaires and semi-narrative interviews. It is expected that the presentation will help inform transdisciplinary research across different disciplines potentially involved in GI implementation at urban level and beyond, including planners, ecologists, political scientists and economists.

**5:15pm - 5:30pm**

## The Biodiversity-Ecosystem Function Relationship Across Gradients In Spatial Scale And Heterogeneity

**Lars Gamfeldt[1], Fabian Roger[2], James Hagan[1], Martin Palm[1], Anne Farewell[1]**

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Biodiversity is an important driver of ecosystem functioning. Our inference is based mainly on empirical studies that have kept spatial scale constant and strived to keep environmental heterogeneity to a minimum. We thus know little about how the role of biodiversity changes with spatial scale and heterogeneity.

With computer simulations and an experiment with 5 species and 4 environments we demonstrate that the effect of biodiversity on production increases with increasing spatial scale, but only when larger spatial scale is associated with increases in environmental heterogeneity. The difference in production of mixtures relative to the most productive species (transgressive overyielding) changed with scale. The slope of the biodiversity-productivity relationship, however, was insensitive to variation in scale and heterogeneity. A synthesis of previous experiments with orthogonal biodiversity and environment manipulations show similar results. Our results can aid in bridging biodiversity-function research with landscape ecology and ecosystem management.

**5:30pm - 5:45pm**

## Grasping the Nettle: Neural Taxa Recognition for Scientific and Vernacular Plant Names

**Isabel Meraner**

Institute of Computational Linguistics, University of Zurich; isa.meraner@gmail.com

The recognition of taxonomic entities plays a key role in natural language processing and understanding in biodiversity contexts. Automating entity and knowledge extraction is hence a core endeavour in order to enrich international ontologies and digitally interlink scientific and ethnobotanical plant knowledge. We present a semi-supervised approach to automatically detect and disambiguate plant names in their Latin and vernacular variants in German and English texts. Besides tailoring linguistic pre-processing for biodiversity literature, we use dictionary-based annotations to automatically label a low-effort silver training set using nine hierarchical entity classes. To assess the domain adaptation potential, we train and cross-evaluate the bi-LSTM-CRF models on text genres differing in terms of formality (scientific/non-scientific), writing style (blogs/Wikipedia), and period (historical/recent). By incorporating both token-level and character-level pre-trained word embeddings, we additionally leverage contextual semantic information. An evaluation of the neural tagger on a representative, manually corrected gold test set shows F1-scores of >89% and >94% for the English and German combined-dataset models. In comparison to the dictionary-based baseline, we observed a promising boost in recall (≈ +10p.p.) leading to the identification of further multilingual vernacular names. Including a capitalisation feature dimension, as well as fine-tuning the dropout rate during training, led to more accurate tagging of unseen entities in related sub-domains, e.g. mycology. These positive results for cross-corpus applications to lower-resourced domains highlight the potential of state-of-the-art deep learning approaches in hitherto under-represented biodiversity contexts. Finally, the entity candidates are disambiguated and mapped to currently accepted taxonomic concepts in the Catalogue of Life knowledge base. To overcome the ontological gaps and further boost the linking coverage, we integrate a lookup table to pre-disambiguate the vernacular names. Our approach aims to make the potential of deep learning-based text mining for biodiversity more visible and to

computationally explore lower-resourced genres for knowledge preservation purposes.

# 176S-2: Ethics and Biodiversity Conservation

*Time:* Wednesday, 26/Feb/2020: 4:00pm - 6:00pm · *Location:* Dischma
*Session Chair:* Anna Deplazes Zemp, University of Zurich, Switzerland
*Session Chair:* Anna Wienhues, University of Zurich, Switzerland

In this session we welcome contributions that discuss different types of ethical conflicts in biodiversity conservation. Amongst other things, such conflicts could concern the aims, methods, costs or policies of biodiversity conservation.

Potential topics include the conflicts between social justice and conservation goals in certain conservation areas or questions about whether (or to what extent) biodiversity should be conserved by 'unnatural' means such as biotechnology or assisted migration or. The session will consist three to five presentations selected from submitted abstracts. We encourage submissions from different disciplinary backgrounds, but we want to highlight that the presentations should focus on ethical conflicts involving different principles, values, normative theories or similar.

**4:00pm - 4:30pm**

## Novel Ecosystems And Responsibility For Nature: Some Ethical Considerations

**Tina Heger[1,2], Uta Eser[3]**
[1]University of Potsdam, Germany; [2]Technical University of Munich, Germany; [3]Büro für Umweltethik, Tübingen, Germany; tina.heger@uni-potsdam.de

Novel ecosystems consist of combinations of species and environmental conditions that have not been previously known. Typical examples are spontaneous species assemblages on abandoned quarries or urban wastelands. There is ongoing debate as to whether these ecosystems are of value from a nature conservation point of view. Defenders of the concept argue that in the Anthropocene, new concepts are necessary to account for the fact that pristine nature often is an aim that cannot be reached, and that ecosystems may have conservation value even if they do not represent the ideal of an undisturbed, historic ecosystem. Opponents argue, on the other hand, that naming such systems with a term that has a rather positive connotation is undermining nature conservation efforts, because it opens the door for inaction, and that welcoming novel ecosystems as 'new nature' means neglecting responsibility.

With our contribution, we would like to highlight the different ethical dimensions of responsibility. Responsibility is a threefold relationship, involving a subject of responsibility, an object of responsibility, and an authority of responsibility. With regard to nature conservation or the evaluation of novel ecosystems, neither of these three elements is easy to pinpoint. We show that differences in assigning what are object, subject and authority of responsibility lead to different lines of argumentation concerning what exactly it means to act responsibly in nature conservation. Based on this, we argue that none of the common lines of argumentation in favour of or against novel ecosystems is fundamentally flawed or morally wrong for principled reasons. We suggest that the Rio-Declaration can be viewed as an explicit formulation of broadly agreed ethical values, and thus as a starting point in the search for common ground in evaluating novel ecosystems.

**4:30pm - 5:00pm**

## The Importance of Environmental Authenticity

**Kimberly Mae Dill**
Santa Clara University, United States of America; kdill@scu.edu

Elsewhere, I have argued that the conservation of biodiverse environments is partially justified by reference to the transformative power that they bear, which is explicable in terms of their (i) capacity to facilitate human intellectual achievements, technology, and understanding (Sarkar 2011), and (ii) their capacity to facilitate human psychological functioning and well-being. In order to justify (ii), I refer to a series of empirical studies in environmental psychology, which demonstrate that immersion in these restorative environments decreases stress, facilitates quicker recovery rates after surgery (Ulrich 1991), and alleviates negative symptoms associated with attention- and mood based disorders (e.g., ADHD and depression) (Kaplan & Kaplan 1989; 1985; 2012).

My task in this piece will be to introduce and address a worry that is particularly problematic for my transformative power account of biodiversity conservation. In particular, Roger Ulrich's (1991) studies have demonstrated that showing patients who are recovering from abdominal surgery mere photographs or videos of natural environments has a similar (albeit lesser) positive, psychophysiological effect to genuine, biodiverse environments. This is worrisome, as we can imagine a case in the not-so-distant future wherein technology has advanced to the point that video game play is a completely immersive, cross-modal experience, replete with simulated sights, sounds, smells, tactile sensations, etc. An objection to my view might go: in this not-so-distant future, we won't need to worry about conserving biodiverse environments, as we will be able to construct simulations of biodiverse environments that will induce the same positive effects on human psychophysiological functioning. Call this the 'Simulation Problem'.

In order to address the Simulation Problem, I will show in this paper that, even if the psychophysiological effects of biodiverse, restorative environments are replicable to some degree, simulations of biodiverse environments are in some important sense inauthentic. Furthermore, I will claim that the authenticity of artifacts and environments matters, for authenticity plays an important psychological, cultural, and personal role in the lives of human agents.1 I will argue, in particular, that authenticity is a necessary, though not sufficient, condition on the transformative power that e.g., biodiverse environments bear (and the restorative experiences that they thereby induce). In other words, artifacts, environments, and people must be authentic (so far as I define the term) if they are to fully (i) facilitate intellectual discoveries and insights, (ii) play an important cultural role, and (iii) induce psychophysiological restoration.

**5:00pm - 5:30pm**

## Ethical Conflicts Between Biodiversity Conservation and Ecological Restoration.

**Linnea Susanna Luuppala**
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The world is in the midst of significant environmental change. Large-scale environmental degradation and sixth mass extinction are reducing biodiversity at unprecedented rate and ecological restoration is one of the leading strategies suggested as a solution to halt biodiversity loss. However, it is important to pause and rethink the connection between biodiversity and ecological restoration. In this presentation, I will explore this relationship and the ethical conflicts that emerge. At first glance, biodiversity and ecological restoration fit seemingly together – restoration is often referred to as a tool for biodiversity conservation and biodiversity as an important goal of ecological restoration. Biodiversity used to even feature in the Society for Ecological Restoration's 1996 definition

of ecological restoration. However, the link between biodiversity and ecological restoration is not as obvious and unproblematic as it is often portrayed.

I argue that there are two main ethical conflicts that emerge between ecological restoration and biodiversity. The first is regarding ecological restoration's focus on *historical* biodiversity, whereas biodiversity does not appear to make such a distinction between historical and new. Biodiversity can be supported within novel and historic ecosystems alike. This can lead to difficult conflicts between non-native endangered species and historic ecosystems. Should the aim of historical continuity with ecological restoration be relieved if it would lead to safeguarding a non-native but endangered species? The second conflict occurs between culture and nature. Sometimes cultural landscapes can be more biodiverse compared to 'natural' historic landscapes. However, ecological restoration is often aimed at protecting the site prior to human intervention, creating a dichotomy between humans and nature. This can lead to challenging conflicts between protecting human cultural landscapes and historic natural landscapes. In addition, these two conflicts are made more serious and challenging by climate change. To help analyse and provide solutions to these conflicts an important distinction must be made between *natural* and *artificial* biodiversity. I argue that by making this distinction we can better understand the important trade-offs between ecological restoration and biodiversity.

**5:30pm - 6:00pm**

## 'Otherness' in and of Nature: Implications for Understanding the Human-Nature Relationship

**Anna Wienhues, Anna Deplazes Zemp**
University of Zurich, Switzerland; anna.wienhues@uzh.ch

The *otherness of nature* is a central concept within the environmental ethics literature. Yet, what otherness means in this context and what the implications are of respecting such otherness remain often fairly obscure. In this paper we propose a definition of otherness as *difference* and analyse its implications for normative theorising when subdivided into *individual otherness* and *structural otherness*. The former has implications for how the moral status of nonhumans is theorised and the latter has implications for how the nature concept itself is understood. The upshot is that respecting otherness in both senses strengthens relational thinking and should be conceived as a call for their *methodological recognition* in environmental philosophy with the further implication of providing an additional argument for the protection and normative relevance of *biodiversity*.

# 120S-2: Aquatic Biodiversity - State and Challenges ahead

*Time:* Wednesday, 26/Feb/2020: 4:00pm - 6:00pm · *Location:* Flüela
*Session Chair:* Rosetta Blackman, Eawag, Switzerland
*Session Chair:* Ole Seehausen, Eawag and Institute of Ecology & Evolution, University of Bern, Switzerland
*Session Chair:* Florian Altermatt, University of Zurich, Switzerland

The earth's surface is made up of over 70% water, and these aquatic ecosystems are among the most biodiverse worldwide. Key examples of ecological and evolutionary dynamics have been established in aquatic ecosystems, including work on adaptive radiation, spatial ecology and invasive species biology. These ecosystems are also used as an essential resource by humans, ranging from freshwater drinking supplies, fisheries, and transportation.

These uses often negatively affect aquatic ecosystems, their biodiversity and eventually also their ecosystem functions. Consequently, aquatic ecosystems are globally among the most threatened ecosystems. To reverse these rapid declines in biodiversity, concerted and interdisciplinary actions are needed. In this session, we combine talks that give an overview on the state and threats to aquatic biodiversity, discuss the underlying drivers and outline how this affects the ecological and evolutionary integrity of these systems. We want to discuss advancements in the detection and assessment of aquatic biodiversity baseline data, link aquatic biodiversity and ecosystem functioning, and outline socio-economic strategies needed to change the trajectory of aquatic biodiversity.

**4:00pm - 4:45pm**

## Next-Generation Biodiversity Monitoring: Combining Artificial Intelligence and Environmental Genomics

**Jan Pawlowski**
University of Geneva, Department of Genetics and Evolution; jan.pawlowska@unige.ch

The bioassessment of aquatic ecosystems is currently based on various biotic indices that use the richness, abundance and taxonomic composition of selected bioindicator groups to define ecological status. These conventional indices have some limitations related to difficulties in morphological identification of bioindicator taxa. Recent development of high-throughput DNA barcoding and environmental genomics could potentially alleviate some of these limitations, by using DNA sequences instead of morphology, to identify organisms and to characterize a given ecosystem.

Pilot studies inferring biotic indices from environmental genomics data show very promising results. Comparing to conventional methods, the DNA-based approaches allow (1) improving sensitivity of bioassessments by expanding the range of potential bioindicators to include morphologically inconspicuous taxa, (2) enabling wider and more frequent applications by reducing the costs and time of analyses, and (3) by limiting the uncertainties by standardizing the protocols for molecular data acquisition and analysis. However, the generation and interpretation of genomic data are often complicated and require special expertise that is not always available. To overcome these limitations, it is important to develop tools that will make the analysis of genomic data easy and accessible to all potential users. Here we present the AquaGen project that proposes to develop a cutting-edge web-based platform that combines environmental genomics and machine learning technologies to predict the ecological status of aquatic ecosystems. The implementation of such platform will allow rapid and inexpensive routine biomonitoring that will help to protect biodiversity and mange the health of environment.

**4:45pm - 5:00pm**

## Predicting Vulnerability to Climate Change by Linking Environmental Heterogeneity to Genetic and Phenotypic Variation in Mountain Stream Frogs

**W. Chris Funk**
Colorado State University, United States of America; Chris.Funk@colostate.edu

Our goal is to uncover spatial patterns of vulnerability to climate change using an integrative framework that links environmental heterogeneity to genetic and phenotypic variation in resilience traits, an approach we term "landscape phenomics". Our fundamental premise is that environmental variation ultimately generates phenotypic variation through plasticity and evolution, and this phenotypic variation mediates the vulnerability of populations to environmental change. We are currently applying this framework to understand spatial variation in thermal tolerance and vulnerability to climate change in coastal and Rocky Mountain tailed frogs (Ascaphus truei and A. montanus) by integrating environmental (temperature), genomic (SNP and whole genome resequencing), and physiological data. Preliminary genomic results indicate that populations are adapted to their local temperature regime. Moreover, thermal tolerance varies as a function of local temperatures and can change plastically to some degree in acclimation experiments. These early results suggest that both evolution and plasticity cause variation in this key resilience trait. Our ultimate goal will be to infer how this phenotypic variation influences spatial patterns of vulnerability in the face of climate change.

**5:00pm - 5:15pm**

## The Aquatic Biodiversity Crisis in Lake Victoria Basin, Tanzania: Past, Present and Future Trends

**Mary Alphonce Kishe**
Tanzania Fisheries Research Institute, P.O. Box 9750, Dar es Salaam, Tanzania; mkishe@yahoo.com

Lake Victoria is among the world's best-known examples of fish species rich lacustrine ecosystems. However, the lake has faced numerous stressors and changes in its history, in this talk we will discuss those stressors. Prior to the early 20$^{th}$ century the lake was only sparsely fished with simple traditional methods but from 1905 to 1920: gillnets, beach seines and outboard motors were introduced in the lake and consequently increased the fishing pressure. Lake-wide, the main target species was the *Oreochromis esculentus*, but other fish species such as *O. variabilis*, *P. aethiopicus*, *C. gariepinus* and *B. docmak* were also targeted. Fishing pressure continued to increase in the 1950s and 1960s resulting in decreases in catch per fishing effort, especially for the endemic tilapiine species and *Labeo victorianus.* By the late 1960s and 1970s, other species, including the *P. aethiopicus*, *Brycinus* spp. and *Mormyrus kannume* were also becoming rare. To improve the dwindling catches, the Nile perch, *Lates niloticus*, a large centropomid piscivore, Nile tilapia, *Oreochromis niloticus*, *O. leucostictus*, *Tilapia zillii* and *T. rendalli* were introduced. In the 1980s, Nile perch increased in Lake Victoria and complex haplochromine-based ecosystem was replaced by a system dominated by only four species; the exotic Nile perch and Nile tilapia, the native dagaa *Rastrineobola argentea* and the atyid shrimp *Caridina nilotica*. The haplochromine cichlids vanished almost completely and estimation of 200 of the endemic haplochromine species may have gone extinct. Nile tilapia displaced the native tilapiines. From 1990s, after a decline in Nile perch in Lake Victoria, a slow resurgence of some haplochromine species was observed. In 2000s, there was a strong resurgence of detritivorous,

zooplanktivorous and oral mollusc shelling haplochromine species and in 2006, the zooplanktivores in some areas of the lakes outnumbered their reported levels of 1970s. In recent years, a good Nile perch recruitment has been observed indicating its recovery.

**5:15pm - 5:30pm**

### RiverDNA - Complete Biodiversity Monitoring Using e-DNA

**Rosetta Blackman[1,2], Florian Altermatt[1,2]**

[1]Eawag, Switzerland; [2]URPP GBC, University of Zurich, 8057, Switzerland; Rosetta.Blackman@eawag.ch

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.

**5:30pm - 5:45pm**

### Mechanisms Of Trophic Niche Compression: Evidence From Landscape Disturbance

**Francis John Burdon[1,2,3], Angus R. McIntosh[1], Jon S. Harding[1]**

[1]University of Canterbury, New Zealand; [2]Eawag, Switzerland; [3]Swedish University of Agricultural Sciences, Sweden; francis.burdon@slu.se

Natural and anthropogenic disturbances commonly alter patterns of biodiversity and ecosystem functioning. However, how networks of interacting species respond to these changes remains poorly understood. We described aquatic food webs using invertebrate and fish community composition, functional traits, and stable isotopes from twelve agricultural streams along a landscape disturbance gradient. Food-web properties based on stable isotope data ($\delta^{13}C$ and $\delta^{15}N$) from consumers showed that increasing sediment disturbance was associated with reduced trophic diversity, indicated by the invertebrate community occupying a smaller area in isotopic niche space. Reductions in trophic diversity were best explained by a narrowing of the consumer $\delta^{13}C$ range along the sedimentation gradient, and Bayesian mixing-model analyses indicated the loss of the autochthonous food-web channel with increasing disturbance. Similar changes to the horizontal trophic niche for fish along the sedimentation gradient contributed to an apparent ‘trophic shift’ towards terrestrial carbon, further indicating the loss of autochthony. On the vertical trophic niche axis, fish became increasingly separated from aquatic invertebrates with an increase in their estimated trophic position. In combination, these responses were most likely mediated through reduced fish densities and a diminished reliance on aquatic prey. Although species losses remain a major threat to ecosystem integrity, the functional roles of biota that persist dictate how food webs and ecosystem functioning respond to environmental change. Sedimentation was associated with non-linear reductions in trophic diversity which could affect the functioning and stability of aquatic ecosystems. Our study helps explain how multiple mechanisms may reduce trophic diversity and reshape food-web properties in response to this type of disturbance.

**5:45pm - 6:00pm**

### Biological Response to Change in Antarctica

**Peter Convey**

British Antarctic Survey, NERC, United Kingdom; pcon@bas.ac.uk

Marine, freshwater and terrestrial environments in Antarctica and the surrounding Southern Ocean are facing multiple environmental changes. Their unique native biota have existed in and adapted to the region’s extreme conditions over many millions of years, but are now challenged by both these changes and other direct impacts of human activity. Aquatic and terrestrial environments are characterised by very different physical and temporal scales of natural variability, meaning that environmental change presents different challenges in each. Terrestrial biota typically possess considerable physiological and ecological flexibility, and are generally expected to show positive responses to current environmental trends. In contrast, marine biota are often highly stenothermic, and some already appear to be approaching the limits of their ability to respond to ocean warming. Changing sea-ice has large impacts on marine ecosystem processes, while ocean acidification and coastal freshening are also expected to have major impacts on marine communities. Freshwater environments, while showing damped variability relative to the terrestrial, in some respects can magnify the rates of warming and their physical consequences, such as reduction in ice cover. However, direct human impacts, in particular, the establishment of non-native organisms to both terrestrial and marine ecosystems may present an even greater threat to Antarctica’s native biota and communities on a century timescale than climate change itself.

# 125W: Connecting the human dimension and global marine ecosystem services

*Time:* Wednesday, 26/Feb/2020: 4:00pm - 6:00pm · *Location:* Schwarzhorn
*Session Chair:* Andrea Belgrano, SIME, Sweden
*Session Chair:* Sebastian VILLASANTE, University of Santiago de Compostela, Spain

Global oceans biodiversity provides a wealth of ecosystem services (ES) and benefits such as food from capture fisheries, aquaculture and wild foods. Despite international commitments, the vast majority of the world's nations declared that human actions were dismantling the Earth's ecosystems at an alarming rate, crossing safe planetary boundaries.

By evaluating the impacts of human activity on biodiversity, ES and their social and economic consequences we can highlight the trade-offs between actions to reverse the declining states of marine biodiversity and ecosystems, and possible competing economic interests from different sectors (e.g., commercial and recreational fisheries, aquaculture, coastal tourism, etc.).

Marine and coastal ES can be valued in quantitative terms using metrics such as monetary value or health value or in qualitative terms, which will always be non-monetary and usually have some consideration of health, socio-cultural or conservation value including Indigenous and Local Knowledge (ILK) perspectives. A whole array of methods and techniques for ecosystem valuation exist, but are only occasionally implemented in policy decisions. With this workshop proposal we want to provide a transdisciplinary platform for sharing current research on the role of coastal and marine ecosystems in providing wealth and health to humans and to stimulate cooperation between the United Nations, International Platform for Biodiversity and Ecosystem Services (IPBES), the Future Earth program, the International Council for the Exploration of the Sea (ICES) and the Ecosystem Services Partnership (ESP), all global networks working for the maintenance of marine biodiversity.

**4:00pm - 4:30pm**

## Subsidizing the Depletion of Ocean Biodiversity

**U. Rashid Sumaila**
University of British Columbia, Canada; r.sumaila@oceans.ubc.ca

to be submitted.

**4:30pm - 4:37pm**

## Operational Goals For Managing Biodiversity And Ecosystem Services

**Helmut Hillebrand**
University Oldenburg, Germany; helmut.hillebrand@uni-oldenburg.de

In this short presentation for the workshop I would like to focus on the aims for marine biodiversity management. In contrast to the clear-cut goals for climate (1.5 or 2° warming), the assessment of biodiversity change (and measures to mitigate it) suffer from unclear definitions of metrics and goals. I would like to start a discussion on what operational targets for biodiversity management we can develop and how we measure the success of mitigation strategies in the light of these goals.

**4:37pm - 4:52pm**

## Biodiversity Multitrait Dynamics in Exploited Seascapes

**Carlos Melian**
EAWAG, Switzerland; carlos.melian@eawag.ch

Declining condition of fishing communities is a dominant trend affecting severely seascapes. Many studies have independently shown human actions driving the declining condition of fish communities, like overfishing, contamination, anoxic expansion, predator-prey reversal, invasions and rapidly shifting environmental gradients. Yet, deciphering the strength of biotic and abiotic processes affecting the declining condition of fisheries when accounting for multiple traits remain challenging. In this talk I will discuss open questions when merging nested and multiscale samplings with process-based multitrait modeling approaches from individuals to populations and ecosystems to map the spatiotemporal declining condition of fish communities. I will focus on a case study to show the scalability and predictability trade-offs when connecting micro-ecological processes to the declining condition patterns observed at the macroecological scale.

**4:52pm - 4:59pm**

## Anthropogenic Influences Erode the Persistence of Marine Food Webs

**Jordi Bascompte**
University of Zurich, Switzerland; jordi.bascompte@uzh.ch

Marine coastal environments are particularly susceptible to global environmental change. While the effects of human activities on individual species have been the subject of much research, we know less about how they affect the resilience of entire communities. Here I will review work on the structure and dynamics of a Caribbean regional food web. This work shows that anthropogenic influences may reduce the persistence of marine food webs, thus eroding their capacity to withstand further degradation.

**4:59pm - 5:06pm**

## Cultural Ecosystem Services from a Marine Protected Area Provide Multiple Benefits to Human Well-being

**João Garcia Rodrigues[1], Sebastián Villasante[1], Isabel Sousa Pinto[2]**
[1]University of Santiago de Compostela, Spain; [2]University of Porto, Portugal; joao.rodrigues@rai.usc.es

Cultural ecosystem services (CES) are frequently the most valued and demanded ecosystem services by people. This is because CES provide many benefits to human well-being in the form of identities, experiences and capabilities. Yet, while research on tangible CES such as tourism and recreation abound, studies of more intangible CES are relatively scarce. This research gap results in a limited understanding of the relationships between CES and human well-being, especially in the marine environment. To understand the contributions of intangible CES benefits to subjective human well-being we surveyed 453 users of Litoral Norte, a multiple-use marine protected area in Portugal. Our survey included 16 statement indicators reflecting constructs of well-being. With the help of factor analysis, we show that well-being derived from relating to, interacting with, and experiencing marine and coastal sites can be grouped into four interpretable cultural dimensions of well-being. These dimensions are 'engagement with

nature & health', 'sense of place', 'solitude in nature', and 'spirituality'. We found significant differences in reported levels of CES benefits among the four cultural dimensions of well-being. Reported levels of well-being varied with interviewees' socio-economic characteristics and environmental behaviour. Our findings offer interesting insights for marine conservation practice and policy that aims to foster both biodiversity and human well-being.

**5:06pm - 5:13pm**

### FAO's Engagement in the Post-2020 Global Biodiversity Framework: Mainstreaming Biodiversity for Sustainable Fisheries and Aquaculture

**Marina Demaria Venâncio, Paulo Augusto Lourenço Dias Nunes**

Food and Agriculture Organization of the United Nations, Italy; marinademariavenancio@gmail.com

The emergence of a genuinely anthropogenic era poses several challenges to global policymaking. As the latest report from the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) points out, "[h]uman actions threaten more species with global extinction now than ever before". The sixth edition of the Global Environment Outlook (GEO-6) also highlights that the decline in genetic diversity has been "threatening food security and the resilience of ecosystems, including agricultural systems and food security" (UN Environment 2019). In this context, the loss of biodiversity directly affects the resilience of marine ecosystems and their contribution to food security and nutrition, requiring innovative and cross-cutting tools, practices, and policies. Given that biodiversity mainstreaming emerges as an essential element of the post-2020 global biodiversity framework process, as stated by the Cancún Declaration on Mainstreaming the Conservation and Sustainable Use of Biodiversity for Well-Being (from CBD COP 13). FAO defines mainstreaming as the process of embedding biodiversity concerns into all strategies, policies, and practices that are adopted by public and private actors. Mainstreaming biodiversity across agricultural sectors (which encompass crop, livestock, agroforestry, forestry, fisheries, and aquaculture) is crucial to ensure that biodiversity is not only conserved but also used sustainably. Of note, mainstreaming is also addressed by CBD COP 13 Decision XIII/3, and CBD COP 14 Decision 14.3, which established the Informal Advisory Group on Mainstreaming of Biodiversity (IAG). Within this background, this presentation will focus on the interconnection between mainstreaming, food security, and marine ecosystems, highlighting the work of FAO and its Biodiversity Mainstreaming Platform (BPM) in the context of the Post-2020 process. It will also discuss the outcomes of the regional multi-stakeholder dialogues organized by the Platform, focusing on their recommendations regarding the fisheries and aquaculture sectors.

**5:13pm - 5:20pm**

### Getting The Balance Right – Thoughts From A South African Fisheries Perspective

**Lynne Jane Shannon[1], Lauren Waller[2]**

[1]University Of Cape Town; [2]SANCCOB; lynne.shannon@uct.ac.za

Globally, there is general acceptance for the Ecosystem Approach to Fisheries (EAF) in principle, however, in most instances there are significant difficulties in implementing it. The challenges faced in mobilising management to lift EAF off the ground are many and complex. Here we use a South African case study to emphasize the multi-faceted trade-offs requiring careful consideration in the purse seine fishery for small pelagics. The fisheries management body faces enormous pressure from industry and society in general in terms of safeguarding fishing companies and associated communities against economic stress and job loss. However, are we missing the bigger picture? If we do not safeguard our marine ecological resources and ecosystems, we risk losing potential economic gains and social upliftment which other industries may generate. For example, the South African marine ecotourism industry and coastal tourism in general is a major source of revenue, not least for previously disadvantaged and poorer coastal communities. South Africa is a top international travel destination particularly owing to its rich biodiversity – the fauna and flora it supports. Our marine ecosystems are especially attractive to holiday makers and support (and could potentially support substantially more) formal and informal employment and economic opportunities. Several charismatic species (for example the endangered African penguin, the great white shark, dusky dolphin, Cape fur seal), endangered species such as the Cape gannet and Cape Cormorant, and overfished, commercially important fish species such as geelbek rely on small pelagic fish as important prey items. However, in recent years the South African sardine stock has collapsed and reduced availability of sardine particularly off South Africa's west coast is stressing the marine ecosystem; high profile predators such as the afore-mentioned; the purse seine fishery and tourism-based industries along the coast. Isn't it time that we take a broader, more pragmatic view and strive for "ecosystem-based management" rather than focussing mostly on trying to achieve the ever-elusive EAF?

# 572S: Solution-oriented scenarios to the loss and restore global biodiversity

*Time:* Wednesday, 26/Feb/2020: 4:00pm - 6:00pm · *Location:* Seehorn
*Session Chair:* Rob Alkemade, Netherlands Environmental Assessment Agency, Netherlands, The
*Session Chair:* Jelle Peter Hilbers, PBL, Netherlands, The

The increasing human pressures on the environment pose significant threats to biodiversity and, in turn, to people's well-being and livelihoods. Without dramatic changes in efforts, the severe decline of Earth's biodiversity will continue and lead to serious consequences for nature and people. Scenario-based modelling allows exploring the possible future states of biodiversity under a set of assumptions concerning human development and efforts to reduce pressures or impacts. It is a vital tool that can help to provide measures aimed at halting and/or reversing current and future biodiversity loss.

In the recent years, a variety of scenarios has been developed to explore options capable of achieving CBD's biodiversity vision for 2050 stating "By 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people". Yet, it is important to qualitatively and quantitatively discuss the benefits and challenges of these scenarios and the measures highlighted therein. For example, what are the best measures to halt biodiversity loss and what is needed to reverse it? What are the limits of the modelling exercises and how may these effect the explored measures? What trade-offs with other SDGs are expected? How can we align biodiversity conservation with human land use when implementing the measures?

This session will bring together biodiversity modelling experts, practitioners and policy-makers to discuss solution-oriented scenario experiences including options capable of halting the loss and potentially restoring biodiversity. Our aim is to promote collaboration and exchange between the research community and policy-makers, and to develop a research agenda for the years to come.

**4:00pm - 4:15pm**

## Biodiversity Conservation, Land-Use Change, And Tackling The Ultimate Drivers Of Extinction

**David R Williams**
University of Leeds, United Kingdom; d.r.williams@leeds.ac.uk

Agricultural expansion is a major and growing threat to biodiversity. Reducing its impacts while supporting a growing population requires knowing which species and landscapes are most at risk, and which changes to food systems have the greatest potential to benefit biodiversity.

I will present the results of new, high-resolution projections of global agricultural expansion up to 2050, and the likely impacts of this expansion on over 20,000 species of terrestrial vertebrates. Under Business-As-Usual conditions, we project widespread biodiversity losses across the world, particularly in highly biodiverse countries—losses which current conservation strategies are unlikely to be able to address. However, I will also explore the impacts of various proactive changes to the global food system, and demonstrate how these could alleviate many of the pressures on biodiversity from agricultural expansion, whilst providing healthier diets for the global population. Finally, I will discuss why I believe that biodiversity science needs to expand its scope to provide more insight into the ultimate drivers of biodiversity loss and, vitally, increase research into developing and testing responses to the biodiversity crisis, rather than just reporting on threats to biodiversity and their impacts.

**4:15pm - 4:30pm**

## Projected Global Loss of Mammal Habitat due to Land Use and Climate Change

**Carlo Rondinini[1], Daniele Baisero[1], Michela Pacifici[1], Piero Visconti[2]**
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Human pressure on the environment is driving a global decline of biodiversity. Anticipating whether this trend can be reverted under future scenarios is key to support policy decisions. We used the InSiGHTS framework to model the impacts of climate change and land cover change on future habitat availability for 2827 terrestrial mammals at 15 arc minutes resolution, under five contrasting global change scenarios based on combinations of Representative Concentration Pathways (RCP) and Shared Socio-economic Pathways (SSP) between 2015 and 2050. Global habitat availability for mammals declined (5-16%) in all scenario combinations. Africa (decline up to 25%), South America and Oceania were the most impacted regions. African insectivores, Primates, Australian carnivorous marsupials and marsupial moles, and South American opossums declined the most. Halting loss of mammal habitat would require a mix of actions across scales, including global shift towards sustainability, addressing land-use change in sub-Saharan Africa, and helping endemic species track climate change in Oceania and South America.

**4:30pm - 4:45pm**

## Reversing Terrestrial Biodiversity Declines Due To Habitat Loss: A Model Ensemble Approach

**D Leclere[1], M Obersteiner[1], M Barrett[2], S H M Butchart[3,4], A Chaudhary[5,6], A De Palma[7], F De Clerck[8,9], M Di Marco[10], J C Doelman[11], M Durauer[1], R Freeman[12], M Harfoot[13], T Hasegawa[14,1], S Hellweg[15], J P Hilbers[11], S L L Hill[7,13], F Humpenoeder[16], N Jennings[17], T Krisztin[1], G M Mace[18], H Ohashi[19], A Popp[16], A Purvis[7,20], A M Schipper[11,21], A Tabeau[22], H Valin[1], H van Meijl[22], W J van Zeist[11], P Visconti[1,12,18], R Alkemade[11,23], A Rosamunde[24], G Bunting[3], N D Burgess[13], S E Cornell[25], F Di Fulvio[1], S Ferrier[26], S Fritz[1], S Fujimori[14,27,28], M Grooten[24], T Harwood[26], P Havlik[1], M Herrero[29], A J Hoskins[26], T Kram[11], H Lotze-Campen[16,30,31], T Matsui[19], C Meyer[32,33], D Nel[34,35], T Newbold[18], G Schmidt-Traub[36], E Stehfest[11], B Strassburg[37,38], D P van Vuuren[11,39], C Ware[26], J E M Watson[40,41], W Wu[14], L Young[3]**
[1]ESM Program IIASA, Austria; [2]WWF-UK, UK; [3]Birdlife International, UK; [4]University of Cambridge, UK; [5]IFNH ETH-Z, Switzerland; [6]IIT Kanpur, India; [7]NHM, UK; [8]EAT, Norway; [9]Biodiversity International, Italy; [10]CSIRO Land and Water Brisbane, Australia; [11]PBL, Netherlands; [12]ZSL, UK; [13]UNEP-WCMC, UK; [14]CSESR NIES, Japan; [15]IFU ETH-Z, Switzerland; [16]PIK, Germany; [17]Dotmoth, UK; [18]CEBR UCL, UK; [19]CIPRCC FFPRI FRMO, Japan; [20]Imperial College London, UK; [21]Radboud University, Netherlands; [22]WCER, Netherlands; [23]ESAG WUR, Netherlands; [24]WWF-NL, Netherlands; [25]SRC, Sweden; [26]CSIRO Land and Water Canberra, Australia; [27]Kyoto University, Japan; [28]ENE Program IIASA, Austria; [29]CSIRO Agriculture and Food; [30]Humbolt University IRITHES, Germany; [31]Humbolt University DAE, Germany; [32]iDIV, Germany; [33]University of Leipzig, Germany; [34]WWF International, Switzerland; [35]GRP SRC, Sweden; [36]SDSN Paris, France; [37]RCSRC PUC Rio de Janeiro, Brazil; [38]IIS Rio de Janeiro, Brazil; [39]CISD Utrecht University, Netherlands; [40]Queensland University, Australia; [41]Wildlife Conservation

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Increased efforts are required to prevent further losses of terrestrial biodiversity and the ecosystem services it provides. Ambitious targets have been proposed, such as reversing the declining trends in biodiversity – yet, even just feeding the growing human population will make it a challenge. We use an ensemble of land-use and biodiversity models to assess whether and how we can reverse the terrestrial biodiversity declines due to habitat loss and degradation – major threats to biodiversity. We show that jointly feeding the growing the population and reversing by 2050 the declining global trends in five aspects of biodiversity under habitat loss will require immediate efforts that are both of unprecedented ambition and coordination, and consistent with the broader sustainability agenda. Biodiversity trends could become positive by 2050 but not for all models (95% confidence interval CI: 13 2040-2063) if increasing the extent and management of protected areas, restoring degraded land, and increasing landscape-level conservation planning altogether. However, this could increase food prices while avoiding only 56% (CI: 46-65%) of future biodiversity losses due to habitat loss. Tackling in addition the drivers of land-use change through sustainable intensification of agriculture, increased trade, reduced food waste and healthier human diets altogether avoids conflicting with affordable food provision, reduces our food system's environmental impacts and allow in almost model combinations (96% on average, CI: 88-100%) to both avoiding >67% of future biodiversity losses and reversing the biodiversity trends by 2050. Although limiting further loss will remain challenging in several biodiversity-rich regions and truly reversing biodiversity trends will need addressing other threats, our results suggest that a transformation of our food system, in combination with bold targets, should be central to the post-2020 biodiversity strategy.

**4:45pm - 5:00pm**

## Half Earth vs Whole Earth conservation: global biodiversity impacts

**Jelle Peter Hilbers[1], Marco Immovilli[2]**

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A major challenge remains regarding aligning biodiversity conservation with human land use when implementing measures capable of realizing the CBD 2050 vision in the context of the SDGs. Typically, conservationists differentiate between two alternative strategies: land sparing and land sharing. The former is traditionally considered as the most effective way to counteract biodiversity loss, as it leads to larger wildlife populations. However, the CBD 2050 vision is broader than biodiversity conservation alone, as it also aims for maintaining ecosystem services, sustainable use and benefit sharing. As our society, our economy and nature are intertwined, focusing solely on the SDGs related to biodiversity conservation may come at the expense of achieving other SDGs. Land sharing has been advocated to be the more beneficial conservation strategy in this regard.

Recently the debate between land sparing and land sharing has reignited following a call to protect half of the earth as an ultimate attempt to save global biodiversity. It is believed that the only solution to prevent mass extinction is increasing the amount of protected areas from approximately 15% currently to 50% in 2050. Opponents, however, argue that the approach might do more harm than good as it leaves the underlying drivers of biodiversity loss untouched. They propose a whole earth approach with a focus on a sustainable political economy. To move the debate forward, it is important to quantify the benefits and challenges of both approaches in the context of the SDGs. In this presentation, we will first provide a conceptual overview of the half earth and whole earth approaches to place them within the CBD 2050 vision. Next, we will discuss our findings on the potential impacts of a realization of both approaches on global terrestrial and aquatic biodiversity.

**5:00pm - 5:15pm**

## Implications of 'Half earth' and 'Whole Earth' Conservation Strategies for Agricultural Systems

**Willem-Jan van Zeist[1], Elke Stehfest[1], Johan Meijer[1], Marcel Kok[1], Jonathan Doelman[1], Andrzej Tabeau[2]**

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Among the strategies aiming at ambitious biodiversity conservation, the 'Half Earth' and 'Whole Earth' strategies represent two well-known yet contrasting approaches. While the first mainly focusses on protecting natural areas, the latter envisions shared spaces and a "living in harmony with nature", and consequently, also extend to the socio-economic implications related to these strategies vary substantially. Applying the IMAGE-MAGNET modelling we evaluate the agroeconomic impacts of these strategies based on recent protected area maps in GLOBIO at the PBL Netherlands Environmental Assessment Agency. The Half Earth approach, based on the protection of 50% of each ecoregion, puts high restrictions on land supply and requires strong intensification of agriculture, whereas the Whole Earth approach implies mixed systems with somewhat lower productivity, yet more room for nature in agricultural areas. We evaluate these approaches against a baseline SSP2 scenario and compare land use metrics and socio-economic impacts. We find that, for example, in the Half Earth approach the overall restriction on agricultural area achieved by 2050 (preventing biodiversity loss), food prices increase by 40% in 2050 compared to the baseline scenario (add regional number). Thus, additional policy options are needed to counterbalance trade-offs in the food system via, for example, decrease food waste, reducing meat consumption and increasing crop productivity.

**5:15pm - 5:30pm Warning: The presentations finish prior to the end of the session!**

## Global Areas Of Importance For Species Conservation And Carbon Storage

**Martin Jung, Piero Visconti**

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Meeting the objectives of the UNFCCC and the CBD requires clarity on how those ambitious targets can be translated into national policies. In the case of biodiversity and carbon, the world lacks fully integrated spatial-explicit maps to translate politically agreed levels of ambition into operational targets at local to global levels. Such integrated maps could support governments in translating politically agreed levels of ambition into spatially-explicit policy objectives and promote synergies between relevant multilateral environmental agreements and actions.

We performed the most comprehensive data-driven analyses of the global distribution of areas of importance for terrestrial species conservation and carbon storage. We obtained distribution data for the world's terrestrial amphibians, birds, mammals and reptile species representing approximately 95% of the species known to science in these groups. As a first for these global analyses, we also gathered distribution data for almost half of all vascular plant species known to science, while accounting for geographic and taxonomic biases. We use the distribution maps, together with data on above-ground biomass carbon and vulnerable soil organic carbon, to determine the value of each 10 km grid-cell for species conservation and carbon sequestration on land.

We find that accounting for plant and reptile species gives more importance to several centers of endemism for these groups in sub-tropical and temperate regions, including the Caucasus, the Mediterranean Basin, Japan and the Atlantic Forest. Achieving persistence targets for all species would require managing for conservation at least 80% of the terrestrial land-surface of the

planet. However, 30% of the planet is already sufficient to achieve these targets for 77.7% of the species when prioritizing biodiversity only. Selecting 20% of additional land, would conserve 82.8% of the estimated total organic carbon stock in addition to achieving persistence targets for 80.4% of all species.

# 141S-2: Phylogenetic and genetic diversity

*Time:* Wednesday, 26/Feb/2020: 4:00pm - 6:00pm · *Location:* Wisshorn
*Session Chair:* Luc De Meester, KU Leuven, Belgium
*Session Chair:* Felix Forest, Royal Botanic Gardens, Kew, United Kingdom

Evolution is the fundamental biological process that is the underlying driver of biodiversity. Past evolution has led to the tree of life with millions of species, each with their own unique characteristics and adaptations to specific environmental conditions. This phylogenetic diversity fosters resilience of ecosystems to environmental change and provides insurance and options for the future.

Genetic diversity is key to the potential of populations and species to evolve and adapt to novel conditions. In the last decade, it has become increasingly clear that evolutionary dynamics can strongly impact the response trajectories of populations to global change. Yet, at the same time, global change impacts the distribution and amount of genetic diversity that fosters evolutionary potential. In this session, we will highlight and discuss the important links of evolution to sustainability. Both phylogenetic diversity and contemporaneous evolution (genetic diversity and eco-evolutionary dynamics) are key drivers of ecological responses to global change and of resilience of ecosystems in the face of anthropogenic disturbance. Concepts and tools rooted in evolutionary biology can be used to enhance sustainability of food production, reduce the incidence of antibiotic and pesticide resistance, reduce the spread of disease and inform health decisions. In this session, we will discuss how past and contemporary evolution, evolutionary applications in agriculture and health, and the evolutionary toolbox can contribute to the sustainable developmental goals.

**4:00pm - 4:15pm**

## Biodiversity and Evolution Sustain Ecosystems

**Bernhard Schmid[1], Debra Zuppinger-Dingley[2], Sofia Julia van Moorsel[3]**
[1]University of Zurich, Switzerland, Peking University, China; [2]University of Zurich, Switzerland; [3]University of Zurich, Switzerland, McGill University, Canada; bernhard.schmid@uzh.ch

For a long time, research in ecology and evolution was focused on the causes of biodiversity, exemplified by attempts to explain global patterns of species richness. As we are facing the modern extinction crisis, interest shifts to potential consequences of biodiversity loss. Experiments simulating biodiversity loss have consistently demonstrated a reduction in ecosystem performance and stability. However, the role of evolution in sustaining ecosystems in the face of biodiversity loss is largely unexplored.

In a series of interrelated experiments, we found that evolution in plant communities can increase ecosystem performance and stability, particularly after more severe biodiversity losses. These evolutionary processes involved division of labor due to character displacement and occurred very rapidly, presumably due to the presence of standing genetic variation in populations on which community selection could act.

Our results suggest that biodiversity effects on ecosystem functioning are not merely coincidental but may be shaped by the coadaptation of species evolving in a community context. Therefore, biodiversity “breeds” biodiversity and in the process generates more sustainable ecosystems. In contrast, the loss of species diversity or genetic diversity within species poses a real threat to ecosystem health. As a consequence, we argue that maintaining the potential of biodiversity and evolution to sustain ecosystems requires the protection and restoration of species within their community context.

**4:15pm - 4:30pm**

## Phylogenetic And Functional Diversity: Just Unorgainzed Twins Or A Divorced Couple?

**Marten Winter**
German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Germany; marten.winter@idiv.de

In the recent years evolutionary history measured as phylogenetic diversity became a popular biodiversity facet to be analyzed. More and more studies show relationships with few ecosystem functions and generally functional aspects of biodiversity. However the argumentation lines why we should look at, why we should conserve this facet of biodiversity are often not well understood and need more research attention. Here I present an overview based on past synthesis and other projects to show the relationship of evolutionary history of functional diversity and other aspects for which it is often claimed to be important. I'll also briefly touch the complex jungle of methods to compare phylogenetic and functional diversity and how to find a path through it.

**4:30pm - 4:45pm**

## Eco-evolutionary Partitioning Metrics: Quantifying Contributions of Ecology and Evolution to Community Trait Change

**Lynn Govaert**
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Ecological and evolutionary processes can occur on similar time scales resulting in eco-evolutionary dynamics. One of the main goals in eco-evolutionary dynamics is to quantify the relative contribution of evolution, ecology and their interaction to the eco-evolutionary change under study. This has led to the development of several methods aimed to quantify the contributions of ecology and evolution to observed trait change, here referred to as eco-evolutionary partitioning metrics. I will provide an overview on currently-used partitioning metrics with a focus on methods that can quantify evolutionary and non-evolutionary contributions to community trait change.

**4:45pm - 5:00pm Warning: The presentations finish prior to the end of the session!**

## Diversity In Plant Defense Genes Increases Food-web Persistence

**Matthew Barbour[1], Daniel Kliebenstein[2], Jordi Bascompte[1]**
[1]University of Zurich, Switzerland; [2]University of California, Davis; matthew.barbour@ieu.uzh.ch

Genes determine an organism’s phenotype, which influences its trophic interactions with other species. The strength and organization of trophic interactions define food-web structure, which plays an important role in determining the stability and persistence of ecological communities. Despite these obvious links between biological scales, we do not know how genetic change will restructure food webs, and thus community persistence in the face of environmental change. To gain insight into these processes, we used a multi-trophic community comprising the plant *Arabidopsis thaliana*, two species of aphids, and a parasitoid wasp. We used transgenic lines of *Arabidopsis* to manipulate the presence/absence of functional alleles at key genes that control

its metabolic defenses against insect herbivores. With these transgenic lines, we created experimental plant populations that varied in genetic diversity under two different temperature regimes (20 C or 23 C). We then quantified the dynamics of each insect species over time to quantify variation in food-web structure and community persistence among our experimental treatments.

We found that higher genetic diversity enhanced the persistence of the multi-trophic community. This enhanced persistence resulted from a decrease in the relative strength of interspecific interactions (aphid-aphid and aphid-parasitoid). Temperature, on the other hand, had conflicting effects on community persistence. For example, temperature enhanced the persistence of the faster-growing aphid species, but this resulted in a more rapid exclusion of the slower-growing aphid. Taken together, our results show that genetic diversity in plant defense metabolism can enhance the persistence of multi-trophic communities in the face of climate change. Given that the current rate of population extinction, and subsequent loss of genetic diversity, is orders of magnitude higher than the rate of species extinction, our results highlight the pressing need to understand how the loss of genetic diversity within species will affect the stability and functioning of ecosystems.

# Plenary 6: Plenary Session 6

*Time:* Thursday, 27/Feb/2020: 8:30am - 10:00am · *Location:* Davos (2/3)

## Rashid Sumaila, University of British Columbia

## Barend Erasmus, University of Pretoria

**The maximum number of 0 presentations has been exceeded! There are now 1 presentations in this session.**

**8:30am - 9:15am Warning: The presentations finish prior to the end of the session!**

### How Illicit Trade In Seafood Impacts Marine Biodiversity, People And Economies

**U. Rashid Sumaila**
University of British Columbia, Canada; r.sumaila@oceans.ubc.ca

Illegal, unreported and unregulated (IUU) fishing is widespread globally, and therefore one should expect illicit trade in marine resources to be rampant too. In this talk, I will report the findings of new research that combines several ecological-economic databases to estimate the scope and magnitude of illicit trade in marine resources and its impacts on people worldwide. This preliminary results from this work suggest that the likely economic effects of illicit trade is substantial, running into billions of losses annually in fishers' revenues, economic and household income and tax revenues to the legitimate formal economy. This results lead to the conclusion that bold policies and actions are needed at all levels of society to eliminate IUU and illicit trade globally in order to ensure the conservation and sustainable use of marine biodiversity.

# 183DE: Panel discussion on new and disruptive approaches for biodiversity

*Time:* Thursday, 27/Feb/2020: 10:30am - 12:30pm · *Location:* Forum
*Session Chair:* Kathrin Ludwig, Adelphi, Germany

Scientific knowledge on drivers and impacts of biodiversity loss is well established. With time running short to mitigate or reverse trends in biodiversity loss and land use change, parties to the Convention on Biological Diversity (CBD) are to agree upon a new post-2020 Global Biodiversity Framework during their fifteenth Conference of the Parties (COP-15) in 2020 in Kunming, China.

To realize the potential and impetus of COP15 as well as a growing public attention to the issue, we need a better understanding of what the CBD vision of "living in harmony with nature" and transformative change – as called for by IPBES- actually mean for people and economic sectors. The past two COPs, as well as the Aichi targets adopted in 2010, have stressed the role of mainstreaming biodiversity objectives in economic sectors.

Yet, so far mainstreaming efforts have not led to the transformative change need within economic sectors. On the one hand, this is partially rooted in our limited understanding of what such a transformative approach would imply for economic sectors. On the other hand and related to that, the business case for many companies and financial service providers is not yet sufficiently clear. For a successful new global framework, a dialogue within society, with the private sector, but also within the biodiversity community itself is needed to further imagine a future in which biodiversity can be protected and used sustainably in economic sectors.

New perspectives on how we could live "in harmony with nature" can help to spur our imagination and break down entrenched patterns of thinking. This can help to obtain a better understanding of what transformative change would mean and where we may need new complimentary approaches.

Several of such potentially disruptive approaches already exist but have not been implemented at scale. These approaches especially relate to the integration of biodiversity objectives in economic sectors, e.g. through standards and certification systems for sustainable supply chains, the economic valuation of ecosystem services and the true cost/price approach. In addition, food and agriculture is an important issue, which is able to mobilise more and more people for biodiversity - especially in the Global North - and to connect urban and rural areas (urban farming, regional and "forgotten varieties", food coops etc). Such approaches have already been tried and tested and enjoy wider acceptance, but could not be scaled up sufficiently in the past.

Further, there are less established approaches which are only emerging and which have hardly been piloted. These include proposals such as a basic income for so-called biodiversity hotspots or degrowth as a different paradigm of living from and with the land. Another idea is to protect half of the earth ("Half Earth"), which is represented by scientist Edward Wilson and the NGO Avaaz, among others. While Half Earth's approach reflects traditional conservation thinking, this idea could possibly be combined with that of a basic income for certain areas.

This panel discussion aims to explore the notion of transformative change by discussing new and more established approaches. Highlighting the role of experimentation and learning from the climate debate, we aim to further illustrate what transformative change could entail and contribute to a broader discussion on rethinking biodiversity governance.

**Our confirmed panellists**

**Biodiversity revisited - taking a fresh look at biodiversity**

— Dr Rebecca Shaw, Chief Scientist and Senior Vice President, WWF

**Imagining transformative change for biodiversity – what can we learn from the climate debate?**

— Prof Andrew Light, Distinguished Senior Fellow at World Resources Institute and Professor at George Mason University, United States

**No Net Loss of biodiversity and the example of biodiversity offsets - What does transformative change mean for the private sector?**

— Dr Marianne Darbi, Coordinator of the German Network-Forum for Biodiversity Research (NeFo) and Researcher at Helmholtz-Zentrum für Umweltforschung (UFZ)

**Degrowth and the conservation revolution**

— Prof Bram Büscher, Wageningen University, Netherlands

**A universal income for people in biodiversity hotpots**

— Dr Felipe Campos, NOVA Information Management School, Portugal

**Connecting cities and rural areas for biodiversity-friendly local food systems**

— Serena Milano, General Secretary of the Slow Food Foundation for Biodiversity.

**Moderation:** Kathrin Ludwig, Project Manager for Biodiversity and Climate Policy, adelphi consult

## Imagining Transformative Change For Biodiversity - What Can We Learn From The Climate Debate

**Andrew Light**
George Mason University and World Resources Institute, United States of America; alight1@gmu.edu

Andrew Light is University Professor of Public Policy, Philosophy, and Atmospheric Sciences at George Mason University, and Distinguished Senior Fellow in the Climate Program at the World Resources Institute, in Washington, D.C. From 2013-2016 he served as Senior Adviser and India Counselor to the U.S. Special Envoy on Climate Change, working on the senior strategy team for the UN climate negotiations.

In recognition of this service, Andrew shared in a Superior Honor Award from the U.S. Department of State for his work creating and negotiating the Paris Agreement. Andrew is the author of over 100 articles and book chapters, primarily on climate change, restoration ecology, and urban sustainability, and has authored, co-authored, and edited 19 books, including Environmental Values (2008), Moral and Political Reasoning in Environmental Practice (2003), and Environmental Pragmatism (1996). He is currently serving on a U.S. National Academies of Science Panel on research and governance of solar geoengineering.

## What Does Transformative Change Mean For The Private Sector?

**Marianne Darbi**
Helmholtz Centre for Environmental Research UFZ, Germany; marianne.darbi@ufz.de

Marianne Darbi is a landscape architect, environmental planner and researcher with many years of experience in landscape and spatial planning. Since 2017 she is working as a postdoctoral researcher in the Department of Conservation Research at the UFZ. Previously, she worked at the Leibniz Institute for Ecological and Regional Development (Dresden). She received her PhD at the Technical University of Dresden on the topic of Voluntary Biodiversity Offsets which was awarded the Study Prize of the Society for Environmental Impact Assessment in 2016.

Her research focuses on biodiversity protection and management as well as the consequences of environmental interventions in a national and international context, sustainable land use, green economy and market-based instruments. In addition, she is involved in science policy transfer and has worked in an advisory capacity for the European Commission, the Business and Biodiversity Offsets Program, the Federal Environment Ministry, the Federal Agency for Nature Conservation and KfW, among others.

## Degrowth And The Conservation Revolution

**Bram Büscher**
WUR, Netherlands, The; bram.buscher@wur.nl

Prof. Bram Büscher is the Chair of the Sociology of Development and Change group at Wageningen University, Netherlands and he holds visiting positions at the University of Johannesburg and Stellenbosch University, in South Africa. Bram received his PhD (Cum Laude) from the VU University Amsterdam in 2009 and held a post-doctoral fellowship at the University of Johannesburg from 2008 to 2012. His research interests revolve around the political economy of conservation and development, the politics of energy and extraction, ecotourism, new media and social theory. He has received two of the most prestigious excellence research grants from NWO (Dutch Research Foundation).

Bram has published over 80 articles in peer-reviewed journals and edited volumes and is the author of Transforming the Frontier: Peace Parks and the Politics of Neoliberal Conservation in Southern Africa (Duke University Press, 2013) and co-author, together with Robert Fletcher of The Conservation Revolution. Radical ideas for Saving Nature Beyond the Anthropocene (Verso, 2020). Since 2012, Bram is one of the senior editors of the open-access journal *Conservation & Society*.

## A Universal Income For People In Biodiversity Hotpots

**Felipe Campos**
New University of Lisbon, Portugal; fcampos@novaims.unl.pt

Felipe Campos is Postdoctoral Researcher at NOVA Information Management School (NOVA IMS). He received his PhD in Biodiversity at the University of Barcelona, awarded with International Mention and Cum Laude. The most important parts of his thesis focused on the economic perspective of biodiversity–ecosystem-services for improving human well-being in threatened hotspots. In 2017, he was awarded by the Spanish Association of Terrestrial Ecology (AEET) National Prize for ecology research projects led by young researchers. A key contribution he has made to the field is a research article in Science Advances, validating the usefulness of an ecological and evolutionary approach for improved cost-effective outcomes. He also contributes as reviewer of many important scientific journals, such as Biodiversity and Conservation, Journal of Environmental Management, Tropical Conservation Science, Annals of the Brazilian Academy of Sciences, Ecology and Evolution, among others. Currently, he is working on the FCT project ASEBIO – Assessment of Ecosystem Services and Biodiversity in Portugal.

## Session Chair And Moderation Of The Panel Discussion

**Kathrin Ludwig**
Adelphi, Germany; ludwig@adelphi.de

Kathrin Ludwig is a Project Manager at adelphi in the areas of biodiversity and climate change. She leads projects on global biodiversity governance, working with ministries and other actors in international environmental cooperation. Prior to joining adelphi, Kathrin worked as an advisor for Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) in Mexico where she supported the Mexican ministry of environment in planning the implementation of national climate policy and the development of innovative digital tools for climate protection. In the Netherlands, she advised Dutch ministries on new approaches to international biodiversity policy for PBL Netherlands Environmental Assessment Agency. Kathrin Ludwig holds two MSc degrees from VU University Amsterdam in Global Environmental Governance and Social Research.

# 004GS-1: People and Nature - Nature and People

*Time:* Thursday, 27/Feb/2020: 10:30am - 12:30pm · *Location:* Dischma

**10:30am - 10:45am**

## Key Biodiversity Areas Safeguard Potential Ecosystem Services For Nature And People

**Gregory M. Verutes[1,2,3], Chad B. Wilsey[3], Villasante Sebastian[1]**

[1]Universidade de Santiago de Compostela; [2]Campus Do*Mar - International Campus of Excellence; [3]National Audubon Society; gregory.verutes@usc.es

Natural capital stocks flowing as ecosystem services, such as carbon sequestration, freshwater availability, and coastal protection, provide vital benefits to people and are featured targets for global conventions on biodiversity, sustainable development, and climate change. We quantified the proportions of national totals found within Key Biodiversity Areas (KBAs) for carbon (5-39%), freshwater balance (15-33%), and kilometers of shoreline providing high coastal protection (6-64%) in five countries across Latin America and the Caribbean (Fig. 1). None or limited protection (e.g., 67-95% of carbon stocks) of these KBAs present an opportunity to further secure potential ecosystem services in pursuit of global targets. In addition, we compared KBAs to designated protected areas and ideal parks for securing carbon, freshwater and coastal protective services (top 10% per country) in terms of resource allocation efficiency. The natural capital datasets used in this study are globally available and can inform direct actions such as designating new parks or stepping up enforcement in specific KBAs that do well (i.e., higher proportion of total resources) along the resource efficiency frontier.

**10:45am - 11:00am**

## The Implementation Status Of Biodiversity In High School Curricula In German-Speaking Countries

**Christine Börtitz**

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Education is, and has always been, an important tool for learning and for the advancement of humankind because it influences future generations and their dealing with our planet. With the integration of Article 13, education about biodiversity became an important goal of the CBD (United Nations 1992). Educational institutions explicitly receive the task for biodiversity education. However, the actual knowledge of the public about biodiversity is limited (c.f. European Commission 2015). One possible explanation for this could be an inadequate implementation status of biodiversity in curricula.

To reach the goal of Article 13, biodiversity needs to be integrated into pedagogical institutions and curricula worldwide. However, the actual implementation status of biodiversity in school curricula is difficult to measure. Consequently, there is little knowledge about it. This is problematic, since many pedagogues do not consider teaching a topic until it is mentioned in curricula (Dalelo 2012).

The implementation status of biodiversity as a topic in school curricula will be presented using content analysis. The analysis focuses on biology and science high school curricula of German-speaking countries. The occurrence of the term biodiversity itself and biodiversity-relevant terminology (e.g., species, ecosystems, genetic diversity) will be considered as well as the context of their occurrence. Possible explanations for the low occurrence of the term biodiversity will be discussed.

The presentation emphasizes the need for a broader implementation of biodiversity in school curricula.

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**11:00am - 11:15am**

## Experiential Learning in Biodiversity is Vital for Real Conservation

**Rajesh J Rajaselvam**

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**Experiential Learning in Biodiversity is Vital for Real Conservation**

***Rajesh Rajaselvam***

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*Halifax, Canada*

Changes in ecosystems in tropical developing countries can make substantial impacts on the aspects of environment, health and economy of the developed countries in the West. Experiential learning in biodiversity broadens our focus on global issues by giving real world experiences to formulate ideal conservation strategies. Rights of the indigenous people to practice sustainable harvest, setting up protected areas, promoting environmentally friendly ecotourism, justifying various conservation measures for different places, encouraging volunteering in species specific conservation programs, understanding the influence of local politics which impact conservation, and paying for ecosystem services; all can get a realistic boost when experiential learning get involved. An experimental field course on biodiversity conducted in Sri Lanka for foreign students encouraged collaboration and paved way for exchange of ideas and perspectives. The exploration to Sri Lankan national parks in 2017 and 2019 via educational field trips made students to understand the global concerns and promote awareness to make biodiversity conservation in tropics a reality. The experiential learning approach gets an overwhelming acceptance due to it's success in promoting real conservation.

## The Dilemma of Participatory Conservation: Grassroots vs. Global Scales

**Elliot Connor[1,2,3,4,5]**

[1]Human Nature Projects; [2]CoalitionWILD; [3]Lawrence Anthony Earth Organization; [4]Jane Goodall Institute Australia; [5]Youth for our Planet; elliotconnor@humannatureprojects.org

In the globalized world in which we live, much change is afoot. Since the moon landing, human populations have doubled whilst the abundance of other vertebrates has halved. Surely there can be no clearer sign of our intimate interconnectedness with natural

systems, which we so desperately try to rid ourselves of. Yet in the face of such widespread negligence, a critical consideration arises as to where success in conservation might be garnered. Should one standardize, embracing the principles that allowed McDonalds and others to gain their global reach? Or should one rather diversify to best accommodate the circumstances of countries and communities? Where then might resources and messaging best be utilized, where might priorities be set?

Through his work with Human Nature Projects and across youth environmental movements, Elliot seeks to promote the 4 C's of conservation and a 'glocal' approach to these issues. Hard-set as humans are in their beliefs, change in our ways must be grown and not forced, hence arises the need for Connection. People must be engaged and cultivated for such an organic model of environmental stewardship to ever succeed, thus Curiosity is key. Creativity brings the ever-present knack we have for innovation to the plate, and with it huge opportunity for achieving that which was thoughts impossible. Then of course we must bring all of this together with a single clearly defined vision, for which Collaboration is essential.

Reminiscing and prophesizing on the field through a minor's eyes, Elliot covers everything from leopards encounters to school with stick insects, Durrell, Goodall and everything in-between. A fresh perspective truly that has the power to change the world.

**11:15am - 11:30am**

## Heterogeneous Substitutability and Biodiversity Valuation

**Jasper N. Meya[1], Moritz A. Drupp[2]**

[1]German Centre for Integrative Biodiversity Research, Germany; [2]Department of Economics, University of Hamburg, Germany; jasper.meya@idiv.de

Substitutability is a key driver of the economic value of biodiversity conservation. If a person can easily substitute a good or service associated with biodiversity (hereafter: environmental good), then the economic value of this environmental good is typically low (e.g. Meya et al. 2019). Conversely, when environmental goods are difficult to substitute, their value tends to be high. However, people's individual preferences regarding the substitutability of environmental goods by human-made goods may differ substantially. Understanding the implications of heterogenous substitutability preferences is therefore key for societal decision making on biodiversity conservation.

In this paper, we study how heterogenous substitutability preferences across a population of households affect the economic value society attaches to biodiversity. Thereby, we extend the equal-preference models by Ebert (2003) and Baumgärtner et al. (2017). In particular, we introduce the elasticity of substitution as a random, normally distributed variable that describes the continuous distribution of willingness to substitute in the population of households. In this respect, our approach is similar to Gollier (2019), who studies the implications of uncertain substitutability. However, while uncertainty may resolve over time as knowledge improves, heterogeneities of substitutability preferences are likely to remain considerable across a heterogeneous society.

Our preliminary results show that mean willingness-to-pay decreases in the degree of substitutability, but increases in the heterogeneity of substitutability preferences. Thus, for heterogenous substitutability preferences a specific environmental good is the more valuable from a societal perspective the more people differ in their substitutability preferences (holding mean substitutability across the population constant). Compared to the standard case of homogenous substitutability, considering a heterogeneous distribution increases the societal value of biodiversity. We illustrate these results with an updated empirical dataset on substitutability preferences for a range of different environmental goods.

**11:30am - 11:45am**

## The Role of Botanical Gardens as Urban Biodiversity Sanctuaries

**Katja Rembold**

University of Bern, Switzerland; katja.rembold@boga.unibe.ch

Botanical gardens are more than parks with a nice plant display. They are centres of research, education, culture and relaxation. The Botanical Garden of the University of Bern (BOGA) is a green oasis in the centre of the city. It not only contains a wealth of carefully arranged and labelled plant species, but also provides habitat, food source and nesting sites for a variety of wildlife. The BOGA covers an area of 2.5 ha and harbours 5,500 plant species from all over the world. Those plants are nursed, monitored and recorded in databases. Previous observations and studies of individual taxa such as wild bees and fungi demonstrated that, in addition to the cultivated plants, there are plenty of wild living species, which colonized the BOGA by themselves. In order to get a better overview of the BOGA-wildlife, a species inventory was carried out in spring 2019 in collaboration with 30 experts from different institutions. In total, 14 taxa of animals, plants, fungi and lichens were investigated (molluscs, arachnids, beetles, orthopterans, butterflies, amphibians, reptiles, bats, terrestrial mammals, fungi, lichens, mosses, vascular plants). We identified 1.187 wild living species of which two thirds were composed to almost equal parts of plants (381 species) and invertebrates (321 species), followed by fungi. As several organisms could not yet be studied or require a different season, it is to be expected that more species remain to be discovered. One highlight of this inventory was e.g. the first record of the spider *Triaeris stenaspis* in Switzerland. Some taxa are surprisingly well represented: 34% of the Swiss bird species were recorded at the BOGA, even if the area only accounts to 0.00005% of the country's area. This inventory demonstrates the enormous conservational value of the BOGA as a diverse habitat supporting urban biodiversity.

**11:45am - 12:00pm**

## Reconciling Opposing Views on Biodiversity Conservation: Rewilding and Human Intervention

**Koenraad Van Meerbeek[1], Bart Muys[1], Simon D. Schowanek[2,3], Jens-Christian Svenning[2,3]**

[1]Department of Earth and Environmental Sciences, KU Leuven, Belgium; [2]Department of Bioscience, Aarhus University, Denmark; [3]Center for Biodiversity Dynamics in a Changing World (BIOCHANGE), Aarhus University, Denmark.; koenraad.vanmeerbeek@kuleuven.be

In times of alarming rates of global biodiversity loss, the discussion about how to ensure a biodiverse future is more relevant than ever. Two paradigms prevail today in nature conservation with an opposing view about whether we have to intervene to safeguard our natural heritage or not. In the West-European nature conservation tradition, human intervention has been dominating, while elsewhere rewilding aiming at restoring self-regulating ecosystems has often been preferred. These views are not solely based on ecological differences or different land-use histories, but are also strongly culturally defined and depend on prevalent values and beliefs about nature. As the relationship between people and nature shapes environmental policies, this may lead to different ecosystem management strategies that are not always beneficial for biodiversity conservation.

Scientific work integrating different conservation strategies could provide proper guidance in the development of global change-robust management strategies. Here, we propose a framework based on the relationship between human footprint, including land-use legacies, and ecosystem dynamics to guide conservation practices in order to ensure a biodiverse future. We combine concepts from natural disturbance ecology with the alternative stable state theory to explain how human pressure on ecosystem

dynamics gives rise to different ecosystem states. The focus here is on how the degradation cascade from self-regulating to anthropogenic ecosystems and the possible non-reversible nature of this process.

The restoration of natural processes could provide a solution to the unpredictability of future ecosystem responses to the rapid changing environment. However, due to land-use legacies and the increasing, pervasive human footprint on world´s ecosystems, the restoration of self-regulating ecosystems is neither feasible, nor wanted in every situation. Moreover, not all rewilding actions completely remove the need for human actions. We argue that these paradigms are not conflicting but complementary and advocate for rewilding where possible, human intervention where needed.

# 210S: Indigenous Knowledge in science-policy assessments

*Time:* Thursday, 27/Feb/2020: 10:30am - 12:30pm · *Location:* Flüela
*Session Chair:* Rodrigo Cámara Leret, University of Zurich, Switzerland
*Session Chair:* Jordi Bascompte, University of Zurich, Switzerland

Science-policy assessments that aim to understand how humans interact with ecosystems have been dominated by “western” viewpoints. However, this is at odds with our planet’s cultural diversity: indigenous societies occupy one quarter of terrestrial lands and over 7,097 indigenous languages are spoken on Earth. Indigenous communities not only inhabit a large portion of the world’s hyperdiverse tropical regions —they have also assembled sophisticated knowledge about plants and their services which has significantly enhanced local livelihoods and global economies. Unlike the burning of Amazonia or the Library of Alexandria, however, the knowledge acquired by indigenous societies may vanish in silence. Moreover, the ability of indigenous groups to share knowledge may rapidly decline as indigenous languages go extinct. This, in turn, may substantially diminish the ability of future generations to identify and benefit from natural resources.

The loss of indigenous knowledge about nature’s services cannot be understood by studying local communities in isolation, as has been typically the case. Rather, multi-scale and networked approaches are needed to examine how biological and cultural factors determine the turnover and resilience of indigenous knowledge. This session brings together leading experts on indigenous knowledge, ecology, complex systems, and anthropology to examine the role of indigenous knowledge for the future of biodiversity, ways to quantify indigenous knowledge networks at macroecological scales, and theoretical approaches to study the resilience of indigenous knowledge.

**10:30am - 10:50am**

## The Role of Indigenous People in Ecological Science and Biodiversity Conservation

**Vojtech Novotny[1,2], Francesca Dem[3], George Weiblen[4], Scott Miller[5], Yves Basset[1,6], Gibson Sosanika[3], Alfred Kik[2,3], Pagi Toko[1,2,3]**

[1]Biology Centre, Czech Academy of Sciences, Czech Republic; [2]University of South Bohemia, Czech Republic; [3]New Guinea Binatang Research Center, Papua New Guinea; [4]University of Minnesota, USA; [5]Smithsonian Institution, USA; [6]Smithsonian Tropical Research Institute, Panama; novotny@entu.cas.cz

Rainforest-dwelling indigenous people are known for extensive traditional knowledge and understanding of ecology that only partially overlaps with the methods and theories of contemporary ecological science. This tension between two knowledge systems, traditional natural history vs. formal ecology, can be productive and generate novel ways of collaboration between indigenous people and scientists, enhancing our understanding of natural world and contributing to biodiversity conservation. Such collaborations can be exceptionally productive, but they are also difficult, which is why there are so few successful examples of the integration of indigenous knowledge to biodiversity research and conservation policies. We are reviewing status quo and propose approaches to increase the input of indigenous peoples to science and conservation decisions on their rainforests. We are using especially examples from Papua New Guinea, country where customary land ownership has been legally recognized, providing indigenous people with freedom of choice not experienced elsewhere - often with rather surprising results.

**10:50am - 11:10am**

## Integrating Humans in Nature: A proposal for a New Deal

**Pablo A. Marquet**
Pontificia Universidad Catolica de Chile, Chile; pmarquet@bio.puc.cl

Continuous innovation is a hallmark of the human phenomenon. In this contribution we propose, using correlational, experimental data, and models, that Innovation dynamics in human systems is rooted in the contributions that nature and biodiversity makes towards our species. We propose a simple model that use the link between innovation and population size and how this link generates a positive feedback to increase the flow of ecosystem services and thus population size. Innovation is not only restricted to the material (technological) realm but also to the ideological, political, philosophical and economic, one. Thus managing the current biodiversity crisis should consider both changes in the technological and the ideological realm. And foremost embrace the notion that humans are part of biodiversity and nature.

**11:10am - 11:30am**

## High Mobility is Associated with Increased Knowledge in Hunter-gatherer Populations

**Andrea Bamberg Migliano**
University of Zurich, Switzerland; andrea.migliano@uzh.ch

Extant forest hunter-gatherers live in small highly connected bands, with mobility between bands happening as frequently as once every 15 days. Most countries where hunter-gatherers are still exist have policies to promote settlement of these groups, to facilitate provisioning of health and education. However these policies normally bring more negative than positive effects for hunter-gatherer-groups. Besides negative health consequences, we have found that settlement leads to decreased sex equality and loss of traditional knowledge, as traditional knowledge depends on information exchange over large social network systems, which includes different interconnected mobile camps. We will discuss medicinal plant knowledge and hunter-gatherers social structure in both Congo and the Philippines, and the implications of settlement and changes in social structure for traditional knowledge transmission.

**11:30am - 11:50am Warning: The presentations finish prior to the end of the session!**

## Title: Shifting paradigms to shifting cultivation

**Marta Gruca**
Food and Agriculture Organization of the Unite Nations, Italy; marta.gruca@fao.org

Shifting cultivation provides an important foundation for the livelihoods and food security of indigenous peoples globally. While accurate numbers are lacking, it is estimated that it is practiced at forest landscapes scales over roughly 280 million hectares worldwide, including both cultivated fields and fallows. Forest-based food systems that integrate shifting cultivation have long provided nutritious foods, enhancing the dietary diversity and resilience of forest-dependent peoples. But, this practice is one of the most misunderstood and controversial forms of land use. A growing body of research indicates that, particularly where traditional knowledge is well developed and applied, shifting cultivation can be managed sustainably without undermining soil fertility and

productivity, while preserving significant biodiversity and forest ecosystem services. Nevertheless, it continues to carry negative connotations with policies focussing on eradicating this practice indiscriminately. The consequences of restrictive policies on shifting cultivation include missed opportunities to build prosperity, loss of food security, deteriorating quality of nutrition, and loss of domestic and natural plant diversity and pollinators. Where the practice is discontinued, it is often replaced by intensified land uses with negative environmental impacts. As a consequence, traditional knowledge and crop biodiversity are disappearing along with opportunities to learn from indigenous strategies to address current and future challenges.

*How to reframe the negative narrative around 'slash-and-burn' and convey the message that SC systems can be invaluable source of useful plant species adapted to the local environmental and climatic conditions and enhance biodiversity of fallow forests?*

# 178S-2: Using Earth Observations to understand changes in biodiversity and ecosystem function

*Time:* Thursday, 27/Feb/2020: 10:30am - 12:30pm · *Location:* Sertig
*Session Chair:* Jeannine Cavender-Bares, University of Minnesota, United States of America

Talks followed by 40 minutes discussion

Earth observation is an essential complementary component to in situ observations and experiments designed to observe and understand changes in biodiversity, forcing mechanisms, and changes in ecosystem function across a range of spatial and temporal scales. NASA is a recognized a leader in satellite technologies for earth observation and the scientific understanding that underlies global ecological processes and forces of change. In recent years, the NASA Biodiversity and Ecological Forecasting program has pushed the research community to explore new methods to monitor biodiversity.

We introduce NASA supported state-of-the-art work, with keynote presentations illustrating the response of biodiversity and ecosystem function to environmental change, and exploring the impacts of (anthropogenic) drivers of change and their interactions and feedbacks with ecosystems. This session is linked to session 155S The future of remote sensing of biodiversity, where we will identify future research directions in assessing biodiversity (change) with remote sensing technologies.

**10:30am - 10:50am**

## Indirect Remote Sensing of Biodiversity: Using Environmental Proxies to Monitor and Quantify Shifts in Species and Genetic Diversity

**Ana Carolina Carnaval[1,2], Andrea Paz-Velez[1,2], Connor French[1,2], Laura Bertola[1,2], Michael Hickerson[1,2], Kyle McDonald[1,2], Thiago Silva[3]**

[1]City College of CUNY, United States of America; [2]The Biology Program at The Graduate Center of CUNY; [3]The University of Stirling; acarnaval@ccny.cuny.edu

The last decade has witnessed growing capabilities of remote sensing systems for monitoring biodiversity from Earth orbit, at broad spatial scales. However, many of the world's diverse groups of organisms cannot be directly observed through satellites, including the majority of animals and non-canopy plants. For those species, indirect biodiversity sensing – that is, remote sensing of environmental correlates of diversity – may be a valuable yet still underexplored tool in the context of monitoring. We present three ways by which our research group is coupling Earth Observations with ground data from invertebrates, vertebrates, and plants, with the goal of understanding how different biodiversity metrics change in response to environmental shifts. The first uses species occurrence and phylogenetic information to model the distribution of taxonomic and phylogenetic diversity in geographic space as a function of present-day and past climatic conditions, and then applies the model to environmental measurements taken by satellites at near-real time – allowing the quantification of expected diversity loss or gain per given area. The second explores the links between climatic conditions – now and under extreme conditions of the past (e.g. the last glacial maximum) – and the distribution of potentially adaptive genetic variation. Both approaches are applied to the endemic fauna and flora of the endangered Atlantic Rainforest. The third approach provides a global model of community-wide genetic diversity of invertebrates. For that, it uses supervised machine learning to couple environmental descriptors from interpolated weather-station data and remote sensing products with available genetic barcode data. By exploring correlations between Earth Observations and species-specific data obtained in the field, in scientific collections, and in public repositories, we plan to improve our understanding of biological responses to future environmental shifts, and to provide realistic quantifications of associated biological change over time.

**10:50am - 11:10am**

## Using Earth Observations To Map Biodiversity In Three Dimensions.

**Temilola Fatoyinbo**

NASA GSFC, United States of America; lola.fatoyinbo@nasa.gov

The ability to map vegetation species composition and ecosystem structure is crucial to inform conservation and biodiversity management. However, a majority of efforts using satellite or airborne datasets rely primarily on two-dimensional data. In this talk, we will provide an overview of several efforts to incorporate 3 dimensional datasets of vegetation structure from Lidar and Radar sensors to inform studies of vegetation biodiversity. Here ecosystem structure, is defined as a combination of vegetation height, cover, and vertical distribution of canopy material, which is directly dependent on in the interactions of plant diversity, disturbance, faunal activity and environmental conditions.

Specifically, examples of the use of vegetation structure data in specific ecosystems, such as mangroves and tropical forests will be shown. In addition, we will highlight how ecosystem structure and biomass estimates can be incorporated into efforts to advance natural capital accounting. Finally, new insight into how ecosystem structure data from the GEDI mission maybe used for biodiversity studies will be provided.

**11:10am - 11:30am**

## Assessing Key Environmental Drivers of Ecosystem Functional Diversity in the Circumpolar Arctic

**Amanda Armstrong[1], Howard Epstein[1], Domingo Alcaraz-Segura[2], Antonio Castro[3], Qin Yu[1], Martha Raynolds[4]**

[1]University of Virginia, United States of America; [2]Universidad de Granada; [3]Idaho State University; [4]University of Alaska Fairbanks; akh6u@virginia.edu

The Arctic is a region with a high degree of spatial variability in ecosystem functioning, but is also one that is changing dramatically over time due to dynamics in climate and land use. To assess the spatial and temporal heterogeneity of ecosystem functioning, we identified Ecosystem Functional Types (EFTs): patches of the land surface that process energy and matter in similar ways and potentially show coordinated responses to environmental factors. We classified EFTs for the circumpolar Arctic Tundra using three key functional attributes derived from the seasonal dynamics of the MODIS Normalized Difference Vegetation Index (NDVI) for the time period 2001- 2017. To analyze the relationships between vegetation composition and EFTs for the Arctic Tundra biome, we conducted a multivariate analysis (PCA) of several independent environmental variables (climate, geology, land use) and analyzed how the different EFTs are distributed throughout the multivariate space of the environmental variables. Using the new raster version of the Circumpolar Arctic Vegetation Map (CAVM), we then assessed the correspondence between vegetation structure and ecosystem functioning for each of the vegetation subzones. Here, we present our development of the circumpolar Artic EFTs, assess ecological functional diversity metrics, and shed light on the drivers of distribution and change based on our multivariate analysis. This functionally-based framework will aid in the identification of "functional hotspots," as potential targets for

conservation priority.

**11:30am - 11:50am Warning: The presentations finish prior to the end of the session!**

## Integrating Earth Observations And Models to Advance the Understanding of Land Use As A Driver of Climate Change And Biodiversity Loss

**George Caleb Hurtt**

University of Maryland, United States of America; gchurtt@umd.edu

Land-use change is an important driver of climate change and biodiversity loss. Here we present results from the use of Earth observations in global models of land-use change to derive consistent estimates of both climate change and biodiversity loss past-future. The Land-Use Harmonization 2 (LUH2) provides critical forcing to both the world's climate models and biodiversity assessments. The consistent treatment of land-use across these major assessments provides new opportunties for simultaneously addressing the challenges of both climate change and biodiversity loss.

# 146S-1: Nature-based solutions for for adapting and mitigating climate change

*Time:* Thursday, 27/Feb/2020: 10:30am - 12:30pm · *Location:* Schwarzhorn
*Session Chair:* Nadia Castro, University of Zurich, Switzerland
*Session Chair:* Veruska Muccione, University of Zurich, Switzerland
*Session Chair:* Cornelia Krug, Universität Zürich, Switzerland
*Session Chair:* Maria Santos, University of Zurich, Switzerland
*Session Chair:* Christian Huggel, University of Zurich, Switzerland

Climate change and the loss of biodiversity are issues that affect each other. Nature is declining globally, and climate change is amongst the five direct drivers of loss in biodiversity. Biodiversity loss cripples our ability to adapt to climate change and affects many other earth system processes and ecosystem services. More diverse ecosystems can store more carbon than monocultures, are more resilient and can cope better with droughts, floods and pests. It is essential that the climate crisis and biodiversity loss are addressed together. However, climate change has received far more attention than the biodiversity crisis. Moreover, certain mitigation and adaptation responses to climate change pose risks to biodiversity and ecosystem services. For example, afforestation efforts for carbon sequestration may promote the establishment of monoculture plantations at the expense of diverse grasslands.

In this context, nature-based solutions (NbS) are a promising approach to simultaneously address climate change and biodiversity loss. NbS are actions to sustainably manage and use nature to tackle societal challenges, including climate change, while providing human well-being and biodiversity benefits. However, evidence on the effectiveness of NbS is still lacking and some questions remain open. What are the limits and trade-offs between biodiversity and climate change mitigation and adaptation actions? Do NbS work under different climate scenarios and different biodiversity assemblies? How do we involve stakeholders to promote the NbS social acceptance? Are NbS economically feasible?

This session will bring together biodiversity and climate change academics, practitioners, policy-makers and business leaders to discuss the current state of NbS and their potential to simultaneously address climate change and biodiversity loss. Our aim is to promote collaboration and exchange between the climate change and biodiversity research community to identify knowledge gaps and to set a research agenda on NbS as one of the options to mitigate and adapt simultaneously for climate changes and biodiversity losses.

**10:30am - 11:00am**

## Understanding the Value of and Limits to Nature-based Solutions in a Warming World

**Nathalie Seddon**
University of Oxford, United Kingdom; seddon.nathalie@gmail.com

There is growing awareness that “Nature-based Solutions” (NbS) can help to protect us from climate change impacts whilst slowing further warming, supporting biodiversity and securing ecosystem services. Here I will discuss the potential of NbS to provide the intended benefits, highlighting issues around reliability and cost-effectiveness compared to engineered alternatives, and their resilience to climate change. I will highlight the rise of NbS in climate policy—focussing on their potential for climate change adaptation as well as mitigation—and discuss barriers to their evidence-based implementation. As climate policy turns increasingly towards greenhouse gas removal approaches such as afforestation, there is an urgent need for natural and social scientists to engage with policymakers. They must ensure that NbS can achieve their potential to tackle both the climate and biodiversity crisis while also contributing to sustainable development.

**11:00am - 11:20am**

## Nonlinear Dynamics and Tipping Points for Biodiversity in a Changing Climate

**Wolfgang Cramer**
CNRS IMBE, France; wolfgang.cramer@imbe.fr

(Can I submit the abstract later?)

**11:20am - 11:40am Warning: The presentations finish prior to the end of the session!**

## Networks by Design: Connected Ecological Networks for Biodiversity and Ecosystem Services

**Andrew Gonzalez**[1,2]
[1]McGill University, Canada; [2]Quebec Centre for Biodiversity Science; andrew.gonzalez@mcgill.ca

Climate and land-use change are altering the diversity and functioning of ecosystems at local, regional and continental scales. In many parts of the world efforts are underway to manage urban and rural landscapes to protect biodiversity but also maintain the benefits supplied by nature to people. Managing and restoring the connectivity of ecosystems is a powerful strategy for achieving biodiversity targets and managing the supply of ecosystem services at large scales. In cities, natural infrastructure (NI) networks have similar benefits often mitigating the impacts of climate change on people and the economy.

The current research challenge lies in identifying, designing and monitoring networks of ecosystems at multiple spatial scales while ensuring they are robust to climate and land-use change. In this talk, I present the approach we have taken to quantifying connectivity and prioritizing networks of habitat and NI to maintain diversity and ecosystem services in urban and rural settings under different future scenarios. I will argue that connectivity can mediate the safe-operating space of a region’s social-ecological system.

We applied our methods to Montreal and the Saint Lawrence lowlands ecoregion of Quebec. Setting conservation priorities based on habitat quality and connectivity maintained a large proportion of the region’s connectivity, despite anticipated habitat loss due to land-use change. Accounting for connectivity strongly modifies conservation priorities for multiple social and ecological criteria. These findings are being applied in and around Montreal and expanded to the entire ecoregion. These network methods are well suited to the design of ecological networks and NI for the conservation of biodiversity and ecosystem services in regions that include large cities, where connectivity can be critically low and the threats from climate change are great. Our approach is quite general and can be applied to many contexts and scales. We are now working to develop plans to manage connectivity for the NE region of North America. This work aligns with the vision of the IUCN WCPA Connectivity Conservation Specialist Group that argues for the need to manage landscapes to reduce fragmentation and foster the connectivity that is essential to the functioning and resilience of ecosystems.

# 165S: Drivers of success and failures in conservation management

*Time:* Thursday, 27/Feb/2020: 10:30am - 12:30pm · *Location:* Seehorn
*Session Chair:* Jutta Beher, University of Melbourne, Australia

Despite increasing time, effort, and investments into conservation research and actions across the globe, biodiversity gets lost at accelerating speed. We have to increase our impact quickly, but to do so have to understand the drivers of successes and failures of the projects that are currently implemented.

Are there underlying big commonalities on a national or even global scale that need to be addressed, such as failing environmental laws in many countries as it for example Australia, where many industrial projects go ahead despite the destruction of last remaining habitats for threatened species, or Brazil and the US, where the recent government is removing "green tape" at concerning speed, and how do these relate to the unique set of challenges regarding effectiveness and feasibility that every project has to face at the local scale? Are conservation actions that aim for the local protection of a small fraction of remaining populations doomed to result in a likely end through disturbance events like disease, wildfire or climate change? As much of environmental destruction is driven by consumer-demand-driven industry, a interdisciplinary discussion between policy, financial, law and technical sides of management actions is needed to share current strategies and insights.

**10:30am - 11:00am**

## What Is Next For Biodiversity Research, Globally And In Europe?

**Hilde Eggermont**
Belgian Biodiversity Platform/ BiodivERsA; h.eggermont@biodiversity.be

*2020 will be the year of important global moments for the environment. Governments will decide on a new 10-year framework for biodiversity under the UN Convention on Biological Diversity. These goals and targets will set the path for nature recovery around the world, and for sustainable societies in the face of climate change. In 2020, countries will also have the opportunity to enhance their national action plans to ensure that the goals of the Paris Agreement are achieved. The "IPCC special report on global warming of 1.5°C" and the "IPBES Global assessment on Biodiversity and Ecoystem services" make it clear that each half degree matters, and that biodiversity loss and climate change are inseparable threats to humanity that must be addressed together. How can the research community support the implementation of goals in the post-2020 era? What type of research is most needed to guide policy implementation? This presentation will set light on the new biodiversity context, and opportunities for research in securing the 'new deal for nature'*

**11:00am - 11:30am**

## Insights For Catalysing Conservation

**Morena Mills**
Imperial College London, United Kingdom; m.mills@imperial.ac.uk

Despite billions of dollars spent annually on conservation initiatives, we have very little knowledge on why some initiatives take off and spread around the world, while others languish and disappear. In this talk, I will show you new insights on the factors that accelerate the speed and extent to which conservation initiatives are adopted. I will highlight some of the stories behind the conservation initiatives that have had rapid and widespread adoption, with potential to transform the relationship between people and nature. I will situate our research within the community based conservation framework, which integrates theories from sociology, economics, and political science to understand the establishment, sustainability, and spread of community-based conservation. This framework enables practitioners to synthesize insights across social and cultural contexts, and improve conservation planning, implementation, and evaluation.

**11:30am - 11:50am**

## Lessons from New Zealand's National Policy Statement on Indigenous Biodiversity

**Sally Rhiannon Gepp**
Barrister, New Zealand; sally@sallygepp.co.nz

New Zealand has devolved management of activities' impacts on indigenous biodiversity to local government, but also provides nationally consistent policy guidance and direction through legally binding National Policy Statements. Two previous attempts to produce national policy have failed due to political sensitivity. A third attempt is currently being produced, following a collaborative process in which industry, farming, forestry, indigenous and environmental interests participated. Will this approach produce national direction on biodiversity regulation that overcomes past failures? What are the lessons learned through this process for successful environmental law and policy development and implementation?

**11:50am - 12:10pm**

## 10 Years Of Decision-Making For Biodiversity Conservation Actions: A Quantitative Literature Review On Objectives, Trade-Offs, Constraints and Confidence

**Jutta Beher**
University of Melbourne, Australia; beherj@student.unimelb.edu.au

For several decades the goal of conservation science has been to halt and reverse the decline of

biodiversity. Unfortunately, many species and ecosystems continue to decline despite current expenses and implemented actions. There exists little understanding and documentation of the current practices in conservation decision-making, including the degree to which current decision-making practices exhibit common weaknesses that are recognised in the behavioral psychology and decision theory literature.

My research investigates if there is a clear and consistence message from the scientific literature that could be utilised to inform policy and managers that are responsible to plan and implement conservation projects. To do so, I investigate how decision problems are described and resolved in recent peer reviewed publications through a quantitative literature review.

My presentation will show a quantitative assessment of ~500 publications from the last 10 years that describe a decision for a conservation problem, including the type of objectives, species and threats, proposed management interventions, considered constraints and frequency of sensitivity analysis. Possible best practice and important gaps will be highlighted to induce discussion of how science can improve standards of conservation planning in order to produce robust plans for real world conservation

problems.

**12:10pm - 12:30pm**

## Developing Generic Theories of Change and Performance Measures for Key Conservation Actions

**Nick Salafsky**

Miradi Software / Foundations of Success, United States of America; nick@fosonline.org

** Note: This will be a video presentation. **

Perhaps the most critical factor driving the success or failure in any conservation management effort involves selecting, implementing, and adaptively managing the conservation actions needed to achieve desired outcomes. The specific action needed in any given conservation situation depends on local conditions, including the type of conservation target, the nature of the threat being addressed, the capacity of the project team, and other potential contributing factors. Nonetheless, we can use experience from real-world implementation of specific conservation efforts to create generic theories of change for any type of conservation action. These generic archetypes are analogous to the type specimens in the Linnaean classification system of living things or the generic template patterns used by dressmakers or computer programmers. In this paper, I first describe specific efforts to develop generic conservation actions and associated performance measures for two complex conservation strategies. I then introduce the Conservation Actions & Measures Library (CAML), a global open-source repository of archetypal conservation actions and performance measures available at https://www.miradishare.org/actions. This library enables practitioners to search or browse the collection to find actions that may address their specific circumstances and to use a generic action as a template to develop their project's specific theory of change without reinventing the logic from scratch. It also enables groups of practitioners and researchers to collect common performance measures to efficiently report on a portfolio of many similar actions implemented by a given organization or under a funding source, and to collect data about implementation of similar actions under varying conditions, providing the basis for evidence-based conservation.

# 152S: Spatial Biodiversity Data Platforms: Current Resources and Future Opportunities

*Time:* Thursday, 27/Feb/2020: 10:30am - 12:30pm · *Location:* Wisshorn
*Session Chair:* Davnah Payne, Global Mountain Biodiversity Assessment, Switzerland
*Session Chair:* Eva Spehn, Swiss Biodiversity Forum, Switzerland
*Session Chair:* Michelle Duong, Yale University, United States of America
*Session Chair:* Walter Jetz, Yale University, United States of America

The provision of knowledge on biodiversity conservation and management that is scientifically rigorous, regularly updated, and relevant for policy, as well as the delivery of information on biodiversity-related opportunities for sustainable development (e.g. through the restoration of ecosystems and the services they provide) require extensive knowledge about the status and trends in biodiversity and ecosystems.

Yet, global knowledge about the spatial distribution of species is orders of magnitude coarser in spatial and temporal resolution than other spatially explicit environmental information, such as climate, topography, or land cover datasets. To improve the situation of global biodiversity information and support research, monitoring, and decision-making, several biodiversity monitoring networks and partnerships have been established and numerous spatial biodiversity platforms developed. Examples of biodiversity platforms with a global scope include Map of Life, which assembles, integrates, and synthesizes disparate data describing species distributions worldwide; the Global Mountain Biodiversity Assessment (GMBA) Mountain Portal, which leverages Map of Life tools for mountain biodiversity specifically; and GBIF, which is the largest collection of biodiversity observation data. National-scale platforms include BioModelos, which integrates both expert opinion and species distribution models to map species distributions, the Atlas of living Australia, or CONABIO's Remib.This session focuses on spatial biodiversity platforms with the objective to gain an overview of (i) the processes these platforms support, (ii) the international conventions and agendas they support, (iii) the end-users they target, and (iv) the specific tools they offer (e.g., the Global Biodiversity Change Indicators developed using data from Map of Life). Relevant processes include monitoring, reporting, governance (planning, priority setting), forecasting (scenario development), as well as transparency and advocacy (awareness creation, lobbying). Relevant conventions and agendas include the Strategic Plan for Biodiversity of the Convention for Biological Diversity, the Agenda 2030 of the United Nations, and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. The delivery of comprehensible policy-relevant information on species occurrence, distribution, and trends is key for biodiversity conservation and management and for the identification and deployment of sustainable development strategies that promote biodiversity and support responsible use of natural resources. Modular and user-friendly spatial biodiversity data platforms that can provide this information while retaining their scientific value and precision and fulfill additional monitoring and education roles are therefore critical. However, their development and maintenance represent a considerable challenge with limited financial means. This session will therefore also explore what the requirements are and what options exist for the long-term sustainability of such platforms.

**10:30am - 10:45am**

## Map of Life

**Walter Jetz**
Yale University, United States of America; walter.jetz@yale.edu

I will discuss Map of Life and its tools in support of species distribution and change assessment.

**10:45am - 11:00am**

## Making The Most Of The UK's Biodiversity Data Sharing Infrastructure

**Jo Judge**
National Biodiversity Network Trust, United Kingdom; j.judge@nbn.org.uk

The National Biodiversity Network (NBN) is a partnership, facilitated by the National Biodiversity Trust, that makes data about the UK's wildlife accessible for use by politicians, planners, academics, educators and the general public. We have adopted the Atlas of Living Australia's (ALA) open source platform for our digital data sharing infrastructure, launching the NBN Atlas in 2017.

There is a rich history of biodiversity data collection in the United Kingdom (UK) from the with the 224 million occurrence records covering 45,500 species available on the NBN Atlas stretching from 1605 to last week. The majority of this data is collected by volunteers, sometimes as part of structured surveys, but mostly through ad hoc species observations collected to varying specifications and submitted complex data flows. We have made adaptations to the underlying ALA code to cope with these requirements and particularly to work with the grid based location data used by the vast majority of UK recorders.

Due to the way much of wildlife data collection in the UK is (not) funded, we are working with the not-for-profit organisations who support the volunteers and perform data curation services (necessary to take the observations from raw data to records of known quality and verification status) to make data accessible via the NBN Atlas under the FAIR Principles, while not impacting on the income they obtain from providing data information services to users such as planners and developers.

Additionally, we are working with the UK's County Nature Conservation Bodies to ensure that the data can be used to report on national and international biodiversity indicators, Sustainable Development Goals and Aichi Targets.

In this talk we will discuss how we have dealt with the challenges of the data and our users requirements along with the opportunities for development of the Atlas and its tools.

**11:00am - 11:15am**

## BioTIME: a Global Database of Biodiversity Timeseries

**Maria Dornelas[1], Laura Antao[2], Amanda Bates[3], Faye Moyes[1], Anne Magurran[1]**
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The BioTIME database contains raw temporal data on species identities and abundances in ecological assemblages across the planet. These data enable users to calculate temporal trends in biodiversity within and amongst assemblages using a broad range of metrics. The database contains over 12 million species abundance records, from assemblages consistently sampled for a minimum of two, not necessarily consecutive, years. In addition, the database contains metadata relating to sampling methodology and contextual information about each record. BioTIME is a global database of over 300 thousand unique sampling locations spanning the marine, freshwater and terrestrial realms, spanning from 1898 to 2016. BioTIME includes data from nearly 30 thousand species across all eukaryotic taxa, ranging from plants, plankton, terrestrial invertebrates to small and large vertebrates.

BioTIME is being developed as a community led open-source database of biodiversity time-series. Our goal is to accelerate and facilitate quantitative analysis of temporal patterns of biodiversity in the Anthropocene.

**11:15am - 11:30am**

### BioModelos Better Models With The Support From Experts

**María Cecilia Londoño-Murcia, Elkin Alexi Noguera-Urbano, María Helena Olaya-Rodríguez, Daniel López, César Gutiérrez, Erika Suárez, Cristian Cruz, Alejandro Moreno, Jose Manuel Ochoa**

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BioModelos is a digital and open platform created to collect and make available the existing knowledge about geographical distribution of species in Colombia. BioModelos has designed functionalities that facilitate and promote the participation of experts in the development, validation and publication of distributional maps of species. These maps provide the most robust and reliable information on the location of the species, as it contains data that integrate records of the species, statistical algorithms with expert knowledge. BioModelos concentrates on a network of 500 experts who consider collaboratively to improve knowledge about the distribution of a growing number of species (4.597 charismatic species). The main users of the tool, since its creation in 2014, have been researchers and stakeholders, which include people from the NGOs and Colombian governmental institutions. Currently, for each species there are national values of the size of the distribution area, trends towards the year 2030 due to loss of forest, percentage of representativeness of the species in conservation areas and percentage of natural coverage in which the species is distributed. As a result, BioModelos has become a source of information to support processes related mainly to territorial planning and risk assessments of extinction (IUCN national committees). The platform has so far allowed the development of several decision support products, such as risk assessments, biodiversity compensation manuals, maps of ecosystems in Colombia, generation of maps of species richness, evaluation of the effect of deforestation and other promoters of change on biodiversity, generation of baseline information on species, evaluation of ecosystem services associated with species, among others. Information based on BioModelos has been included to support some indicators in the “IPBES” Colombian valuation. BioModelos is a BON-in-a-box tool for Colombia’s BON, that represent the operationalization of an essential variable of biodiversity in Colombia to support the governance of Science. The platform continues to grow to represent the country's biodiversity and the maps can be used directly for the management and conservation of species from a regional to local level.

**11:30am - 11:45am**

### Leveraging Global Biodiversity Infrastructure And Tools To Develop The Tana River Basin Data Portal, Kenya

**Patrick Siro Masinde[1], Mark de Blois[2], Peris Kamau[1], Kevin Odhiambo[1]**

[1]National Museums of Kenya; [2]Upande Limited; siromasinde@outlook.com

The Tana River Basin (TRB) biodiversity data and information system project aims to mobilize data and information from past and current studies and present it in an interactive openly accessible portal. TRB is a biodiversity hotspot of global significance with a variety of habitat types and has over twelve protected areas, as well as six IUCN red-listed species, and several endemic plants and animals. It is also economically important for Kenya as it supplies over 80% of drinking water for Nairobi City and about 32% nationally, and is the source of about 70% of Kenya’s hydroelectricity which constitutes about 38% of Kenya’s power supply. Data and information on TRB are disparate and often scanty. A multidisciplinary approach to the project was adopted in order to mobilize biodiversity and environmental data layers that can be integrated for use by diverse users including scientists, conservationists, and policymakers. We discuss how we have leveraged existing global biodiversity infrastructure, tools, and standards to mobilize biodiversity data. We harvest occurrence data already published to GBIF using an API and at the same time also publish new data from the project to GBIF. Data presentation and visualization is done with the aid of a GIS GeoNode instance. We comply with FAIR data principles so that our data is Findable, Accessible, Interoperable, and Reusable. This approach should create a sustainable portal that serves the local needs and at the same time contributes to global biodiversity portals and agendas.

**11:45am - 12:00pm**

### Publication of Biodiversity Data with EnviDat: From Idea to Realization

**Ionut Iosifescu Enescu, Gian-Kasper Plattner, Dominik Haas-Artho, David Hanimann, Konrad Steffen**

Swiss Federal Research Institute WSL, Switzerland; ionut.iosifescu@wsl.ch

EnviDat – www.envidat.ch – is the institutional Environmental Data portal of the Swiss Federal Research Institute WSL. EnviDat focuses on the registration, integration and hosting of quality-controlled, publication-ready research data from a wide range of terrestrial environmental systems. EnviDat provides unified access to WSL’s environmental monitoring and research data, including on the topic of biodiversity and related disciplines.

The registration of research data in EnviDat results in the formal publication with DOIs and the assignment of appropriate citation information. In order to improve knowledge sharing and for supporting Open Science, EnviDat encourages data producers to complement their data publications with the publications of, e.g, models, software, scripts, and any further information relevant for understanding the published research data

EnviDat was launched in 2012 as a small project to explore possible solutions for a generic WSL-wide data portal. It has since evolved into a strategic initiative for the entire WSL. EnviDat is formally cutting across the five WSL research themes forests, biodiversity, landscape, natural hazards and snow & ice, and concerns all research units and central IT services. Since 2017, the development of EnviDat has been intensified and the system has become operational. Today, many requests and a large part of the gradually increasing set of requirements from researchers across WSL research themes can be satisfied.

Yet, specific support for incorporating biodiversity data in EnviDat is currently being evaluated. We actively seek and welcome exchanges with well-established and successful biodiversity platforms such as the Global Biodiversity Information Facility (GBIF), the Global Mountain Biodiversity Assessment (GMBA) Mountain Portal, the Map of Life or BioModelos. We want to learn from these platforms, as they might assist in further shaping EnviDat features foreseen for the 2021-2024 planning period, such as incorporating geoservices and spatial mapping of complex biodiversity data.

**12:00pm - 12:15pm Warning: The presentations finish prior to the end of the session!**

### Mobilising Biodiversity Knowledge By Mining Heritage Literature

**Christine Driller[1], Markus Koch[1], Giuseppe Abrami[2], Manuel Stoeckel[2], Adrian Pachzelt[3], Gerwin Kasperek[3]**

[1]Senckenberg Society for Nature Research, Germany; [2]Goethe-University Frankfurt am Main, Germany; [3]University Library Johann Christian Senckenberg, Germany; christine.driller@senckenberg.de

Along with the ongoing decline in biodiversity, the number of studies on its possible causes is increasing. At the same time, there is

a growing demand for species occurrence data over longer periods of time to evaluate today´s data in relation to a pre-agroindustrial baseline. Many data sources already exist, but they are difficult to access due to their physical format (e.g. printed media), structure (natural language text) and/or copyright regulations. Against this background, we develop the Specialised Information Service for Biodiversity Research (BIOfid, https://www.biofid.de/en/ ) to promote the findability and accessibility of historical data, which become more and more relevant for biodiversity research.

In Germany, Specialised Information Services not only serve to cover the researchers' needs for access to pertinent literature, but also to set up and maintain digital archives and search systems. In the case of BIOfid, this service package is enhanced through a web portal for semantic queries based on state-of-the-art and easy-to-use text mining tools that are freely available through our website. With this approach, we want to enable scientists to search a large open access text corpus for biodiversity-relevant data and to extract these data in various common file formats for sophisticated analysis. In addition, our text mining pipeline allows users to analyse their own text corpora in different languages.

BIOfid is currently in the pilot phase with an initial focus on 20$^{th}$ century Central European literature (mainly German) on the distribution and ecology of vascular plants, birds, as well as moths and butterflies. Here, we present this platform and its specific features, which will highlight new facilities for researchers to gain knowledge about spatiotemporal changes and biodiversity trends. Incorporating long-term species occurrence records with recent data markedly improves our understanding on species-habitat relationships, thereby contributing to a sustainable biodiversity management in the 21$^{st}$ century.

# Posters 3: Poster Session 3

*Time:* Thursday, 27/Feb/2020: 12:30pm - 2:00pm · *Location:* Hallway

## Participatory Approaches, Collaboration And The Power Of Play For Nature-based Solutions And Collaborative Infrastructures

**Nikolett Puskas**
University College London, United Kingdom; niki.puskas@gmail.com

Based on a PhD research carried out in University College London, as part of the RELIEF Centre and working with the American University of Beirut's Landscape Design and Ecosystem Management Department, this poster wishes to introduce a framework being tested in two fieldwork sites: Budapest and Beirut.

This transdisciplinary research explores possibilities of establishing place-based values for wellbeing and a good quality of life (QoL) in urban public spaces. Co-defines infrastructural challenges (water, waste, energy, food) and investigates how can these be addressed via nature-based solutions and ecosystem services, which in turn contribute to increasing wellbeing and QoL in an inclusive, diverse and ecological manner. The approach employs participatory methods and gamification in the research framework.

It is at the core of research to engage with local communities, enable them to vote on the infrastructural topic they want to focus on, and co-construct the notions of wellbeing and ideas of 'the good life' with them, building on their knowledge and experiences of the neighbourhood. The gamification element is means to facilitate informal knowledge transfer, provide a sense of ownership and enable people to make their own connections between nature and their wellbeing and to co-construct pathways to urban prosperity in their public spaces.

Ultimately, the research aims to contribute to realizing SDGs via local actions linked to the global level, provide informal learning in an inclusive and diverse manner to enable people to make more informed decisions on how they would like to develop their built environment, thus ultimately aiming to contribute to environmental justice.

## Impacts of Global River Delta Modification on Biodiversity and Ecosystem Services

**Martin Oliver Reader[1], Alexander Damm[2], Owen Petchey[1], Hugo de Boer[3], Maria J. Santos[1]**
[1]URPP Global Change and Biodiversity, University of Zurich, Zürich, Switzerland; [2]Remote Sensing Laboratories, Department of Geography, University of Zurich, Zürich, Switzerland; [3]Copernicus Institute of Sustainable Development, Environmental Sciences, Universiteit Utrecht, Utrecht, Netherlands; martin.reader@geo.uzh.ch

Human modification of natural systems has typically enhanced provisioning ecosystem services (ES) at the expense of biodiversity and other service types. Long-term sustainability must balance ES flows to uphold human wellbeing, while maintaining biodiversity and the ecosystem functioning it supports. In river deltas this balance is critical – fertile land, well stocked fisheries, and water for use and navigation, have promoted rapid development – over 600 million now live in these relatively small areas. However, this very development accelerates biodiversity loss and the key services it provides to protect these deltas from hazards and pollution. Many deltas face a critical juncture, risking 'lock-in' to unsustainable states.

Combining a new global dataset of 237 deltas, with over 50 biodiversity and ES indicators, we assess the impacts of delta modification on biodiversity and ES provision. We considered several modifications to the most important aspects of delta systems – overall human impact (human footprint), population density, flow disruption and human appropriation of net primary productivity (HANPP); grouping deltas by modification state. We then use space for time substitution to illustrate the impacts on biodiversity and ES provision as deltas become more modified.

Modification of delta systems most commonly showed U-shaped relationships with ES, e.g. biodiversity intactness declined in moderately modified deltas, then increased in the most modified; provisioning services showed the inverse, presumably pushed out of highly modified deltas by other land uses. A correlation matrix showed clear synergies within provisioning services, and a clear trade-off between these and supporting services, alongside weaker synergies within and between regulating and supporting ES. Similarly, PCA showed bundles within provisioning and regulating ES. This global analysis is the first to illustrate how biodiversity and ES vary along a gradient of development in deltas, and highlights the need to balance further modification against these critical services.

## Providing MetaData for Biodiversity Research

**Rainer M. Krug, Owen L. Petchey**
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To adress questions about the future of biodiversity, it is essential to use a wide range of data from different sources. This is only possible, if the relevant datasets can be found, accessed, and understood through the metadata accompanying them. To promote this essential open data culture, the FAIR data principle was launched (https://www.force11.org/group/fairgroup/fairprinciples), which is gaining traktion throughout the scientific community.

With this increasing need and use for FAIR data, metadata, and it's quality, plays an ever increasing role. Nevertheless, providing metadata is not easily accomplished. One of the reasons for this is the cumbersome way of entering metadata in formats or webforms needed by repositories. Also, there is little or no quality control. Finally, the metadata schemes used by the repositories are either restricted to bibliometric metadata (e.g. DataCite) or are using metadata schemes which have to cover a vast diversity of different data (e.g. EML or Darwin Core).

I will present an approach which uses domain specific metadata schemes to overcome these problems, by developing these schemes together with scientists of their domain. It can be employed without detailed technical knowledge, e.g. using spreadsheets and a web browser. This will help researchers recognise the value of metadata for their own research and sharing. The provided validation tool increases quality of metadata.

## Environmental Changes in Island Ecosystems: Through the Lens of the Past

**Giorgia Camperio[1,2], S. Nemiah Ladd[1,2,3], Matthew Prebble[4], Christiane Krentscher[2], Amicie Delahaie[2,5], Nathalie Dubois[1,2]**
[1]Department of Earth Science, ETH Zürich; [2]Department of Surface Waters, Research and Management, Eawag; [3]Ecosystem Physiology, University of Freiburg; [4]Department of Archaeology and Natural History, Australian National University; [5]Department of Chemistry, École Normale Supérieure; giorgia.camperio@eawag.ch

Islands are emblematic cases of anthropogenic impacts on ecosystems. First human settlements in Remote Oceanic Islands came along with major landscape modifications. Through the multi-proxy analysis of lakes sediment cores from the Archipelago of Vanuatu, we provide palaeoclimatic and palaeoenvironmental reconstructions, combining geochemical tools based on biomarkers (fossil molecules of known origin) with traditional sedimentological, archaeological, and palaeoecological methods. In this study, we highlight the tight interplay between humans, climate and the environment in shaping current landscapes to identify key factors related to the ecological resilience and the adaptive capacity of islands socio-ecological systems.

## Functional Shifts In Alpine Plant Communities Of Humid- And Arid-Growing Season Habitats

**Klaus Steinbauer[1], Andrea Lamprecht[2], Harald Pauli[1], Manuela Winkler[2]**

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Global climate change is altering the patterns of species distribution and vegetation composition irrespectively of the degree of direct human interference. This includes also remote regions such as high-mountain environments, where ecosystems have previously been far less transformed compared to that of lowlands. In response, an international network of long-term monitoring sites in alpine summit areas (GLORIA; www.gloria.ac.at) has started at the onset of this century, with the aim to track climate-driven vegetation changes across different biomes.

Climate-driven changes in the composition of alpine vegetation are expected to affect the functional composition of plant communities, especially in low-temperature habitats, being strongly governed by abiotic ecological filters.

This study, therefore, is aligned along a thermal and humidity gradient from Mediterranean (Crete, Central Apennines) to temperate (North-Eastern Alps) GLORIA sites and combines permanent plot vegetation data (2001-2015) with climate-related functional traits of leafs, plant height and the distribution preferences of species along the elevation gradient.

Across all three regions, changes in community-weighted means of species' elevational preferences and increases in plant height, leaf area and LDMC (leaf dry matter content) indicate a shift to warmer and/or drier conditions. Notably, the increase in LDMC was most pronounced in the North-Eastern Alps. This might signal that species in humid plant communities are less prepared to dry summer seasons than species in the Mediterranean mountains.

## Spatial Scaling Of Functional Diversity Observed From Satellite Remote Sensing

**Leon T. Hauser, Joris Timmermans, Nadejda A. Soudzilovskaia, Peter M. van Bodegom**

Institute of Environmental Sciences (CML), Leiden University, The Netherlands; l.t.hauser@cml.leidenuniv.nl

Spatial functional diversity patterns are of key importance to monitor our ecosystems and provide insights in spatial patterns in ecosystem functioning. While species richness is known to be highly scale-dependent, such scaling is less understood for plant functional diversity. Advances in satellite remote sensing are opening new opportunities to study the effects of spatial scaling.

Here, we analyzed Sentinel-2 satellite imagery, through radiative transfer model inversion, over the vast and biodiverse region of Sabah, Borneo, to assess the relationship between functional diversity and area and its link to traditional scaling concepts in ecology. The remotely sensed functional diversity metrics were calculated over increasing grain, i.e. plot sizes, and are evaluated against land use, environmental drivers and null models.

The findings reveal consistent differences in functional diversity between land use types across scale. Functional richness increases with area, while evenness and divergence are relatively scale independent. The idiosyncratic scale dependency of different functional diversity metrics follows a similar curvature as random null-models, but digresses from a purely mathematical effects of increasing data. Instead our results indicate a spatial convergence of trait distributions consistent with environmental filtering and biotic sorting. The functional diversity–area curvatures are moderately, yet increasingly with scale, associated with environmental drivers that can be tied to habitat heterogeneity.

Using satellite remote sensing, the study thus highlights the continuous change in functional diversity over spatial scales and extents. Traditional concepts of alpha and beta diversity, which are more discrete, can still play a role in the interpretation of the findings. However, these patterns can now be observed in a non-discrete and show the gradual changes from within- to between-community dynamics. This continuity of scaling and spatial coverage contributes to the development theories that go beyond a discrete scaling of alpha and beta diversity.

## Climatic And Soil Factors Explain The Two-Dimensional Spectrum Of Global Plant Trait Variation

**Julia Sophia Joswig[1,2,3], Christian Wirth[2,3,4], Björn Reu[5], Jens Kattge[1,3], Sebastian Sippel[6], Ronny Richter[4,7], Nadja Rüger[3,8], Ian Wright[9], Peter van Bodegom[10], J. H. C. Cornelissen[11], Sandra Diaz[12], Wesley N. Hattingh[13], Koen Kramer[14,15], Frederic Lens[16], Ülo Niinemets[17], Peter Reich[18,19], Markus Reichstein[1,3], Christine Römermann[20], Franziska Schrodt[21], Madhur Anand[22], Michael Bahn[23], Chaeho Byun[24], Grandiego Campatella[25], Bruno E. L. Cerabolini[26], Joseph M. Craine[27], Andres Gonzalez-Melo[28], Alvaro G. Gutierrez[29], Tianhua He[30], Pedro Higuchi[31], Hervé Jactel[32], Nathan Kraft[33], Vanessa Minden[34], Vladimir Onipchenko[35], Josep Peñuelas[36], Velério D. Pillar[37], Michael Schaepman[1], Enio Sosinsky[38], Nadejeda A. Soudzilovskaia[10], Evan R. Weiher[38], Miguel D. Mahecha[1,3,4]**

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Plant functional traits are used to infer the evolution of life history strategies across the plant kingdom. They are also powerful predictors of plant community assembly and ecosystem functioning and are thus widely employed in global models of vegetation dynamics and climate feedbacks. A recent global analysis of trait-based plant ecology has revealed two axes of trait variation: (i) an axis of size variation at the organ and plant level and (ii) an axis of leaf economics balancing leaf persistence against plant growth potential. The orthogonality of these two axes suggests they may be underpinned by different environmental drivers. Tackling this issue for the first time, and at global scale, we here show that on average size traits co-vary more with climate variables, whereas economics traits more so with soil properties. This insight has the potential to improve our understanding of biodiversity patterns and predictions of climate change impacts on biogeochemical cycles.

## Exploring Global Plant Biodiversity Pattern Based On A Process-based Model

**Lisha Lyu[1,2], Loïc Pellissier[1,2]**

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The large scale patterns of biodiversity are one of the most important issues in macroecology and biogeography. The contemporary biodiversity patterns are results of the reciprocal impacts of ecology and evolutionary dynamics including adaptation and radiation of lineages, contemporary climate, past climate, topography, etc. To explain the current biodiversity distribution pattern, we applied a process-based model integrating ecology and evolution in species diversification process to reproduce the lineage evolutionary history. Here we used two globally distributed plant orders – Fagales and Pinales – as a case study. We generated the high-resolution biodiversity maps based on public biodiversity databases for the two orders and used the model to simulate the modern biodiversity maps. By simulating and regenerating the distribution, we are exploring the mechanism behind the large scale biodiversity patterns.

## Feedbacks Between Biodiversity and Climate - how Diversity of Plant Traits Influences Light Absorption and Albedo

**Elena Plekhanova, Pascal Niklaus, 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 energy budget components of the plant community (i.e. albedo and fraction of absorbed photosynthetically active radiation - FAPAR). We employ a 3D radiative transfer model, which allows us to simulate different trait diversity levels and track complex radiation-vegetation interactions in an artificial tree community. We simulate monocultures and different levels of mixtures following classical biodiversity experimental designs by varying the following traits:

a) leaf angle distribution as being representative of structural traits;

b) and leaf optical properties representing biochemical light-related characteristics.

Our results indicate an overall decrease in albedo and increase in FAPAR of plant mixtures with increasing trait diversity. Additionally, we observe a significant redistribution of light absorbed within canopies, indicating that some trees absorb more light in mixtures compared to monocultures and others less, depending on their structural and biochemical properties. The results of this study shed light on mechanisms governing the effect of biodiversity, specifically structural diversity, of a plant canopy, 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.

## VegLib, Using Python in Vegetation Data Analysis

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Vegetation data analysis is a crucial process in vegetation classification. Hereby, I introduce the VegLib Python package in the context of data analysis for vegetation. This package provides many useful analysis processes like basic statistics, ANOVA & MANOVA, ordination, cluster analysis, Diversity modelling, Simulation studies and randomization procedures, Analysis of spatial data and Analysis of time series. The package contains many modules with classes that can be used effectively in the vegetation data analysis. Moreover, it has the power of scraping data from different offline and online resources.

## Waterscapes As Hydro-Chemo-Social Hybrids?

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With a focus on visuality, we study the relationships between representations shaping environmental imaginaries and the practices imagined as leading to sustainable
water management.
The participatory photography project reflects on the perceptions of "practices affecting or affected by the water quality". Farmers

and beekeepers took pictures of waterscapes that capture best their relation to water. By eliciting their selection of pictures in a semistructured interview, the participants expose their inter-/intrarelations
to water, aquatic ecosystems and waterscapes.

Intermediary results: On the basis of the elicitation of the photos, we explore how water, chemicals and social practices interact, influence and co-create each other. In that sense, waterscapes appear to be increasingly imagined as hydro-chemo-social hybrids.

In those, material practices impacting on water quality and (oral and visual) discursive practices addressing water quality issues modify our imaginations of (fluid) resource frontiers from a problematization focused mostly on water quantity - in terms of scarcity and distribution - to additional qualitative aspects of water such as drinking water pollution or depletion of ecosystems.

## The Role of Political Drivers on Forest Conservation

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The state of São Paulo (Brazil) had long had strict legislation to protect the forests due to the longstanding settlement pressure. In the late 1970s, three state parks were established on the north coast of the state of São Paulo (NCSP) to protect the Atlantic Forest and prohibit any settlement and forest management. In addition, ecological-economic zones were created as buffers along the park boundaries (EEZ1 and EEZ2), in which only activities with minor impacts are permitted, such as sustainable forest management, including agroforestry, and in which the native forest must account for at least 90% and 80%, respectively. Ecological-economic zoning also defines zones for agriculture and urban development. Our study aimed to understand the role of political drivers for forest protection, as measured in terms of land-use change from 1985 to 2015 in the NCSP. We used Partial Least Squares - Path Modeling and a wide range of biophysical and socio-economic factors to assess their impact on forest persistence and urban/peri-urban increase in protected areas. We found that forest persistence was high in the parks and in EEZ1 and EEZ2, and that urban growth occurred mainly outside the parks and EEZ1 and EEZ2. The designation of parks and EEZ1 and EEZ2 were thus effective measures to protect forests from 1985 to 2015. However, EEZ1 and EEZ2 show an increasing trend of settlement development, as does the agricultural zone. In addition, several recent government actions outside the realm of the Ministry of the Environment and Secretaries, such as the reduction of financial support for forestry authorities and research institutes and the amendment of protection legislation, may reduce the effectiveness of public authorities in preserving forest cover. This is expected to lead to an invasion of settlements into protected areas and have other negative consequences.

## Status and development of the Russian Arctic Vegetation Archive

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The Arctic Vegetation Archive (AVA) is a circumpolar effort to assemble Arctic vegetation plot data into a publically accessible web-based archive. The goal is to unite and standardize Arctic vegetation data that will give researchers a unique opportunity to analyze vegetation at pan-arctic scale. The initiative is endorsed by the Conservation of Arctic Flora and Fauna of the Arctic Council and the International Arctic Science Committee.
At present, AVA consists of about 30’000 plots, mostly from North America and Scandinavia, stored in Arctic regional databases. The Russian AVA section is under development. A significant part of Russian tundra vegetation plots is not published or integrated into the AVA yet. This poses considerable risk to the safeguarding of important legacy data, reaching back 30 years, due to retirement or death of the researchers who acquired plot data and related metadata information. In cooperation with authors, we are working on archiving and harmonizing information on the vegetation composition of the Russian Arctic. Our study presents the status of the Russian section, provides an overview of potentially available data for inclusion and their spatial distribution in the framework of the pan-arctic data set effort.

The total amount of plots that were identified for possible inclusion into AVA is approximately 8’000. Approximately 5’000 relevés have been published to be included as a first priority. Large parts of the West Siberian data are already in the archive and a related website is under construction. Once legacy data are incorporated and AVA is established as a platform to archive new relevés, the resulting pan-arctic plot database will serve as the reference to estimate biodiversity and species turn-over across floristic regions, as a base-line for vegetation change assessments and predictions under global change and for the identification of plant biodiversity hotspots and vegetation conservation management in the Arctic.

## Molecular Phenology in the tropical forests of South-East Asia

**Chongmeng XU**

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One representative phenology in south-east Asia forest is mass flowering. It refers to the synchronous heavy flowering of most dipterocarp trees with many other families with irregular intervals of months to years. Understanding and predicting mass flowering will benefit plant reproduction, related animal dynamics, local human economic activities, and forest protection. Although several environmental cues are reported to trigger the mass flowering, such as drought, cool temperature, and sunshine, the ultimate and proximate causes are not totally clear. This study will reveal the mystery and predict mass flowering by molecular phenology. The time-course gene expression, flower phenology, and meteorological data of four tropical tree pieces along three years will be used for analyzing.

## Exploring Environmental Conceptions In An Indigenous Amazonian Population: Implications For Improving Biodiversity Conservation Strategies

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While indigenous societies are increasingly viewed as fundamental actors in guaranteeing the success of biodiversity conservation strategies in their localities, such initiatives are largely based on western notions of the world, grounded in a scientific approach and ignoring local environmental conceptions. The relatively recent development of ontological approaches in anthropology addresses this issue by emphasizing the existence of alternative conceptualizations, i.e., ontologies, that constitute alternative worlds or realities, and by attempting to understand people on their own terms. However, such approaches tend to exoticize indigenous and local peoples, assuming *a priori* the existence of radical differences that can hamper understanding and collaboration with indigenous peoples. Here, I challenge both approaches from an empirical, middle-ground position by: 1)

examining the environmental conceptions shared within a community of indigenous Matsigenka, located inside Manu National Park in Amazonian Peru; 2) exploring how Matsigenka notions correspond to their environmental behavior; and 3) determining whether these conceptions of animals and plants are as radically different from those of Western societies as some anthropologists claim. Through use of mixed qualitative and quantitative methods, the results of this study suggest that the Matsigenka world is populated by different types of subjects with varying degrees of agency, intentionality, and human-like consciousness. In addition, such ideas have behavioral consequences for Matsigenka interaction with non-human species that potentially impact biodiversity through mechanisms not included in traditional western theories of human-environment interactions. These results suggest that, while there are similarities to Western conceptualizations of certain animal and plant species, the Matsigenka world is different in several important respects that require an expansion of current theories of environmental decision-making, and that should be considered when designing and applying effective, culturally appropriate biodiversity conservation programs.

## Cool Plants in a Warming World – how Warming Changes Grisons' Alpine Plant Communities

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Alpine plants are iconic ambassadors of pristine mountain regions. Ongoing climate change is strongly altering their habitats and growing conditions. By re-surveying the species composition of summits with historical baseline data, we studied how the alpine flora changed over the past century (mainly in Grisons, among other in the Swiss National Park, three regional nature parks and one UNESCO world heritage area). The species numbers strongly increased, and this trend accelerated over the past three decades of accelerating climate warming. Many species from lower, warmer regions were newly found on summits. Will it become too warm for alpine species specialized to surviving harsh conditions? Will they be outcompeted by generalist species from lower regions? We discuss patterns, drivers and consequences for the flora of the Alps.

## A Case Study in Use of a Multi-Actor Framework for Agro-Ecological Farming Systems

**David Miller[1], Katherine Irvine[1], Gerald Schwarz[2], Inge Aalders[1]**

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A central dilemma for policy and practice in Europe is how to produce public goods whilst having viable production of private goods, securing economic and social sustainability at a farm level which is not overly dependent on public funds. The project 'Understanding and Improving the Sustainability of Agro-Ecological Farming Systems in the EU' (UNISECO) aims to strengthen the sustainability of European farming systems, delivering public goods through economically viable agro-ecological farming systems.

The poster presents provisional findings of an assessment of the state of a set of farms in a case study in north-east Scotland, UK, covering general cropping and mixed farming with livestock. A transdisciplinary Multi-Actor Approach was adopted to focus on problems or opportunities for farmers and other actors in the relevant value chains. The assessment comprised a set of in-depth interviews using the Sustainability Monitoring and Assessment RouTine (SMART) tool for analysis of sustainability and assessment of food production companies and farms. The assessment is made in terms of Good Governance, Environmental Integrity, Economic Resilience and Social Well-being of farms underpinned by results for 58 sub-themes.

Results are reported for the set of farms, and a 'Hypothetical Farm' to represent the case study. Results for the Hypothetical Farm show indicator scores ranging from accountability at 40% to animal welfare at 86%. Values for atmosphere, water and land were within the range 61% to 69%, and those for biodiversity in a separate grouping with lower values (46%, genetic diversity, to 57%, species diversity).

The findings are discussed in relation to how agro-ecological farming practices can be used to address issues of sustainability are biodiversity support practices, and what limitations there may be to transitions to agro-ecological farming systems.

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## Diversity-Functioning Relationships in Agroecosystems: from Crops over Weeds to Soil Microbes

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Biodiversity–ecosystem functioning relationships are a major research topic in ecology. It is indeed widely acknowledged that increasing diversity in plant communities affects plant interactions which in turn influence ecosystem functioning. These ecological concepts are well studied in natural ecosystems; however, applying them to an agricultural setting such as intercropping has only rarely been done. In particular, it is still poorly understood how crop diversity influences the diversity and functioning of other communities composing an agroecosystem. To close this knowledge gap, we conducted a diversity experiment using crop species and determined how diversity and functioning of the crop communities scale up to diversity and functioning of weed and soil microbial communities. The experiment was conducted in Switzerland and in Spain, two countries with drastically different climates, and was repeated in two different fertilizing conditions to determine how these diversity-functioning relationships respond to changes in abiotic conditions. We hypothesized that increasing crop diversity would lead to an increase in soil microbial diversity, but a decrease in weed diversity; likewise, highly productive mixtures would show higher soil microbial activity quantified through soil basal respiration, as well as lower weed biomass. At all levels, we expected that higher diversity would go along with increased productivity and activity, respectively, and assessed potential interactive effects between the diversity-functioning relationships of the different communities. Preliminary results suggest that crop diversity positively affects crop yield, that weed biomass negatively correlates with crop yield and crop diversity, and that soil microbial activity is influenced mostly by abiotic factors and interacts with crop yield. This holistic approach to the assessment of crop diversification effects on ecosystem functioning in agricultural systems provides evidence for intercropping as a sustainable method of food production.

## The Context Dependence Of Resource Partitioning In Crop Mixtures

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Biodiversity can increase productivity in (agricultural) ecosystems. This biodiversity effect has been attributed to a better use of resources, where resource partitioning and facilitation are enhanced by plant diversity. However, we still have a limited understanding of how environmental conditions such as climate and soil fertility modulate biodiversity effects on productivity. In order to understand this environmental context dependence of biodiversity effects in crop mixtures we aim to study the context dependence of resource partitioning and facilitation. We measured nitrogen (N) and carbon (C) content of plants growing at different diversity levels (monoculture, 2- and 4-species mixtures, isolated single plants), in two different climate zones (Spain and Zurich) and on two soil fertility levels in a full-factorial design. The crop plants used for the experiment include cereals (wheat and

oat), legumes (lupine and lentil) and herbs (flax, false-flax, coriander and quinoa). We expect to observe that increasing crop diversity leads to increased leaf N and C content and increased seed production compared to monocultures, but still less than as single plants. This would explain increased resource partitioning for crop species mixtures compared to monocultures, while demonstrating prevailing competition for resources in monocultures and mixtures. Furthermore, we expect the difference in resource uptake of mixtures compared to monocultures to be more pronounced under more stressful environmental conditions, i.e. in the semiarid environment of Spain compared to the temperate climate of Switzerland and on nutrient-poor soils compared to fertilized soils. Finally, we expect the nutrient status of plants to be related to yield based on the hypothesis that resource partitioning in mixtures would explain the observed biodiversity effects on productivity in our study system. With this research, we will contribute to a better understanding of the mechanisms beneath biodiversity effects in cropping systems and provide evidence for the benefits of mixture cropping.

## The Role Of Transition Zones For Maintaining Functional Diversity In Agricultural Landscapes – A Modelling Approach

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Especially in agricultural landscapes, the expansion and intensification of agriculture leads to the loss of biodiversity. Transition zones such as flowering strips or hedges are frequently mentioned as suitable mitigation measures which promote diversity in agricultural landscapes. However, the effectiveness of such transition zones is recently questioned. This mainly results from the fact that flowering strips are often established in areas of low productivity, which are already extensively managed. Thus, they have less promoting impact on biodiversity then if they were established adjacent to intensively managed fields.

In the current study we developed a spatially explicit modelling approach to analyse the influence of transition zones on functional diversity in a typical agricultural landscape. The model simulates population dynamics of interacting functional types of typical pollinating insects in an agricultural area in Northeast Germany (AgroScapeLabs). The simulated transition zones varied in their location within the landscape and their size. The results showed the importance not only of the size of transition zones but also on the spatial integration within the surrounding landscape for enhancing diversity.

Our study highlights the importance to explicitly consider the surrounding landscape composition and configuration for establishing transition zones as effective mitigation measures to counteract functional diversity loss. In the future, the model approach can be used to implement an optimized design for establishing transition zones on the farm level and thereby support sustainable agriculture.

## Assessing The Resilience Of Organic, Climate-Smart and Conventional Cocoa Systems To Drought In Ghana

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Climate related shocks to food systems are predicted to increase in the future. These shocks cause food insecurity and cement poverty traps for vulnerable smallholder producers, as well as causing many other negative impacts for the broader food systems they serve. Cocoa production systems vary from monocultures of open sun cocoa trees to complex agroforests, each with their benefits and tradeoffs in relation to local and global biodiversity. This research compares the ability of different production systems of cocoa in Ghana, namely; organic, “climate smart” and conventional, to deliver resilience against drought. This assessment uses a producer survey (n=480) and biophysical on farm assessments (n=70) coupled with remotely sensed climate data to make the comparison.

## "Feedbacks Between Charcoal Production And Biodiversity In The Tropics"

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Transitions to biomass-based renewable energy, necessary to mitigate GHG emissions, result in higher land use as well as losses in biodiversity, and affect livelihoods. A biomass-based renewable energy that is particularly interlinked with livelihoods is wood charcoal. Wood charcoal provides energy for hundreds of millions of people as well as income for 40 million people in the tropics but at the same time causes deforestation and biodiversity loss. This raises the question in which ways charcoal production can be sustainable for both forests and people. To answer this question, it is important to differentiate the different types of charcoal production systems in the tropics and understand their effects on forest stocks and other livelihood resources. Through a combination of a systematic review and social-ecological modelling we (i) identify charcoal production systems in tropical biomes and ii) conceptualize the effects of a transition from one system to another on feedbacks between livelihood resources of charcoal producers (forest biomass and charcoal biomass). We find 6 different charcoal systems organized along two gradients, of charcoal production and user accessibility. Most of the systems with high production occur in Brazil and Sub-Saharan Africa. We find examples of open access systems across tropical biomes and private systems mostly in Brazil. Our modeling simulations show stability with low charcoal production, alternative stable states when demand matches forest growth rate, and a collapse with high production. The results indicate that degradation causes a system collapse and potential poverty, allowing for an understanding of limits and opportunities for commons renewable energy. The study provides a gateway towards a more in depth understanding of charcoal system dynamics and their effect on important resources, such as biodiversity, and carbon sequestration.

## The Global Extent and Impact of Agriculture Inside Terrestrial Protected Areas

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Driven by human population growth, agricultural expansion is one of the most important drivers of habitat loss, which is the leading cause of species extinctions. Policy targets such as the UN Sustainable Development Goals and Aichi Biodiversity Targets include a focus on meeting food security needs while minimizing loss of habitat and biodiversity. Our study examines potential trade-offs between conservation and food production through the lens of the global terrestrial protected area (PA) network. Specifically, we explore spatial patterns of cropland extent inside PAs and examine the relationship to regulation, biodiversity and socio-economic factors, such as agricultural production and hunger. Addressing this critical conservation challenge is key to meeting international

policy goals. As identifying cropland within PAs requires a high degree of precision, we developed a new remotely sensed global cropland dataset using a spatially hierarchical accuracy-weighted approach implemented in Google Earth Engine, which draws on the strengths of higher resolution data while using agreement with datasets at coarser scales to improve accuracy. Using these new data, we find evidence that PAs are being impacted and/or designed to incorporate and maintain agriculture. In less strictly protected IUCN categories, agriculture occupies more than 10% of protected land. We show that cultivation inside PAs is most commonly found in temperate forest and grassland regions of Europe and North America, yet development in tropical areas presents the greatest risks to global biodiversity. At the country level, we show a consistent negative relationship between cropland occurrence in protected areas and the GINI index. This relationship is also observed in the subset of countries monitored by the Global Hunger Index. Despite being a somewhat counterintuitive finding, it is consistent with our evidence showing greater presence of cropland in PAs in wealthier nations, potentially related to both availability of intact habitat and patterns of protected area siting and regulation. These findings indicate that choices between effectiveness-based and area-based targets for conservation and restoration need to consider socio-economic context.

## Carbon Recovery of Logged Forests

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Logged-over tropical forests harbour substantial amounts of biodiversity and forest carbon, yet are under ever-increasing threat of land use change. Protecting logged forest from conversion to plantations could help maintain terrestrial carbon stocks, which could be funded by avoided-deforestation carbon-credit schemes. However, there are very few studies reporting the rate of biomass and carbon recovery of logged-forests in Southeast Asia. Accurate estimates of carbon recovery rates are essential to ensure carbon-offset projects are economically viable. To assess the Aboveground Carbon Density (ACD) recovery of logged-forest through time, we combined three different networks of plots in the Ulu-Segama Forest Reserve in Sabah, Malaysia, with historic logging data. All of the forest plots where measured twice between 1996 and 2016, accounting for the inherent variation in logged forests and enabling us to estimate recovery rates over a 20-yr interval. The measured values of ACD in plots combined with a history of times since logging provide a high temporal-resolution to determine carbon recovery rates. We then extend this analysis using extrapolations from a high-resolution carbon map of the entire forest reserve constructed using an airborne LiDAR survey. This combination of approaches provides the first highly resolved estimates of carbon recovery rates following logging for Southeast Asian lowland dipterocarp forests and highlights their potential for rapid recovery.

## Enhancing “Greening” Of The Common Agricultural Policy For Biodiversity Conservation In A Collaborative Way: The Case Of Spanish Dry-Cereal Croplands

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In agricultural landscapes, Green and Blue Infrastructure (GBI) comprises landscape elements that are essential for ensuring ecological connectivity and biodiversity conservation. GBI additionally delivers a variety of ecosystem services that are required to meet environmental policy targets. The BIOGEA project (https://www.biogea-project.eu/) investigates the impact of policy-driven land use changes on GBI, and how GBI relates to biodiversity and associated ecosystem services in European agricultural landscapes.

For this purpose, we use a case-study approach and combine the analysis of policy at the European Union (EU) and national levels, with the analysis of its local level implementation, as well as with in-field biodiversity and habitat monitoring and modelling, in six case study areas from three EU-member states (Germany, Spain and Bulgaria). We present the results of this detailed evaluation for dry cereal croplands in Castilla-La Mancha (Spain), which are representative of the most extended and extensive arable system in Spain

The policy analysis was based on the examination of EU targets for GBI established in “greening” and other conservation tools of the Common Agricultural Policy (CAP), and their transposition into national legislation, through literature reviews and interviews with EU and national experts. The local level implementation of CAP “greening” and other policy tools was analysed by interviewing farmers and local stakeholders in each case study area. Lastly, biodiversity (birds and plants) and habitat (GBI) field monitoring surveys were carried out to subsequently examine the relationships between biodiversity and GBI features, which were linked to distinct CAP options implemented in each case study area.

Based on our results, we discuss how CAP conservation tools could be improved by supporting more effective GBI features for biodiversity, and at the same time integrating the opinions and preferences of different interest groups (farmers, advisors, administrators, and NGOs) in order to increase their acceptance and uptake levels.

## Using Transdisciplinary Knowledge To Develop Adaptable Crop Diversification Measures And Improve Bean Production In North Macedonia

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Agroecosystem diversification measures such as mixed cropping provide vast opportunities for development of sustainable agricultural systems. Mixed cropping systems can enhance ecosystem services, e.g. biocontrol, soil fertility and; increase yield per unit area. Inclusion of beans is particularly promising in mixed systems as beans fix atmospheric nitrogen and may further provide the nitrogen to neighboring plant species. Common bean (*Phaseolus vulgaris* L.) is traditionally grown and widely consumed in North Macedonia. Despite its cultural and economic relevance, total bean production has reduced by ~30% in the last decade. Our project aims to improve bean production in Macedonia by using crop diversification measures. In choosing suitable crop combinations, it is important to understand not only the mechanisms that make certain combinations more productive but also, the factors that make them acceptable and adaptable by the farmers. In order to do so, we applied the transdisciplinary process from the beginning and involved the stakeholders in collaboratively generating knowledge.

We conducted a stakeholder workshop to understand the different drivers affecting bean production in Macedonia. We found drought, sun intensity and weed pressure to be the main climatic factors limiting bean production. Hence, we first conducted a trial to find bean varieties that are drought tolerant. The chosen bean varieties will be tested with additional crop species to determine crop and vareity mixtures that improve bean yield and soil fertility. We have chosen the additional crops on basis of traits that can combat current climatic challenges of bean production. We will discuss the results of our bean variety trial, relevant traits on which we chose the additional crop species and, the designs for the future field trial that could make our chosen combinations more adaptable by the farmers.

## Pollination Services Valuation In The Eastern Amazon

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Natural environments safeguard the majority of living organisms and the ecosystem functions and services delivered by them. Animal pollination is an important Ecosystem Service since it plays a key role for achieving the sustainable development goals by safeguarding worldwide food production. Thus, conservation of pollinators and pollination services is a major priority for guaranteeing global food security in the long term. In this study we evaluated the crop-pollination services in Pará state (Eastern Amazon, Brazil), focusing on answering two questions: (1) What is the economic value of crop production and pollination service in Pará? (2) Which are the most dependent municipalities on pollination services considering local agricultural production? We found 36 crops produced in the state, 20 (55%) crops are dependent on animal pollinators. In 2016, crop production value (CPV) for Pará state was US$ 2.95 billion and total pollination service value (PSV) was US$ 983.2 million, corresponding to 33% of CPV in Pará. Highest PSV value crops were Açaí palm (US$635.6 million), Cocoa (US$187.6 million), Soybean (US$98.4 million) and Watermelon (US$26.1 million), accounting for 96% of Pará´s PSV. Two municipalities (Medicilândia and Igarapé Miri) presented more than 50% of their GDP value based on pollination services. In general, we found low crop diversity in the municipalities of Pará, suggesting an economic rural vulnerability for the state, mainly supported by the high productions of soybean and açaí palm. Also, pollinators loss due to climatic and land use (e.g. fires and deforestation) changes may strongly affect local economies in Pará. Thus, pollinators' conservation and ecological intensified farming practices are urgent for supporting sustainable development and adaptation under climatic changes for the state.

## Water Use and Hydraulic Redistribution in Six Different Crop Species

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Water is a limiting resource for crop production in dry regions and, with the ongoing climate change, it is predicted that extreme heat waves will increase in numbers in Europe. Further, irrigation accounts for 70% of water withdrawals globally. Additionally, world human population in continuing to grow and food production will need to increase. Solutions to decrease water use of agriculture and increase crop production are urgently needed. Planting different crops in the same field (mixed cultures) has the potential to increase yield compared to monocultures. Further, mixed cultures can also improve water use (WU). The reason behind these benefits is species complementarity. WU in mixed cultures can be improve by complementary root structure and/or distribution of the different species. Additionally, deep rooting plants could perform hydraulic redistribution (HR). HR refers to the ability of plants to redistribute through their roots along the soil water potential gradient – usually from the moist lower soil layer to the drier upper soil layer. This could also be beneficial for shallow rooting plants. Here we propose two experiments to study WU and HR in six different crop species (two legumes, two cereals and two oilseed crops): (1) A field experiment to investigate WU of the crop species in monocultures, 2-species and 3-species mixed cultures and (2) a growth chambers experiment to study HR ability of the crop species. The field experiment had two aims: (a) to investigate water source (i.e. soil depth) and (b) to quantify WU of the crop species. This has been done (a) with natural abundance of stable hydrogen isotopes ($^2$H) and (b) with the application of $^2$H-enriched water. HR ability will be tested with a two-compartment pot design and sensors which record soil moisture periodically.

## Văcăreşti Natural Park, the First and Biggest Urban Natural Park from Romania as an Opportunity for Connecting People with Nature Inside the Metropolis

**Irinel Eugen Popescu**

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Văcăreşti Natural Park, with 200 ha, is located close to centrum of Bucharest, the capital of Romania. How became a reality such a big protected area inside the biggest metropolis from Romania? In the eighteen century here was the periphery of Bucharest, a swampy area with a monastery build in 1712-1722, transformed in penitentiary in nineteen century, demolished by communist authorities in 1986. In 1988 the area was transformed in one of the biggest artificial lake in Europe. After the fall of communism nature reclaims his territory and conquers this forgotten project transforming in an urban wilderness. Two scientific papers (Cojocaru & Popescu 2004, Popescu 2009) give the sign that here something it's happened. After two articles for general audience (Popescu 2012, Lascu et al. 2012), one in the Romanian edition of National Geographic and after a mass media campaign and more scientific research in 2016 was accorded the statute of Natural Park.

In natural way this area increase the physical green space of such a busy city like Bucharest with big air pollution problems, the metropolis being the 6$^{th}$ most polluted city in Europe. The park became a sanctuary for wildlife inside the city with more than 330 species of plants (Anastasiu et al. 20117), more than 100 species of birds, 50 species of fishes, amphibians, reptiles and mammals, more than 200 species of insects, all the studies being in working progress. Inside the park are encouraged activities like scientific research, environmental education, bird watching, ecotourism, biking, thematic circuits, leisure areas etc. Văcăreşti Natural Park became a Nature inside the city close to every citizen of the metropolis.

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# Plenary 7: Plenary Session 7

*Time:* Thursday, 27/Feb/2020: 2:15pm - 3:45pm · *Location:* Davos (2/3)

## Workineh Kelbessa, Addis Ababa University

## Fabio Scarano, Federal University of Rio de Janeiro

**2:15pm - 3:00pm**

### African Worldviews, Biodiversity Conservation and Sustainable Development

**Workineh Kelbessa Golga**
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This paper explores the role of African worldviews in biodiversity conservation and sustainable development. African worldviews recognize the interdependence and interconnectedness of human beings, animals, plants and the natural world. For most African cultural groups, it would be wrong to totally destroy a species and human beings are under obligation to live in harmony with other creatures. This implies that although it is not always the case that what one does depends on what one thinks and believes, indigenous African people's ideas and beliefs about the human-nature relationship have influenced what they have done in and to nature. In African worldviews, the present generation has moral obligations to the ancestors and future generations. It ought to preserve the environment which is rich in biodiversity for posterity. The present generation ought to be grateful to, and follow the examples of, past generations with regard to leaving behind a healthy land. African peasant farmers, fishers, hunter-gatherersand pastoralists are the custodians of areas of great biodiversity and the integrity of their local ecosystems owing to their indigenous environmental management practices and systems. However, one ironic, yet tragic, aspect of the current situation in poor African countries and elsewhere is that the poor, who are often the guardians of / custodians of biodiversity are the very people who are being evicted, deprived of their land and livelihood because of internal and external factors.

Therefore, this paper insists that it is extremely urgent that every effort be made to document the knowledge of peasant farmers and indigenous people in general. This paper further stresses that indigenous environmental knowledge makes a big difference to sustaining diverse environments, and it is imperative to preserve such knowledge before it dies out. Experiencing biodiverse environments can benefit human beings, and the attitudes expressed in public policy should accordingly favour conservation of biodiverse environments for educational and aesthetic reasons, as well as for the contribution of these environments to preventing the increase of carbon dioxide in the atmosphere.

**3:00pm - 3:45pm**

### Sustainability: Convergence and Futures

**Fabio Rubio Scarano**
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Sustainability emerged as a core contemporary value, partly as a reaction to the various symptoms of planetary socioecological decay. In this presentation, I will (1) draw on Bunge's (2013) theory of emergence to provide a brief history on the emergence of sustainability; (2) assess the present status of sustainability deadlines; and (3) use the "three tomorrows of postnormal times framework", by Sardar and Sweeney (2016), to discuss sustainability futures. The emergence of sustainability is associated to the convergence of separate modules in science, ethics and policy. However, further convergence is still needed to move sustainability from discourse to practice, in order to confront crucial deadlines and potential tipping points in world history, such as the fast-approaching years 2030 and 2050. The tight deadlines for establishing sustainability as the new normal (2019-2030) require urgent actions, but indications of positive change in equivalent intervals (2008–2019 and 1988–2019) give some reason for optimism. For the discussion on futures, I will use Gaia both as a theory and as a metaphor, and the biosphere-noosphere-technosphere concepts. My central argument is that societies should turn sustainability from a predominantly aspirational and discursive phenomenon into a predominantly practice- and policy-based endeavour driven by a fast-growing transdisciplinary science "hybridised" (sensu Benessia et al. 2012) with non-scientific systems of knowledge. I will use Brazil as a case study and present three recent movements that promote dialogue and co-production of solutions by scientists, artists, practitioners, indigenous and local peoples, religious peoples, and others: the Brazilian Science-Policy Platform on Biodiversity and Ecosystem Services (BPBES), "Selvagem" (*Wild*) and "Fé no Clima" (*Faith in Climate*).

# 003GS-2: Biodiversity in Production Systems

*Time:* Thursday, 27/Feb/2020: 4:15pm - 6:15pm · *Location:* Studio

**4:15pm - 4:30pm**

## Global Food Trade and the Homogenization of Cropland Landscapes

**Thomas Kastner**
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With the commercialization and industrialization of agriculture, cropland landscapes tend to become increasingly homogenous in terms of number of crops and cultivars grown in a given area. Globalization has increasingly decoupled places of crop cultivation from places where the derived food is consumed, enabling regional differentiation and specialization. The implications of this global interconnectedness on landscape structure and heterogeneity have not been systematically explored. We try to fill this gap by combining global maps of crop distributions with a detailed database that links places of crop production to the consumption of food products derived from them, including transfers via use of crops as livestock feed. This setup allows for analyzing differences in landscape diversity in regions dominated by export production compared to regions producing mostly for domestic consumption and regions in countries relying largely on food and feed imports. First results indicate that export-oriented regions exhibit considerably lower diversity in terms of number of crop species grown and are typically dominated by very few crop species. In contrast, areas dominated by production for domestic consumption and areas in countries that rely heavily on imports exhibit higher diversity values. This initial analysis will be supplemented by landscape structure metrics based on remotely sensed to get a fuller picture how the position in the global food trade system shapes landscapes heterogeneity. Our analysis, on the one hand, informs discussions how supply risks introduced by monoculture-dominated intensive farming are perpetuated through global supply networks. On the other hand, it provides indications on biodiversity outcomes of further globalizing of commercial agriculture, for which landscape diversity and structure are a crucial determinant.

**4:30pm - 4:45pm**

## Land Sharing vs. Land Sparing. Does Landscape Diversity and the Presence of Natural Landscape Elements Enhance Ecosystem Services in Intense Agricultural Systems?

**Jasmin Joshi[1,3], Karin Pirhofer Walzl[2], Larissa Raatz[3,4], Matthias Rillig[2], Christoph Scherber[4]**
[1]HSR Hochschule für Technik Rapperswil, Switzerland; [2]FU Berlin, Germany; [3]University of Potsdam, Germany; [4]University of Münster, Germany; jjoshi@hsr.ch

Biodiversity has the potential to buffer ecosystems against change and stabilize ecosystem functions and services. However, the suitable level of biodiversity to maximize ecosystem services in agricultural landscapes is not yet quantified and ongoing, rapid decline of plant as well as insect diversity and abundance across Europe in agricultural landscapes may endanger ecosystem functioning in the future. We investigated whether landscape complexity and the presence of natural landscape elements enhances multifunctionality in agricultural systems across Europe. In our German field experiments, we observed a number of enhanced regulating ecosystem services due to the closeness of natural habitats. The heterogeneity of agricultural landscapes in terms of the number of natural landscape elements such as hedgerows and in-field kettle holes increased the density of earthworms as key ecosystem engineers enhancing soil structure and fertility. The density of mycorrhizal fungi, the diversity of soil fungi as well as the concentration of N, P and organic C in the soils linearly decreased within 50 m from the edge of a natural landscape element to the centre of wheat fields. The closeness of in-field kettle holes was especially important to enhance soil moisture within surrounding agricultural fields. Whereas kettle holes as natural elements did not cause any relevant decline in wheat production in the intensively managed fields, the presence of tall, woody landscape elements did have a negative effect on wheat yield which, however, was measurable only until a distance of 17.8 m from hedgerows as well as forest borders.

**4:45pm - 5:00pm**

## Linking Ecological Theory To Sustainable Crop Production

**Rob Brooker**
The James Hutton Institute, United Kingdom; rob.brooker@hutton.ac.uk

Positive biodiversity-function (BEF) relationships indicate that increases in agricultural biodiversity can have positive impacts on ecosystem functions, enhancing the development of sustainable management options involving fewer external inputs. This is easily demonstrated for example in intercropping systems, where increasing the diversity of contiguously cropped species has benefits for resource use efficiency and overall productivity. But enhancing biodiversity to support sustainable crop production is not simply a matter of increasing in general the biodiversity found within farming systems. A number of key processes are involved in positive BEF relationships, and by understanding the ecology of these processes - for example through concepts developed in plant community ecology - we will increase our ability to manage biodiversity within farming systems in order to deliver sustainable crop production. This presentation explores some of these core ecological concepts including niche complementarity and facilitation, and how these can be – and indeed are being – integrated into the development of sustainable production systems. It also considers how recent advances in plant community ecology can provide pointers for future research to help develop more sustainable crop production systems, for example by highlighting traits that might be of interest to future crop breeding programmes aiming for sustainability from biodiversity. Finally, it discusses how mixed cropping systems can be a valuable tool not only for research, but also for communicating ecological and food production concepts and knowledge to a wide range of stakeholders.

**5:00pm - 5:15pm**

## Integrating Food Production And Biodiversity Conservation In Temperate Agricultural Landscapes

**Silvia Zingg[1], Raphaël Arlettaz[2], Jan Grenz[1], Eva Ritschard[2], Jean-Yves Humbert[2]**
[1]Bern University of Applied Sciences, Switzerland; [2]Bern University, Switzerland; silvia.zingg@bfh.ch

Biodiversity needs space and access to net primary production of ecosystems and therefore often competes with agricultural production. As land is limited and human population rising, this conflict is likely to increase further and calls for more researches on how to better integrate food production and biodiversity conservation. We studied the relationships between bird and butterfly communities and different agricultural landscape descriptors in landscapes of 1x1 km in the Swiss lowland. We first describe how biodiversity changed along three land use intensity gradients, accounting for land cover (farmed vs. natural areas), crop cover (arable crops vs. permanent grassland) and management intensity (intensively managed vs. extensively managed areas). Our results showed that birds were affected by landscape composition and management, while butterflies were mainly affected by

agricultural management. Specifically, from natural (e.g. forest dominated) to agriculture-dominated landscape, bird species richness showed a sharp decrease when 80% or more of the landscape was farmed. We subsequently focused on the extensively managed areas, the so-called biodiversity promotion areas (BPA). We analysed how the composition and configuration of these BPA influenced species communities at landscape scale. Such wider-scale assessments of various types of BPA measures simultaneously implemented, were lacking, although many taxonomic groups are ruled by landscape processes rather than mere fieldsite conditions. Butterfly species richness and abundance increased by 22% and 60%, respectively, when the proportion of BPA in the landscape increased from 5% to 15%. Likewise, bird species richness increased, but to a lesser extent. For both taxonomic groups, the amount and quality of BPA habitats contributed more to species richness than their spatial configuration, connectivity included. We showed that Agri-environment schemes (AES) implemented at the field scale have positive effects on mobile species that are noticeable at the landscape scale, which has strong implications for designing multi-functional agro-ecosystems.

**5:15pm - 5:30pm**

### Biodiversity Conservation And Agriculture: The Urgent Need For Agreements And Monitoring

**Akke Kok, Imke J. M. de Boer, Raimon Ripoll Bosch**
Wageningen University & Research, Netherlands, The; akke.kok@wur.nl

Developments in agriculture are one of the main drivers for biodiversity loss, in which livestock play a major role through pastures and feed crop cultivation. Although actors seem to agree when talking about biodiversity and the need for stronger conservation efforts, they often have different underlying assumptions and biodiversity targets in mind. We reviewed scientific literature assessing effects of livestock on biodiversity in Europe, to provide an overview of general characteristics of these studies and the indicators for biodiversity assessment. The majority of the 131 articles studied direct impacts of grazing on biodiversity, whereas indirect impacts of livestock on biodiversity through feed production were scant. The multitude of indicators used revealed the complexity and diversity of aspects involved in biodiversity assessment. Different conclusions regarding impacts on biodiversity were reached, and sometimes the divergence depended on the indicator used. Likewise, different underlying rationales for biodiversity conservation were observed among actors. In a subsequent study, we interviewed experts to develop narratives for biodiversity conservation on agricultural land. Different narratives for biodiversity conservation emerged, as opposed to one vision, in line with valuing different aspects of biodiversity. Some narratives targeted specific species (mostly farmland birds species), whereas others advocated a more generic approach of conservation (permanent landscape elements, lower intensity of production). Moreover, the experts' emphasized the necessity of context-specific approaches, based on the land use history and the current biodiversity. The narratives were translated into concrete scenarios, that made trade-offs between food production and biodiversity conservation explicit. Thus, setting clear targets to define prioritized aspects of biodiversity is extremely important, to assess effectiveness of conservation measures and possible trade-offs.

**5:30pm - 5:45pm**

### Neonicotinoid Insecticides: Use and Effects in African Agriculture

**Peter Francis McGrath**
InterAcademy Partnership, Italy; mcgrath@twas.org

tbc

**5:45pm - 6:00pm Warning: The presentations finish prior to the end of the session!**

### Neonicotinoid Use and Impact on Ecosystem Services in Cocoa Production in Ghana

**Dankyi Enock[1], Peter Francis McGrath[2]**
[1]University of Ghana; [2]InterAcademy Partnership, Italy; EDankyi@ug.edu.gh

tbc

# 237S: Tropics with the highest biodiversity: Towards interdisciplinary studies

*Time:* Thursday, 27/Feb/2020: 4:15pm - 6:15pm · *Location:* Forum
*Session Chair:* Kentaro K. Shimizu, University of Zurich, Switzerland
*Session Chair:* Michael O'Brien, Universidad Rey Juan Carlos, Spain

The tropical region encompasses the highest biodiversity on earth but has been understudied relative to other terrestrial regions. Recent advances in genomics, remote sensing, physiology and experimental ecology have opened the way for novel multidisciplinary approaches to addressing current issues in the biology, ecology and functioning of tropical ecosystems.

**4:15pm - 4:45pm**

## Measuring Tree Species and Functional Diversity across Heterogeneous Tropical Forest Landscapes

**David Francis Burslem**
University of Aberdeen, United Kingdom; d.burslem@abdn.ac.uk

Pervasive land use change and commitments to restore large tracts of degraded forests have increased demand for rapid and cost effective assessments of tropical forest diversity and ecosystem functions over large spatial extents. The high heterogeneity of tropical forest landscapes, and the inherent diversity of the biotic communities at such scales, pose challenges for measurement using traditional field survey techniques. Powerful new techniques from remote sensing are emerging to solve these problems, but they require extensive field sampling for calibration and validation, which implies integration of large-scale data-sets and expertise across multiple disciplines. Here I outline recent progress on a research programme in Sabah, Malaysia, that aims to determine the impact of anthropogenic disturbance on biodiversity and biogeochemical cycling. The programme couples airborne LiDAR and hyperspectral imagery with extensive field surveys of plant species and functional diversity across a landscape characterised by logging disturbance and conversion to Oil Palm monocultures superimposed on high background variation in soils and topography. Measurements of 32 physical, chemical and physiological traits of leaves and wood from 284 tree species were used to derive community-weighted mean (CWM) trait values and measures functional diversity. Logged plots had greater CWM values for traits that drive carbon capture and growth, whilst old-growth forests predominantly had greater CWM values for structural and persistence traits. Although disturbance was the primary driver of trait variation, soil nutrients explained a statistically independent axis of variation linked to leaf size and nutrient concentrations. Airborne imaging spectroscopy was used to scale these trait measurements across a 400 $km^2$ study area, which uncovered patterns that were undetectable in the field measurements. After controlling for variation in topography, canopy foliar nutrient concentrations were lower in logged than old-growth forest, and leaf N:P ratio declined as logged forests increased in stature, suggesting loss of P availability through disturbance or timber harvests. The independent responses of functional traits to anthropogenic disturbance, topography and soil nutrient availability that was detected through this multi-disciplinary collaboration emphasises the high-dimensionality and context dependency of trait expression, and has important implications for prediction and mapping of ecosystem function across human-modified tropical forest landscapes.

**4:45pm - 5:05pm**

## Causes And Consequences Of Human-driven Environmental Changes On Tropical Epiphytic Communities

**Edicson Parra Sanchez[1,2], Cristina Banks Leite[1]**
[1]Imperial College London, University of Sheffield; [2]Imperial College London; eaparras@unal.edu.co

Human-driven environmental changes trigger positive and negative effects on species and communities. Due to its complexity our understanding of the mechanisms that underlie species responses to habitat disturbance and the potential to destabilize ecosystem functioning is still very limited. To assess the causes and consequences of habitat disturbance across a human-modified landscape we used response and effect life-history traits of epiphytic plants sampled in the canopy and understory strata in the Brazilian Atlantic Forest (BAF). We found that endemic and habitat-specialised species are more prone to disappear as consequence of habitat loss, than species with larger dispersal range and ability to colonize different forest types. Old-growth forests presented higher functional richness and redundancy than human-modified forests across the matrix-edge-interior gradient, indicating a loss of ecological resilience. The effects of habitat transformation leads to the loss of a large set of functions related to pollination and water cycling across strata. Our results indicate that continuous old-growth forest are the only habitat that can maintain the full potential of ecosystem functions delivered by vascular epiphytes. Although limited, human-modified forests still provide ecosystem functions that can positively be influenced by landscape management actions such as increasing forest cover.

**5:05pm - 5:25pm**

## Frequency-Dependent Feedback Constrains Temperate And Tropical Forest Community Diversity

**Maarten B. Eppinga[1], Wilson A. Mugasha[2], Maria J. Santos[1]**
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Despite decades of research, explaining the large number of trees species coexisting within forest communities remains surprisingly difficult. Ecological theory suggests that coexistence of such diverse communities requires frequency-dependent negative feedbacks to prevent exclusion of the least fit species. Although empirical evidence for negative frequency dependence is rapidly accumulating, linking these findings to theory is challenging, as most theoretical frameworks consider much fewer species than the dozens to hundreds of different tree species that coexist within temperate and tropical forests, respectively. Here we present a theoretical framework of negative frequency dependence that can be extended to communities containing any number of species. Specifically, any interaction network can be described by a single metric that quantifies the strength of community-level feedback. it can be shown that negative community-level feedback is a necessary (but not sufficient) condition for all species in the community to coexist. Subsequently, we show how this model framework can be parameterized with large datasets from temperate and tropical forest regions. These parameterized models can then be used to test whether observed gradients in forest diversity can be explained by differences in the strength of negative frequency dependence, and the resulting community-level feedback that constrains species coexistence. This approach reveals how we can now integrate theory with empirical data, to test whether observed feedback-diversity relationships are strong enough to infer causality.

**5:25pm - 5:45pm**

## Partitioning Spatial Turnover Across Phylogenetic Scales To Understand and Conserve Global Biodiversity

## Dynamics

**Ian McFadden[1,2], Fernanda A.S. Cassemiro[3], Marco Túlio P. Coelho[3], Rafael O. Wüest[1], Niklaus E. Zimmermann[1], Loïc Pellissier[1,2], Thiago F. Rangel[3], Catherine H. Graham[1]**

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It is increasingly understood that earth's biodiversity has been shaped by both deep-time and recent lineage dynamics (speciation, dispersal, etc.), however the relative contribution of events at different phylogenetic timescales is poorly known for most groups. A better understanding of how ancient and recent events shape diversity patterns can be used to prioritize regions for conservation and sustainable development that harbor and potentially generate a disproportionate amount of global biodiversity. Here, we introduce a novel method to partition phylogenetic turnover (or beta diversity) into ancient and recent-time components, and use this metric to infer how lineage dynamics have shaped biodiversity over time and space. We then apply this method to a global dataset of 19205 terrestrial vertebrate species (mammals, birds and amphibians), and the freshwater fish fauna of South America (5011 species). We find that species-rich areas of the globe are most often associated with high turnover of recently-derived clades, suggesting that recent lineage dynamics may be a key driver of global biodiversity patterns. The threats due to habitat loss and climate change in the regions we identify should be further assessed and mitigated to preserve ecosystem functions and the earth's ability to produce future biodiversity.

**5:45pm - 6:05pm Warning: The presentations finish prior to the end of the session!**

## Effects Of Rainfall Exclusion On Tropical Emergent Tree In Southeast Asian Tropics

**Yuji Tokumoto[1,2], Masaki J Kobayashi[1,3], Masaomi Hatakeyama[1,4], Yuta Inoue[5], Yayoi Takeuchi[6], Bibian Diway[7], Daisuke Todaka[8], Tomonori Kume[9], Tomo'omi Kumagai[8], Tomoaki Ichie[10], Tohru Nakashizuka[11], Michiko Nakagawa[12], Shoko Sakai[13], Kentaro K Shimizu[1,2]**

[1]University of Zurich, Switzerland; [2]Yokohama City University, Japan; [3]Japan International Research Center for Agricultural Sciences, Japan; [4]Functional Genomics Center Zurich, Switzerland; [5]Forestry and Forest Products Research Institute, Japan; [6]National Institute for Environmental Studies, Japan; [7]Sarawak Forestry Corporation, Malaysia; [8]University of Tokyo, Japan; [9]Kyushu University, Japan; [10]Kochi University, Japan; [11]Research Institute for Humanity and Nature, Japan; [12]Nagoya University, Japan; [13]Kyoto University, Japan; yuji.tokumoto@ieu.uzh.ch

Frequencies of extreme climate, such as heavy rain, less rainfall will increase after climate change era in Southeast Asian tropics. Tropical trees will be affected by the future climate; growth delay, litter fall increase, and, finally, tree death have been expected. However, the tropical trees often use the weather fluctuation as one of the signals of biological developmental process. In order to understand the tropical trees' response to the less rainfall (drought) in future climate, a rainfall exclusion experiment on tropical mature tree was conducted in Sarawak, Malaysia. In this presentation, we will show the effects of rainfall exclusion on plant morphology, physiology, and gene expression, and discuss the possibilities of the methodology to monitor the tree stress status and future forest in Southeast Asian tropics.

# 187S: Public Health and Biodiversity: Potential and Barriers to Integrated Policies

*Time:* Thursday, 27/Feb/2020: 4:15pm - 6:15pm · *Location:* Dischma
*Session Chair:* Mollie Chapman, University of Zurich, Switzerland

When do policies for protecting biodiversity and improving human health align? When do they conflict? New research has explored the potential benefits of biodiversity for human health in areas such as urban green spaces for mental and physiological health; exposure to biodiverse natural areas and development of a healthy immune system; and regulation and transmission of infectious diseases (Hertzen et al., 2015; Sandifer, Sutton-Grier, & Ward, 2015). Scholars of food systems increasingly consider policies to simultaneously improve environmental and public health outcomes (Gordon et al., 2017).

Yet can biodiversity and public health also be at odds? How do practices and policies designed for public health impact biodiversity? Two examples of regulations aimed at food safety illustrate potential negative impacts of health policy on biodiversity. In British Columbia, Canada an outbreak of BSE (bovine spongiform encephalopathy, or mad cow disease) in the beef industry led to new regulations for abattoirs (slaughterhouses) that effectively eliminated small-scale abattoirs and the options for small-scale and remote producers that may use more biodiversity-friendly practices (Miewald, Ostry, & Hodgson, 2013). In California, an E. coliscare in the produce sector led pressure on farmers to remove bird habitat from their fields, a practice since proven ineffective (Karp et al., 2015). These examples show that while public health and biodiversity are not necessarily at odds, policy responses for the former can still negatively impact the latter.

**4:15pm - 4:45pm**

## Biodiversity and Health - Linkages and Pathways

**Aletta Bonn[1,2,3], Melissa Marselle[1,3]**

[1]Helmholtz Centre for Environmental Research - UFZ; [2]Friedrich Schiller University Jena; [3]German Centre for Integrative Biodiversity Research (iDiv), Germany; aletta.bonn@idiv.de

National and global biodiversity policy goals are repeatedly missed. This may be a result of missing values for biodiversity or perceived trade-offs between sectoral policy goals. While we rationally know that biodiversity forms our central human life-support system on our globe, the connection to our human health and well-being is not yet well understood.

Next to biodiversity loss, increases in non-communicable diseases are among the greatest global challenges modern society is facing today. Preventable, non-communicable disease, such as mental illness, obesity and cardiovascular disease, account for 77% of the total disease burden in Europe and significantly drive up the cost of health care. Increasing evidence suggests that biodiversity may present a nature based solution to address some of these health issues. By linking both health and biodiversity policy agendas, we can improve both our health and protect our environment and align finance streams. For this, however, we need to better understand *how* biodiversity matters for human health and well-being.

Here, we present a biodiversity and health framework, that explores the linkages and pathways of biodiversity and health, and we specify with case studies from urban environments. This framework can aid the development of natural 'health treatments' in which biodiverse environments are used to reduce stress, depression or encourage physical activity. Investment into biodiversity conservation could therefore form a globally important (natural) health service.

**4:45pm - 5:05pm**

## Species Richness Is Positively Related To Mental Health Across Germany

**Joel Methorst[1,2,3], Aletta Bonn[2,4], Melissa Marselle[2,4], Katrin Böhning-Gaese[1,2,3], Katrin Rehdanz[5]**

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Nature and biodiversity provide benefits and services that positively contribute to human well-being. Local level studies even show that species diversity, a measure for biodiversity, can have a positive effect on human health. However, little is known about the influence of species diversity on human health at the national level. Here we analysed the relationship between species diversity and human health across Germany while controlling for socio-economic factors and other nature characteristics. We used both the mental health component scale (MCS) and the physical health component scale (PCS) as indicators for human health, two well-established indicators for Health Related Quality of Life (HRQoL). As measures for species diversity we used species richness and abundance estimates for two species groups: plants and birds. Our results demonstrated a significant positive relationship between plant species richness and MCS. We also found a significant positive relationship between bird species richness and MCS, while bird abundance did not show any effect on MCS. As expected, we did not find any relationship between our species diversity variables and PCS, but instead could confirm the positive relationship between distance to parks and both HRQoL indicators. Our study highlights the importance of species diversity for human health and discusses potential implications for future research and policy makers, especially in regard to future loss of biodiversity and increasing societal costs due to public health problems.

**5:05pm - 5:25pm**

## Restoration In Green Spaces: The Effect Of Biodiversity On Human Wellbeing

**Nicole Bauer**

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Numerous studies have shown that green spaces are more suitable for reducing stress or improving mental performance than indoor spaces and urban built-up areas (Hartig et al. 2003; Ulrich et al. 1991) and hence may have an important effect on human wellbeing and mental health. These restorative effects of nature can be measured either by self-report measures (e.g. standardized scales, questionnaires) or by measuring physiological stress responses e.g. cortisol, pulse rates, electrodermal activity.

Currently research is investigating, among other things, whether different natural landscapes have different effects on human restoration and stress reduction and if landscapes with higher biodiversity have a more positive influence on human health. Since biological diversity is often difficult to recognize for laypersons, many of these studies deal primarily with structural diversity.

An experimental study lead by BOKU Vienna in collaboration with WSL in three different biosphere reserves investigated the influence of extensively cultivated and abandoned Alpine meadows on well-being and physiological outcomes (Arnberger et al. 2018). The results for the self-reported stress reduction and attention restoration showed an increase in positive values in a before-after design for the abandoned as well as the managed meadows and the physiological measures (pulse rate) consistently showed

an decrease in this study design but no significant difference between managed and unmanaged meadows for both measures. These results suggest that the current level of “rewilding” of small scale Alpine landscapes does apparently have no negative effects on the restorative qualities.

In the context of increasing urbanization, urban forests and gardens as forms of urban greenspace are an important resource for the psychological restoration of urban dwellers, while underpinning urban biodiversity. In the interdisciplinary Better Gardens project of FibL and WSL we found that being an allotment gardener was associated with higher levels of restoration than being a domestic gardener and that restoration is positively related to the number of plant species by way of the perceived restorativeness of the garden (Young et al., under review).

We discuss the results of these and other studies with regard to policy implications and future study designs.

**5:25pm - 5:45pm**

### Reconciling Mental Health Promotion and Biodiversity Conservation in a Megacity: the Role of Urban Parks' Quality

**Jessica Francine Felappi[1], Jan Sommer[1], Wiltrud Terlau[2], Theo Koetter[3]**

[1]Center for Development Research - University of Bonn, Germany; [2]International Centre for Sustainable Development, Bonn-Rhein-Sieg University of Applied Sciences, Germany; [3]Institute of Geodesy and Geo-information, University of Bonn, Germany; jfelappi@uni-bonn.de

Green infrastructure (GI) has been increasingly promoted as a strategy to transform and build resilient and healthier cities. Public parks are the most targeted type of GI in urban areas and a growing body of evidence supports the potential of these spaces for human health promotion and biodiversity conservation. Despite not being natural environments by definition, they comprise natural elements and functions that make them eligible as potential restorative environments, which allow people to recover cognitive capacities and relax, and as habitats for flora and fauna. However, reconciling in the same place requirements for human use and biodiversity conservation may involve trade-offs and synergies that are not well investigated so far. Usually, design is human-centered and biodiversity support is only a beneficial side effect. In this study, we propose a new integrative framework based on the One Health approach and operationalize it in Sao Paulo, Brazil. This megacity was selected as study area due to the variety in parks' design and quality, high prevalence of mental disorders, and geographic location overlapping a biodiversity hotspot (Atlantic Forest). Based on data collected in 18 urban parks and a survey with 994 park visitors, recommendations will be developed to inform the design and management of urban green spaces that may maximize human mental health and wellbeing promotion and biodiversity conservation.

**5:45pm - 6:05pm Warning: The presentations finish prior to the end of the session!**

### Peatlands In Transition: A Bioethical Appraisal Of The Toxic Haze From Peat Fires In Indonesian Oil Palm frontiers.

**Rachel Carmenta**

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Burning peatlands have raised local, national and international concern in recent decades, are now annual events and have been in the spotlight again this year. Attention has focused predominantly on the inordinate carbon emissions arising from Indonesian peat fires, and the associated biodiversity losses. Peat fires manifest as naturally water-logged peat swamp forests are prepared for plantations of acacia and oil palm at a range of spatial scales. Peat lands are first drained by canals, the vegetation is then felled, and finally burnt to prepare the land for planting. However, peat fires are extremely difficult to contain and can become uncontrolled extensive fires, largely because the peat soil itself is fuel and fires can submerge and re-emerge following coal seams. The high organic content of peat soils results in a smoke signature that is particularly toxic, with fine particulate matter that can cross cell-membranes and cause bioethical damages including affecting brain function and foetus in-utero. Additional health burdens include respiratory ailments, stunting and poorly understood psychological and well-being impacts. Yet, sustainable peatland management has proven complex and the fires are a wicked governance challenge, emblematic of diverse and powerful interests, connected to distant geographies and global demand for commodities. Using Q method to understand stakeholder perspectives, we show that concern for the public health burden created by the peat fires is a concern that unites diverse stakeholders with little else in common. This finding suggests that emphasising the humanitarian dimension of peat fires in the transition to cash crops, could be an emotive and powerful language to lever policy and behavioural change. Such an emphasis would necessitate refocusing the leading discourse from carbon and biodiversity, to the potentially more sensitive issue of health and wellbeing for local and regional constituents. In this talk, I give an overview of stakeholder perspectives concerning peat governance, and then assess the evidence to identify the health implications of peat fires for local and regional populations. I consider the potential to unite the health agenda, particularly as framed within the UN Convention on Bioethics, with the current policy momentum in pursuit of sustainable peatland management.

# 118S: Pastoralist Knowledge Practices and Management for Biodiversity

*Time:* Thursday, 27/Feb/2020: 4:15pm - 6:15pm · *Location:* Flüela
*Session Chair:* Serena Ferrari, FAO, Italy
*Session Chair:* Jesús Garzón, Trashumancia y Naturaleza, Spain
*Session Chair:* Luca Battaglini, University of Torino, Italy
*Session Chair:* SANTIAGO JOSE CARRALERO BENITEZ, YURTA Association, Spain
*Session Chair:* Ilse Köhler-Rollefson, League for Pastoral Peoples and Endogenous Livestock Development, Germany
*Session Chair:* Simon Tagourdeau, CIRAD, France

The session will discuss the application of indigenous pastoralist knowledge and management practices in biodiversity conservation. Pastoralism is a livestock production system that relies heavily on the continued service exchanges with its ecosystems. A close link exists between pastoral peoples, the ecosystems in which they live, and the animals that they breed. It therefore has a significant role to play in the conservation and sustainable use of biodiversity. Pastoralists employ indigenous management systems and naturally adopt many of the principles that target the maintenance and enhancement of ecosystem health.

Nonetheless, factors such as continuing biodiversity loss, accelerating climate variability, and loss of pastoral ways of life – due to enforced sedentarization programs, i.e. agriculture expansion, urbanization and disruption of livestock corridors and mobility routes, etc. – put the future of pastoralism and its role in biodiversity conservation at an imbalance. In addition, invasive plant species are presenting an increasing threat through both competition for grazing or through the replacement of high nutritional value plants with species with a lower nutritional value. The introduction of high water demand invasive tree species is also disrupting water availability in some rangeland areas.Despite the environmental challenges facing pastoral systems, pastoralists have traditionally managed rangelands sustainably and delivered a number of positive benefits for biodiversity. In recent years, research has been providing scientific evidence of these positive environmental externalities. For example, in many cases, sustainable mobility and grazing practices actually increase species diversity and stimulate pasture growth, thus maintaining ecosystem structures. In addition, pastoralism sustains diversity in ecosystems by reducing the risk of local extinctions due to increased inbreeding and loss of animal genetic variation in small populations. Pastoralism also contributes to the reduction of disasters such as fires, drought and flooding through the active management of vegetative cover. Studies have shown that desertification often occurs where policies undermine the pastoralist indigenous knowledge system, otherwise if supported by appropriate policies, biodiversity and ecosystem integrity are usually enhanced. Understanding and promoting these benefits, and thus feeding back positively on the system, have been shown to make good economic sense.Indeed, the pastoral systems apply an ecosystem approach through their indigenous knowledge practices. The approach promotes conservation and sustainable use of biodiversity in an equitable way through recognizing that humans, with their cultural diversity, are an integral component of ecosystems. Supporting and implementing pastoralists' indigenous knowledge practices and management systems to realize the benefits on biodiversity is crucial. Our session will highlight some of these practices and knowledge systems applied by pastoralists to conserve biodiversity. For that purpose, we will use case studies from the field, as well as conceptual frameworks applicable to different geographical landscapes and tools developed by FAO and other stakeholders – such as the FAO Technical Guide 6 (Improving governance of Pastoral lands), the Bio-cultural community protocol, and the IFAD Pastoral Development Toolkit

**4:15pm - 4:30pm**

## Assessing the Contribution of Pastoralism to Biodiversity

**Gregorio Velasco Gil, Serena Ferrari, Caroline Ruto, Natasha Maru**
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Practiced by millions of people across the world, extensive pastoralism presents strong opportunities and potential for conserving both plant and animal biodiversity and providing food and livelihood security and resilience. The triple features of shared use of natural resources, mobility, and rearing of local livestock breeds has allowed pastoralists to exploit the variability of non-equilibrium environments as well as manage resources for their continuous regeneration.

Pastoralism produces sustainable, locally adapted and organic animal source products preserving both local animal and plant genetic resources. It provides a viable alternative in the face of growing concerns over the climate crisis, and provides a range of beneficial ecosystem services. These include improved soil fertility, biodiversity conservation, especially domestic animal genetic resources, seed dispersal, preventing wildfires, promoting nutrient cycling, habitat preservation and carbon sequestration; all contribute to the conservation of local plant and animal life. Therefore, pastoralism is a best case for sustainable, agroecological and ecosystemic livestock production and biodiversity conservation.

However, there is lack of evidence to support these claims. Several initiatives have attempted to bridge the gap in technical and scientific knowledge available regarding pastoralism and its interaction with the ecosystem. Additionally, there is a need to enhance the quality and accessibility of available information. Growing pressures on pastoralism that call for a rapid transformation of the livelihood go hand-in-hand with the lack of knowledge to support pro-pastoralist policy advocacy.

FAO's Animal Genetics and Production Unit has responded to growing interests in pastoralism by providing a platform for pastoral voices within FAO and globally. It hosts the Pastoralist Knowledge Hub (PKH). This platform is made up of, on one hand, pastoralist alliances and networks that wish to join global policy dialogues and share their knowledge and views, and, on the other hand, international partnerships to voice the pastoralist and share the technical knowledge they have gathered on pastoralism. The PKH has been developing a project that will focus on the elaboration of a tool to assess the contribution of pastoralism to biodiversity. Such a tool will allow to get pastoralism-specific and disaggregated data on the contribution of pastoralism to biodiversity.

**4:30pm - 4:45pm**

## How Pastoralists Nurture Biodiversity

**Ilse Köhler-Rollefson**
League for Pastoral Peoples; ilse.koehlerroll@googlemail.com

By its nature, pastoralism supports and nurtures biodiversity at many different levels and scales. Pastoralism is the only way of systematic food production that does not replace native vegetation with crops, usually mono-crops. Pastoralist herds transport seeds over long distances. They directly deposit manure on fields where it feeds micro-organisms in the soil. Pastoralist food production does not require herbicides and insecticides, thereby avoiding damage to bees and other pollinators, including butterflies and moths. Moreover, the droppings of grazing animals act as incubator for a huge diversity of insects that are at the basis of the food chain and feed populations of insectivorous birds, bats and reptiles. Pastoralist livestock is the main source of prey for large carnivores in many protected areas in India. Last but not least, pastoralists are creators plus guardians of the

livestock breeds that are best adapted to remain productive during climate challenges. But pastoralists are squeezed out almost everywhere. Therefore, one of the most important actions humanity can take to adapt to climate change is to ensure that pastoralism remains a part of the landscape by protecting migration routes and key grazing areas. This paper will summarize some of the recent scientific research and insights into the connection between pastoralism and biodiversity.

**4:45pm - 5:00pm**

### Yaks In The High Asia Region: Triggering Biodiversity By Traditional Pastoral Practices

**Santiago Jose Carralero Benitez**
YURTA Association, Spain; sancarnomad@gmail.com

**This paper discusses the function of yak herding practices on keeping biodiversity in the crucial environment and region of High Asia, and how this type of pastoralism is even able to increase biodiversity when is operated in a traditional way by their genuine indigenous breeders and keepers.**

Located in the very heart of the Greater Central Asia area, High Asia is probably the most crucial region on Earth in environmental terms. There is found the World´s greatest concentration of high mountains and plateaus, as well as that of glaciers and icefields out of polar regions.

Considered as a transboundary eco-cultural region, all the human communities of High Asia have something in common, no matter if they are of the Mongol, Turkic or Tibetan stock or they profess Buddism or Islam. All of them somehow depend on the same animal species for surviving, which is a true symbol of High Asia and a key piece for the High Asia biodiversity conservation: the yak.

The Pastoralism Knowledge Hub is an excellent FAO initiative on supporting pastoralism and coordinating pastoral networks around the World. In 2016, it propitiated the concreteness of the proposal of creating a World Yak Herders Association, inspired in the already existing World Reindeer Herders Association. The project has also served to take the pulse of High Asia´s health through dialogue with pastoralists and key related actors. This first step for establishing the WYHA was so-called “Community Dialogues in High Asia”, implemented through an eminently anthropological approach based on intensive and diversified fieldwork oriented in three directions:

1. Formal dialogue with institutions
2. Informal dialogue with pastoralists
3. Representational dialogue in the form of workshops integrating pastoralists and facilitators

The outputs of these dialogues, summarized as the results of the WYHA project (Phase 1), proved to be very illuminating findings.

In summary, the WYHA project demonstrated at this first stage that biodiversity conservation is not only compatible with development, but it is precisely the only way by which humans, animals and nature can walk together for mutual benefit.

**5:00pm - 5:15pm**

### Ecosystem Management from a Pastoralist perspective: Case of Localized Frameworks by Cross border Pastoralists

**Pius Loupa**
Dynamic Agro-pastoralist Development Organisation (DADO), Uganda, Global Youth for Biodiversity Network (GYBN) Uganda, Fikia Beyond Borders (FBB), Ateker Cultural Center Karamoja (ACCK); daahman89@gmail.com

This abstract aims to discuss **the ecosystem management from a pastoralist perspective in Karamoja cluster.** Pastoralism is a livestock production system that is dependent on ecosystem and contributes towards supporting and enhancing ecosystem services such as pasture for livestock and wildlife, watershed protection, forage, shelter from sun and wind, biodiversity (fauna and flora), carbon sink, wild fruits, herbal medicines, and vegetables.

In Karamoja livestock is a source of social prestige, livelihood and important in cementing social ties through marriages. The age-old stories and knowledge on nature, animals, mountains, social taboos and society form a significant basis for ecosystem stewardship and protection. The strong attachment to livestock is key to managing rangelands eco-systems. “*No shepherd would destroy were the herd feast from”.*

Karamoja is immensely rich in biodiversity. Its biodiversity cuts across dry and wet ecosystem space this include; Agro-pastoral, Pastoral and Agricultural ecological zones. The zones provide a habitat to a diversity of indigenous trees, fauna, domestic animals. These zones provide dry and wet season grazing areas. The biomes extend from wetland pots to dryland forests and grasses (mountain and savannah cover in rangelands).

The rich biodiversity is coming under pressure; due to conversion of dry season mobility routes and grazing areas into large agricultural crop lands (coffee, cotton, maize), mineral extraction along the communal cross-borders areas, charcoal production, climate variability, indiscriminate opening up of protected areas boundaries, non-native plants, negative perceptions on pastoralism, limited investments to pastoralists areas and poor policy environment.

In this regard, pastoralists have developed local strategies such as ***localised natural resource sharing agreements*** with their immediate cross-borders neighbours to ensure protection of diverse shared natural ecosystems as number one priority. Pastoralist utilize several eco-zones, following both water and pastures while leaving other areas furrow to regenerate. The processes involved stakeholders mapping, consultative meetings, dialogues and participatory group discussions to identify rangeland ecology, social services, livestock mobility routes and grazing areas.

It was important to recognise the values, and contribution of pastoralists into biodiversity management by supporting local institutions (grassroots traditional governance structures) and frameworks by indigenous pastoralist organisations on dryland ecosystem management is critical.

**5:15pm - 5:30pm**

### Biodiversity makes shepherds of the Italian Alps landscape ambassadors

**Luca Battaglini, Dino Genovese, Martina Zucaro**
DISAFA - University of Torino, Italy; luca.battaglini@unito.it

In the NW Italian Alps, pastoral systems represent examples of resilience and adaptation necessary to maintain and recover grazing lands. Traditional shepherds are aware they represent a defense of biodiversity through their own livestock practices. Thanks to their presence and territory knowledge, they represent ambassadors of biodiversity. The ecosystem approach, from the autochthonous breeds to the local knowledge practices, has to accompany the transfer and diffusion of innovations and demonstration actions, as well as education projects. In this way, pastoralism and relevant landscapes will have a stronger connotation within the political and socio-cultural context.

**5:30pm - 5:45pm Warning: The presentations finish prior to the end of the session!**

## Transhumance in the Face of Climate Change and for the Conservation of Biodiversity

**Jesús Garzón**
Trashumancia y Naturaleza, Spain; pastores.sinfronteras@pastos.es

The millenary transhumance – with large herds of cattle traversing Spain each spring toward the northern mountains, to return in the autumn to the southern pastures – is considered by most modern technicians and specialists as an anachronistic activity, condemned to a rapid and desirable disappearance. However, the current environmental and social problems that affect our planet (increasingly super populated and threatened by global warming) make Spanish transhumance gain special relevance, as an example of sustainable use and adaptation to confront the great challenges that will affect humanity during the next decades: detecting water and food for 9,000 million people, without further degrading natural resources and soil fertility; conserving biodiversity and traditional cultures; reducing greenhouse gas emissions; mitigating and adapting to climate change and rising sea levels, which will flood many of the most productive and populated regions on the planet.

By being able to adapt immediately to changing climatic conditions, transhumant herds can avoid adverse situations, by having a unique livestock infrastructure in the world: the national transhumance corridors, with more than 125,000 km in length and 400,000 Ha of surface, which connect all the regions of the country. Nonetheless, their functionality as ecological corridors requires that they be grazed and fertilized regularly by cattle. Every thousand sheep or every one hundred cows contribute daily to the land they pass by through more than three tons of manure with about five million seeds, of which more than 30% will germinate later. Therefore, during a traditional month- and 500 km-long transhumance, by grazing the grasses and scrubbing the bushes, each herd fertilizes the corridors with more than one hundred tons of fertilizer and two hundred million seeds, which are transferred for tens of kilometers from valleys and hillsides to peaks and plateaus, thus facilitating that the plants, and the animal species that depend on them, can adapt and survive the new climatic conditions.

# 181S: Global Consequences of past and future biodiversity loss

*Time:* Thursday, 27/Feb/2020: 4:15pm - 6:15pm · *Location:* Sertig
*Session Chair:* Forest Isbell, University of Minnesota, United States of America

Biodiversity loss is eroding benefits that people obtain from natural and managed ecosystems. In particular, biodiversity loss threatens several ecosystem services that depend on plant productivity, including wood production, forage and livestock production, crop yield, pollination, and climate regulation.

It remains difficult, however, to predict the extent to which human-driven changes in biodiversity will alter plant productivity or related ecosystem services, especially at the larger spatial and longer temporal scales that are most relevant to policy and conservation.

The current literature includes very few global estimates of changes in plant productivity or related ecosystem services in response to past or projected future changes in biodiversity.For lack of better information, most current ecosystem service models implicitly assume that remaining fragments of nature will indefinitely continue to provide the same level of benefits to people, even if they are expected to lose much of their biodiversity in the future. In other words, most projections of future ecosystem service values do not yet account for the depreciation of natural capital that is expected to result from biodiversity loss. New multiscale knowledge is beginning to allow quantification of the cascading effects of human activities on ecosystem services via their effects on biodiversity. In this session, speakers will provide bounded quantitative estimates for the global consequences of past and projected future biodiversity loss for plant productivity and several related ecosystem services. Major sources of uncertainty and future research priorities will be identified. A series of talks will be followed by a panel discussion. The aim of this session is to quantitatively explore how some of the many values of nature depend not only on the quantity of remaining nature, such as the extent of protected areas, but also on the quality (i.e., biodiversity) of natural and managed ecosystems.

**4:15pm - 4:35pm**

## Consequences of Global Biodiversity Loss for Ecosystem Functioning and Services

**Forest Isbell**
University of Minnesota, United States of America; isbell@umn.edu

Biodiversity loss is eroding benefits that people obtain from natural and managed ecosystems. In particular, biodiversity loss threatens several ecosystem services that depend on plant productivity, including wood production, forage and livestock production, crop yield, pollination, and climate regulation. It remains difficult, however, to predict the extent to which human-driven changes in biodiversity will alter plant productivity or related ecosystem services, especially at the larger spatial and longer temporal scales that are most relevant to policy and conservation. Indeed, the current literature includes very few global estimates of changes in plant productivity or related ecosystem services in response to past or projected future changes in biodiversity. For lack of better information, most current ecosystem service models implicitly assume that remaining fragments of nature will indefinitely continue to provide the same level of benefits to people, even if they are expected to lose much of their biodiversity in the future. In other words, most projections of future ecosystem service values do not yet account for the depreciation of natural capital that is expected to result from biodiversity loss. In this talk, I will highlight some of the multiscale knowledge that is beginning to allow quantification of the cascading effects of human activities on ecosystem services via their effects on biodiversity. I will also present the results of a new survey of expert estimates for some of these relationships.

**4:35pm - 4:50pm**

## Quantifying The Role Of Rare Species And Their Contribution To Uncertainty In Biodiversity-Ecosystem Services Estimation

**Rachael Winfree, James Reilly**
Rutgers University, United States of America; rwinfree@rutgers.edu

Methods for measuring biodiversity and its contribution to ecosystem services at large scales of space and time have seen rapid development during the past decade. One important issue for predicting how species loss will impact ecosystem services in nature is that natural communities invariably have a small number of common species and a large number of rare species. Thus, much of biodiversity consists of rare species, the measurement of which entails high uncertainty simply for statistical reasons. The importance of rare species to biodiversity-ecosystem services predictions is compounded when larger spatial and temporal scales are considered, because rare species are more likely to turn over in space and time. They can therefore drive the increase, with increasing scale, in the number of species needed to provide the ecosystem service. Here we use three regional-scale data sets we collected on the crop pollination services provided by wild pollinator species in the eastern USA to demonstrate several approaches to quantifying the role of rare species, and to explore how this issue contributes to the uncertainty of the overall predictions about how biodiversity loss will affect service provision.

**4:50pm - 5:05pm**

## Crop Diversity Stabilizes National Food Production

**Delphine Renard[1,2], David Tilman[2,3]**
[1]Centre d'Ecologie Fonctionnelle et Evolutive, CNRS, Montpellier, France; [2]Bren School of Environmental Science and Management, University of California Santa Barbara, Santa Barbara, CA, USA; [3]Department of Ecology, Evolution and Behavior, University of Minnesota, St Paul, MN, USA; delphinerenard@hotmail.fr

Increasing global food demand, low grain reserves and climate change threaten the stability of food systems on national to global scales. Different types of policies could increase the stability of food production and lessen spikes in food prices, including international trade, expansion of irrigation and development of new crop varieties. We evaluate a complementary strategy: that growing a more diverse suite of crop species and/or crop groups within nations might increase the year-to-year stability of national total annual harvest. We term this the crop diversity–stability hypothesis.

We use a multi-decadal, global dataset (FAO yield data on 176 crops, across 91 nations, from 1961 to 2010) to test this crop diversity–stability hypothesis. We quantified crop production stability as mean production per hectare over its standard deviation (SD) for 10-year periods, and calculated crop diversity as the exponential of the Shannon index. We used linear regression models to test the diversity-stability relationship whilst controlling for agronomic (fertilizer, irrigation), climatic and demographic/social variables (warfare, political instability).

We first show that greater stability reflects markedly lower frequencies of years with sharp harvest losses. Then, we found that

stability of national crop production increased strongly with crop species and group diversity. Crop diversity stabilized national yield by decreasing its year-to-year fluctuations through a mathematical “portfolio” effect. Finally, we found that the stabilizing effect of crop diversity is similar in magnitude to the observed destabilizing effects of inter-annual precipitation variability. Increasing crop diversity could thus buffer the negative effect of climatic variability.

Ensuring stable food supplies is a challenge that will probably require multiple solutions. Our results suggest that increasing national effective crop diversity merits deeper exploration and consideration as an additional, but currently overlooked, way to stabilize national food supplies and reduce the risk of crop failures.

**5:05pm - 5:20pm**

### Global Socio-Ecological Consequences Of Tree Diversity Loss on Ecosystem Functioning

**Akira S Mori**

Yokohama National University, Japan; akira.s.mori@gmail.com

The ongoing climate change and biodiversity crises are the major challenges in this era of global change. Although the tight linkages between them have been increasingly recognized, a vast majority of attention has been paid to the unidirectional relationships; that is, climate change as a cause and biodiversity loss as a consequence. Climate change has been identified as one of the primary drivers of biodiversity loss, and is projected to become increasingly dominant as a direct driver and an indirect driver that can accelerate the crisis. At the same time, there is an increasing recognition and awareness for better managing and restoring natural ecosystems, such as forests, to face with many issues resulting from the ongoing climate change. However, there is, to data, a limited understanding of the roles of biodiversity living therein, despite their ability to store carbon for climate change mitigation. Note that, given the recognized social cost of carbon, such potentials of biodiversity for climate change mitigation may be non-negligible not only evcologically but also economically. Here, based on several empirical and theoretical works, I emphasize that biodiversity changes cannot be solely viewed as a response to human influences, such as climate change, but could also be a non-negligible driver of future changes in biogeochemical cycles and climate feedbacks on Earth.

**5:20pm - 5:35pm**

### Mapping Global Forest Biodiversity, Productivity, and Their interaction

**Jingjing Liang[1], Gfbi Gfbi[2], Mo Zhou[1]**

[1]Purdue University, United States of America; [2]Global Forest Biodiversity Initiative; jjliang@purdue.edu

The biodiversity–productivity relationship (BPR) is foundational to our understanding of the global extinction crisis and its impacts on ecosystem functioning. Both global patterns of tree species diversity and forest productivity remain largely unquantified despite their long-recognized importance to the understanding and conservation of biodiversity and forest ecosystem services. Here, we compiled trillions of tree-level records from millions of global forest inventory plots to quantify, on a per-hectare basis, tree species richness (*S*) and evenness (*E*) at the global scale, as well as forest productivity in terms of mean annual increment of timber volume. Our machine-learning analysis revealed distinct and largely contrasting global patterns, and strong bioclimatic and anthropogenic drivers of *S* and *E,* as well as a profound relationship between S and productivity.

**5:35pm - 5:50pm Warning: The presentations finish prior to the end of the session!**

### Animal Diversity Increases Complementarity in Plant Diversity-Productivity Relationships Regardless of Resource Partitioning

**Georg Albert[1,2], Shaopeng Wang[3], Ulrich Brose[1,2]**

[1]EcoNetLab, German Centre for Integrative Biodiversity Research (iDiv), Germany; [2]Institute of Biodiversity, Friedrich Schiller University Jena, Germany; [3]Department of Ecology, College of Urban and Environmental Science, and Key Laboratory for Earth Surface Processes of the Ministry of Education, Peking University, China; georg.albert@idiv.de

Over the last decades, ecosystem functioning has emerged as one of the central topics of ecological research. Nevertheless and despite recent advances, mechanisms underlying the generally accepted positive relationship between biodiversity and primary production in natural systems remain poorly understood. This is especially true when taking differences between trophic levels as well as their interactions into account. Dynamic simulations of food webs enable us to precisely manipulate ecosystems beyond the limits of real world systems. In doing so, we show that increasing animal diversity amplifies plant diversity-productivity relationships by increasing niche complementarity. This holds true independently of the level of resource partitioning between plants and emphasizes the crucial role animal diversity plays in shaping such relationships. Furthermore, we highlight the importance animals play in maintaining ecosystem functioning and the pressing need to incorporate them into biodiversity-ecosystem functioning research in order to disentangle causes of complementarity and consequently understand the driving mechanisms of ecosystems.

# 146S-2: Nature-based solutions for for adapting and mitigating climate change

*Time:* Thursday, 27/Feb/2020: 4:15pm - 6:15pm · *Location:* Schwarzhorn
*Session Chair:* Nadia Castro, University of Zurich, Switzerland
*Session Chair:* Veruska Muccione, University of Zurich, Switzerland
*Session Chair:* Cornelia Krug, Universität Zürich, Switzerland
*Session Chair:* Maria Santos, University of Zurich, Switzerland
*Session Chair:* Christian Huggel, University of Zurich, Switzerland

Climate change and the loss of biodiversity are issues that affect each other. Nature is declining globally, and climate change is amongst the five direct drivers of loss in biodiversity. Biodiversity loss cripples our ability to adapt to climate change and affects many other earth system processes and ecosystem services. More diverse ecosystems can store more carbon than monocultures, are more resilient and can cope better with droughts, floods and pests. It is essential that the climate crisis and biodiversity loss are addressed together. However, climate change has received far more attention than the biodiversity crisis. Moreover, certain mitigation and adaptation responses to climate change pose risks to biodiversity and ecosystem services. For example, afforestation efforts for carbon sequestration may promote the establishment of monoculture plantations at the expense of diverse grasslands.

In this context, nature-based solutions (NbS) are a promising approach to simultaneously address climate change and biodiversity loss. NbS are actions to sustainably manage and use nature to tackle societal challenges, including climate change, while providing human well-being and biodiversity benefits. However, evidence on the effectiveness of NbS is still lacking and some questions remain open. What are the limits and trade-offs between biodiversity and climate change mitigation and adaptation actions? Do NbS work under different climate scenarios and different biodiversity assemblies? How do we involve stakeholders to promote the NbS social acceptance? Are NbS economically feasible?

This session will bring together biodiversity and climate change academics, practitioners, policy-makers and business leaders to discuss the current state of NbS and their potential to simultaneously address climate change and biodiversity loss. Our aim is to promote collaboration and exchange between the climate change and biodiversity research community to identify knowledge gaps and to set a research agenda on NbS as one of the options to mitigate and adapt simultaneously for climate changes and biodiversity losses.

**4:15pm - 4:22pm**

## The Importance Of Nature-based Solutions For People, The Planet And Prosperity

**Nikolett Puskas**
University College London, United Kingdom; niki.puskas@gmail.com

The loss of biodiversity is happening on a global scale at increasingly alarming rates. Yet, climate change receives more mainstream attention, perhaps because it reached a state of tangibility via unforeseen natural disasters. This in turn gave rise on the agenda to resilience studies, developing resilience strategies for cities and regions. Core elements of resilience are preserving (bio)diversity, employing ecosystem services and nature-based solutions (NbS). Climate change contributes to the loss of biodiversity and ecosystem services, thus weakens our adaptive and resilient capacities. Furthermore, nature is crucial for human physical and mental wellbeing. All of this should be recognised wider and our approach to tackling this complex issue must be one that is holistic, employs systems thinking and acknowledges our interconnectedness on multiple levels as well as urges for collaboration between multiple stakeholders: from scientists through practitioners, governments to private businesses, the third sector and people.

NbS hold great potential, which needs to be explored in empirical ways, ideally via a 4P model. It needs to be implemented in multiple scales and tailored to local microclimatic conditions, whilst also considering cultural contexts and employing (thus preserving) indigenous knowledge. We should promote and facilitate knowledge exchange across stakeholders, education on NbS and involve them in projects from the early stages to collaborate, creating a sense of shared ownership and responsibility. NbS are economically feasible, on the larger scale via a 4P financing model and on the micro scale via low-cost and build-it-yourself solutions (one of the inherent qualities of NbS itself).

I would like to demonstrate the above via a case study, conducted as part of my PhD research. We need to generate more case studies, focusing on transformative processes to create pathways to a prosperous future.

**4:22pm - 4:34pm**

## How to increase Uptake of Nature-based Solutions in Actions on Climate Change

**Cordula Epple**
UNEP WCMC, United Kingdom; Cordula.Epple@unep-wcmc.org

Recent scientific literature has highlighted the importance of nature-based solutions for reaching targets on climate change mitigation, as exemplified by the findings of the 2019 IPBES Global Assessment report. The potential of nature-based solutions to help societies adapt to the unavoidable impacts of climate change is also increasingly being documented, and has triggered investment in studies, pilot projects and pioneering programmes for Ecosystem-based Adaptation (EbA). Policy processes in the areas of Biodiversity and Climate Change have turned their attention to the possible benefits of managing nature to increase carbon storage and climate resilience, with a number of key documents agreed in 2019. Nevertheless, the practical implementation of nature-based solutions to address the climate crisis is still lagging behind that of other, often more technology-based approaches. This presentation will discuss some of the findings from UNEP-WCMC's recent work to identify barriers and enabling factors for EbA, and also illustrate some of the practical challenges that can arise once a decision to apply nature-based solutions has been reached (such as setting clear and realistic targets, identifying appropriate data sources for planning and monitoring, engaging all relevant stakeholders and applying social and environmental safeguards).

**4:34pm - 4:46pm**

## Applying Circular Economy Principles In Forest Landscape Restoration (FLR) To Design Out Deforestation In Brazilian Biomes

**Adriana Marchiori Silva**
Wuppertal Institute for Climate, Environment and Energy; marchiori.silva@gmail.com

Until 20 years ago, the Amazon Rainforest performed an important environmental service of retaining $CO_2$. Nowadays the forest with a high probability to turn into a degraded savannah if the deforestation rate exceeds 25% of its original area. Brazil is the

deforestation leader, due to the deforestation-linked commodities, which are also affecting other biomes. On the other hand, there are massive land restoration opportunities, which are at the heart of natural-based solutions to boost cost-effective $CO_2$ mitigation.

This climate mitigation potential of forests is higher than generally understood, and not reflected well in the NDCs under the Paris Agreement. The objective of this research is to propose a novel approach to forest restoration economy, a vision underpinned by circular economy principles, to halt deforestation in all Brazilian biomes. In order to offer a disruptive alternative to the historical pathways and the deforestation vicious cycle, the study suggests an integrative framework to move from a linear model for ecosystem degradation and habitat conversions to a circular model for ecosystems restoration, enabling a long-term value creation through inclusive bioeconomy, once the most affected stakeholders in the value chain – local communities – have to be included in the solution design. The research focus is the upstream activities, bringing the links in the value chain closer together in order to achieve an effective upward and downward traceability. Additionally, a deep-dive analysis of the effectiveness and mitigation potential of the promised restoration at a country level and companies deforestation pledges have significance for the main output of the study: a roadmap for private and public sector to promote value chain collaborations, contributing to the post-2020 progress. These findings highlight that circularity can be an adaptation and a governance tool to secure the resilient of forests and its environmental services as well to address deforestation-free commodity supply chains, thriving communities.

**4:46pm - 4:58pm**

### The Insurance Value Of Forest Ecosystems – A Stated Choice Study

**Christian Unterberger, Roland Olschewski**

Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Switzerland; christian.unterberger@wsl.ch

Forests provide several ecosystem services, including the mitigation of climate change and the protection against natural hazards. By preventing soil erosion and functioning as natural barriers and buffers, forests protect the population and infrastructure against avalanches and rock fall. The higher an ecosystem's capacity to regulate and withstand adverse effects, such as climate change, natural hazards and other external disturbances, the higher its potential to provide natural insurance services to the population. To operationalize the insurance value approach and to integrate it to climate change adaptation and disaster risk management, information about the supply and the demand of this ecosystem service is required. While assessing the capacity of forests to provide protection services has been a research focus for quite some time, knowledge about the population's demand for the insurance services provided by forests is still lacking. Thus, our study aims at determining the preferences of the beneficiaries of such services. We conducted a choice experiment in several Swiss municipalities exposed to avalanche and rock fall risk taking different spatial and institutional contexts into account. The design of the experiment allows us to estimate the households' willingness to pay for forest management measures that improve forests' protection capacity. Our analysis shows that households are willing to pay a significant amount of money to enhance insurance services of forests. The results can be used to inform decision making in natural hazard management, and represent a further step towards operationalizing the insurance value of ecosystems.

**4:58pm - 5:10pm Warning: The presentations finish prior to the end of the session!**

### Nature-based Solutions and the Role of Insurance – the Example of Coral Reef Insurance

**Oliver Schelske, Jeffrey R. Bohn**

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Insurance, properly designed, distributed, and managed builds financial resiliency into our society. Hereby, it contributes to sustainable development and safety. In the past 160 years, the insurance industry has developed robust financial protection products that have accomplished the goal of making the world more resilient. This said, the gap between what is protected and what could be protected continues to widen. A key natural ecosystem where we see a large insurance protection gap is coral reefs.

Coral reefs provide substantial economic value—particularly to coastal regions—in the form of coastal protection, tourism, fisheries, and biodiversity. Unfortunately, a confluence of factors such as climate change and pollution have weakened these important ecosystems. Major storms sometimes destroy reefs or diminish the services they provide. Insurance can play a role in protecting these important natural ecosystems by generating incentives to invest more in maintenance and conservation. The key is to develop approaches such as parametric insurance. Even with parametric insurance contracts, matching insurance buyers such as business owners & governments and insurance sellers such as insurance & reinsurance companies can be difficult when a new asset is addressed. Risk identification, risk assessment, pricing, and claims processing may not be reconciled among stakeholders in the context of new asset types where little data are available for risk analyses. Governments and non-profit organizations can serve as catalysts for development of new insurance markets. Technologies such as satellite imaging or GPS support the possibility of realizing the promise of insurance contracts. Coral reef insurance is an example resulting from these recent technology & market developments.

One case study showing the promise for insuring coral reefs comes from Mexico where Swiss Re and the Nature Conservancy worked with a Mexican insurance company to sell parametric insurance to cover coral reefs along the coastline of the Mexican state of Quintana Roo. This new contract demonstrates how insurance can be put in place to cover a valuable coral reef. Continued development of new technologies and a growing awareness of how insurance can materially improve a coral reef's resilience will likely lead to more coral reef insurance contracts in the future.

# 165S-2: Drivers of success and failures in conservation management

*Time:* Thursday, 27/Feb/2020: 4:15pm - 6:15pm · *Location:* Seehorn
*Session Chair:* Jutta Beher, University of Melbourne, Australia

Despite increasing time, effort, and investments into conservation research and actions across the globe, biodiversity gets lost at accelerating speed. We have to increase our impact quickly, but to do so have to understand the drivers of successes and failures of the projects that are currently implemented.

Are there underlying big commonalities on a national or even global scale that need to be addressed, such as failing environmental laws in many countries as it for example Australia, where many industrial projects go ahead despite the destruction of last remaining habitats for threatened species, or Brazil and the US, where the recent government is removing "green tape" at concerning speed, and how do these relate to the unique set of challenges regarding effectiveness and feasibility that every project has to face at the local scale? Are conservation actions that aim for the local protection of a small fraction of remaining populations doomed to result in a likely end through disturbance events like disease, wildfire or climate change? As much of environmental destruction is driven by consumer-demand-driven industry, a interdisciplinary discussion between policy, financial, law and technical sides of management actions is needed to share current strategies and insights.

**4:15pm - 4:30pm**

## Concept and Ecological Potential of Eh da-Areas

**Robert Künast[1], Mark Deubert[1], Christoph Künast[2], Matthias Trapp[1]**
[1]RLP Agroscience Neustadt, Germany; [2]E-SyCon; Robert.kuenast@web.de

„Eh da“ is a Southern German idiom meaning „available anyway“. A direct translation of the term Eh da area is under ecological perspectices „ecological habitat development area“. Acordingly, it means the total sum of land along traffic ways, dams, railway embankments and different kinds of municipial spaces. This kind of land is almost everywhere visible, but it is largely underestimated under ecological perspectives. A geodata analysis in different German landscapes showed that 2-6 % (there is high regional variability) of cultural landscapes can be categorized under the term „eh da area“.

Many of eh da-areas are longitudinal, some are more compact, and together they form a network which crosses through cultural landscapes. Given the increasing demand for agricultural land, housing development and nature conservation European societies would be well-advised to pay more attention to eh da areas. Since they are mostly longitudinal, ecological upgrading can be conducted both in terms of isolated plots and in the context of biotope connectivity. Eh da areas form often corridors which can be used for migratory animals and for gene flow between isolated populations of animals and plants. Monitoring data show that the concept of ecological upgrading can result in increasing biodiversity.

Currenty, about 30 German communities conduct eh da-projects. These projects have in common that geodata analyses provide maps for local decision makers which allow the specification of plots and measures in the landscape. Communication plays a key role to enhance the motivation of citizens in order to modify eh da-land for increasing biodiversity.

**4:45pm - 5:00pm**

## The Compatibility of Conservation and Urban Planning Goals: Can Living Conditions for Both Biodiversity and Humans be Optimised?

**Maarten J. van Strien, Amin Khiali-Miab, Adrienne Grêt-Regamey**
Institute for Spatial and Landscape Development, ETH Zurich, Switzerland; vanstrien@ethz.ch

A wide variety of regional planning goals exists, but little is known about their compatibility after implementation. For example, given the dependency of species on well-connected habitat networks, a possible conservation-planning goal is to maximise habitat availability (i.e. the total amount of habitat that is accessible for an animal species). Furthermore, compared to a single urban centre in a region, socio-economic conditions tend to improve with multiple urban centres (i.e. polycentricity), which also has its effect on the configuration of settlement networks (i.e. settlements connected by roads and traffic). However, alterations to any part of a settlement network can trigger a range of, often unforeseen, changes in habitat networks. Therefore, it is unclear whether maximising polycentricity and habitat availability are compatible planning goals. To address this question we developed a model of interacting habitat and settlement networks in a region of Switzerland. With our settlement network model, commuter and traffic flows were calculated from the distribution of jobs and people across the municipalities in our study region. The hierarchy of the commuter flow network was used as an indicator of the level of polycentricity. The traffic flows were used in the habitat network model to calculate the mean habitat availability. We used multi-objective optimisations to maximise both polycentricity and habitat availability by changing the distributions of jobs and people. We found that both goals could be improved compared to the current situation, but that there were trade-offs between these goals along the Pareto-front. To reach optimal conditions, most changes to the distribution of jobs and people would have to take place in mid-sized municipalities. Our results increase the understanding of the complex interactions in coupled settlement and habitat networks and lead to recommendations of policy targets that aim to develop optimal landscapes for both biodiversity and humans.

**5:00pm - 5:15pm**

## Communicating Conservation: The Impact of Visual Message Frames on the Decision to Adopt an Invasive Species Initiative in New Zealand.

**Tara Lal**
Imperial College London, United Kingdom; tara.lal16@imperial.ac.uk

Changing behaviour or encouraging pro-environmental behaviour is a goal for many governments and non-government organisations and framing messages strategically can be a useful tool in achieving that goal. While images are regularly used in biodiversity conservation campaigns, there is a gap in the research when it comes to testing the effect visual frames produce on different audience segments.The case study examined for this research is a national level project with the long term goal of eradicating mammalian predators from all the islands of New Zealand. The ultimate goal of this project, known as the ‘Predator free New Zealand’ goal, is to protect and encourage native fauna and flora which is in decline due to the impact of introduced predators. In this project, I will segment the general public of New Zealand into groups based on their engagement with conservation issues. I will run an experiment to test the impact of visual frames of loss and gain on the decision to adopt the initiative. This will be followed by a more in-depth qualitative analysis of the impact of particular images on audience segments. Images have the potential to be influential in changing behaviours and a systematic examination of their impact can be a useful tool for conservation organisations to plan effective communication campaigns.

**5:15pm - 5:30pm**

## Solutions for an Integrated Landscape Management based on Land Owners‘ Perspective: A Case of Study of the São João River Basin, Brazil

**Agnieszka Ewa Latawiec[1,2,3,4], Bernardo Strassburg[1,2,5,6], Helena Alves-Pinto[2,5], Veronica Maioli[2], Lara Monteiro[2], Isabelle Pepe[1,2], Thiago Barbosa[2], Fernanda Gomes[2], Ingrid Pena[1,2], Fernanda Tubenchlak[2], Nina Pougy[2], Maiara Mendes[2], Adriano Tamm[1,2], Yuri de Carvalho[1,2], Nathalia Dreyer[2], Maria Vitória Palhares[1,2], Camila Pimentel[6]**

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The Environmental Protection Area (APA) of São João River Basin is located in the Atlantic Forest of Rio de Janeiro State. APAs are protected areas for sustainable use, that allow a certain degree of human occupation for public and private areas, whose basic goals are to protect biological diversity, organize the occupation process and ensure sustainable use of natural resources. Approximately 30% of APA São João is occupied by degraded pastures. The region has a highly fragmented landscape due to historical land use such as coffee plantations, agricultural and cattle ranching activities and the construction of infrastructure. We performed focus groups with different dynamics with 100 APA landowners to characterize the landscape from their perception of the land uses and economic activities. The groups were asked to assess their level of satisfaction with the landscape, what are the positive and negative environmental impacts and about their perception about solutions to increase water availability and soil quality. The main activities identified were beef cattle raising (28), dairy cattle raising (21), agroforestry (21), manioc crops (18) and organic farming (16). Most positive impacts were the presence of Golden Lion Tamarin (endemic and endangered species of the Atlantic Forest) (41), wildlife sighting (21), springs (13) and fertile soil (12). Negative impacts of the land use were sedimentation of the river (20), poor soil quality (17), floods (16) and pests and diseases (15). Regarding solutions, participants pointed farmers organization in associations and cooperatives and training. Improvement of sanitation and public infrastructure, alternatives to ensure youthful stay in the countryside and economic incentives for agrotourism and equipment purchases were also reported. We stress that mainly small and medium land owners participated, while the large ones (mainly responsible for beef cattle) did not. The data collected are guiding us towards planning the next actions, which we will present here.

**5:30pm - 5:45pm Warning: The presentations finish prior to the end of the session!**

## A Strategic Approach to Restoration Planning

**Bernardo Strassburg[1,2,3,4], Alvaro Iribarrem[1,2], Hawthorne Beyer[5], Carlos Leandro Cordeiro[1,2], Renato Crouzeilles[1,2,3], Catarina Jakovac[1,2,6], André Junqueira[1,2,7], Eduardo Lacerda[1,2,8], Agnieszka Latawiec[1,2,9,10], Andrew Balmford[11], Thomas Brooks[12,13,14], Stuart Butchart[11,15], Robin Chazdon[16,17,18], Karl-Heinz Erb[19], Pedro Brancalion[20], Graeme Buchanan[21], David Cooper[22], Sandra Diaz[23], Paul Donald[11,15,21], Valerie Kapos[24], David Leclere[25], Lera Miles[24], Michael Obersteiner[25], Christoph Plutzar[19,26], Carlos Alberto Scaramuzza[2], Fabio Scarano[3], Piero Visconti[25]**

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Extensive ecosystem restoration is increasingly seen as central to conserving biodiversity and stabilising the earth’s climate. Yet although ambitious national and global targets have been set, global priority areas for biodiversity conservation and restoration which account for variation in benefits and costs have yet to be identified. This work will show a multicriteria optimisation approach which reveals priority areas for restoration across all biomes and estimates their benefits and costs. We find that achieving current targets in priority areas would provide major contributions to climate change mitigation and biodiversity conservation, and that including multiple biomes is key to achieving multiple benefits. Cost-effectiveness can increase up to eightfold with optimised spatial allocations. Trade-offs between benefits and costs highlight the importance of multicriteria optimisation in revealing cost-effective solutions. Our results confirm the vast potential contributions of restoration to major global challenges while underscoring the necessity of pursuing the goals of the UN climate and biodiversity conventions synergistically. In Brazil, the potential for conservation, restoration and sustainable management of native remnants in private areas is huge. However, lack of integrated landscape planning capabilities hinders the dialogue among different stakeholders.

# 220S: Biodiversity in the Grisons - Threats and Opportunities in an alpine environment

*Time:* Thursday, 27/Feb/2020: 4:15pm - 6:15pm · *Location:* Wisshorn
*Session Chair:* Armando Lenz, Pro Natura GR, Switzerland

The Canton of the Grisons is the largest canton in Switzerland with a vast elevational range from 400 to over 3000 m.a.s.l. The diverse landscape culminated in a large biodiversity and species richness. However, biodiversity is threatened by economic activities as well as climate warming. The main economic activities are focused on tourism (over 70%), with two million tourists producing around 5 million overnight stays. Touristic activities are expanded, and more and more infrastructure is planned and built in ecologically sensitive regions. The second economic threat stems from forestry and agriculture, which tend towards an excessive mechanization with an increasing mobility and intensified production. Richness in landscapes and species is thus decreasing, especially with the additional pressure by climate warming, which leads e.g. to heat waves in the lowlands of the canton, to the potential of more frequent forest fires, and to more drought at all levels. Some of these threats on the one side may turn into opportunities on the other side. Glacier retreat in the high mountain regions as an example opens the potential for new habitats at the front end.

In this session we would like to discuss how biodiversity can be preserved and species' loss decelerated in an environment where nature gets under increased pressure by human activities, and what mitigation and adaptation strategies have to be developed to cope with the threats and opportunities due to climate change. The session addresses the threats and opportunities from different user and protection perspectives. A panel discussion tries to find ways for a more sustainable use of nature in tourism, agriculture, and forestry to strengthen biodiversity.

**4:15pm - 4:30pm**

## Which Laws and Instruments protect Biodiversity in the Grisons and Switzerland, and what is the Current State of Biodiversity in the Grisons.

**Luis Lietha**
Amt für Natur und Umwelt Graubünden, Switzerland; luis.lietha@anu.gr.ch

The purpose of the talk is to set the scene for the session. The first part should explain how biodiversity is protected, which stakeholders are involved, and instruments that are available for protection. The second part of the talk should give an overview of biodiversity in the Grisons. Is it declining as rapidly as elsewhere, or is the decline faster of slower, and if so, why?

**4:30pm - 4:45pm**

## Space Utilisation exerts Pressure on Nature, Environment and Biodiversity

**David Jenny**
Swiss Ornithological Institute, Switzerland; jenny.d@compunet.ch

The purpose of the talk is to showcase the claim for space for tourism, recreational activities,
mobility, agronomy, forestry, and energy in an alpine area, and how this need for space affects biodiversity, especially from the perspective of the avifauna. On the other hand, vast and remote areas within the central Alps still exist and underline the importance of efficient conservation efforts. Positive and negative examples form the Grisons will be presented.

**4:45pm - 5:00pm**

## Protection of Biodiversity – the Perspective of NGOs

**Regula Bollier**
WWF Graubünden, Switzerland; regula.bollier@wwf-gr.ch

What is the role of NGOs and the right of appeal of NGOs (Verbandsbeschwerderecht) in the protection of biodiversity. How large is the impact of NGOs. Where could NGOs advance protection of biodiversity, and how can NGOs help to improve biodiversity in the Grisons.

**5:00pm - 5:15pm**

## The Role of the Swiss National Park and Regional Parks in the Grisons in Protecting and Improving Biodiversity

**Sonja Wipf, Et Al.**
Swiss National Park, Switzerland; sonja.wipf@nationalpark.ch

What is the state of biodiversity in the national park? How can park projects help to improve
or protect biodiversity in the Grisons? What are current projects to protect and improve
biodiversity in the parks?

**5:15pm - 5:30pm**

## How Nature Reserves Help To Protect Biodiversity

**Andrea Haslinger**
Pro Natura, Switzerland; andrea.haslinger@pronatura.ch

Pro Natura is Switzerland's oldest nature conservation organization. Our work focusses on the preservation and promotion of natural diversity of animals, plants and habitats. One of our instruments to contribute to the protection of biodiversity are nature reserves – we oversee about 700 all over the country.

Together with our cantonal office in the Grisons, Pro Natura manages more than 90 protected areas of different categories, size and priority in the canton. To ensure the contribution of nature reserves to the protection of biodiversity, we define SMART goals per reserve. Given the existing data set on species and impacts from outside, the limited resources for the running maintenance and the small dimension of many reserves, this is a challenge. In addition, new dynamic elements like the effects of climate change become important. On our own property the options for preservation are manifold. But neither animals and plants nor habitats are steady.

To improve the effect of nature reserves on biodiversity it is necessary to strengthen the consideration of dynamic processes, the cooperation with research and the network of the protected areas.

**5:30pm - 5:45pm Warning: The presentations finish prior to the end of the session!**

## Endophyte Infection and Alkaloid Detection in European Seed Mixtures

**Katja Baerenfaller[1], Jochen Krauss[2], Veronika Vikuk[2], Carolyn A. Young[3], Markus Krischke[2], Martin J. Mueller[2]**

[1]Swiss Institute of Allergy and Asthma Research (SIAF), Switzerland; [2]University of Wuerzburg; [3]Noble Research Institute;
katja.baerenfaller@siaf.uzh.ch

Infection of cool season grass species with fungal endophytes can enhance resistance against drought and herbivores. Endophytes of the genus *Epichloë* have therefore been commercially used in grass seed mixtures, but they often produce vertebrate and insect toxic compounds that can lead to severe livestock intoxication and the mycotoxicoses ryegrass stagger, fescue toxicosis and drunken horse syndrome. Despite the toxicity of fungal alkaloids to grazing animals, European seed mixtures are rarely tested for *Epichloë* infections and their infection status is unknown for consumers. In this study we tested 24 commercially available seed mixtures for their infection rates with *Epichloë* endophytes and measured concentrations of the alkaloids ergovaline, lolitrem B, paxilline, and peramine. We detected *Epichloë* infections in six seed mixtures, and four contained vertebrate and insect toxic alkaloids typical for *Epichloë festucae* var. *lolii* infecting *Lolium perenne*. In typical European meadows, infected toxic grasses have so far been diluted by a high diversity of species and low infection frequencies, which might however change now with the use of species-poor seed mixtures and increased frequencies of hot and dry summers. Therefore, the results provided here must be a cause of concern, as these seed mixtures could potentially harm livestock when Epichloë infected grass seeds are further distributed within Europe.

# Plenary 8: Plenary Session 8

*Time:* Friday, 28/Feb/2020: 8:15am - 9:45am · *Location:* Davos (2/3)

## Benis Egoh, University of California Irvine

## Gary Varner, Texas A&M University

**The maximum number of 0 presentations has been exceeded! There are now 2 presentations in this session.**

### The Value of Ecosystem Services in Biodiversity Conservation: MA, IPBES and what next?

**Benis Egoh**
University of California Irvine, United States of America; begoh@uci.edu

Ecosystem service research has grown significantly in the past two decades gaining momentum immediately after the publication of the Millennium Ecosystem Assessment (MA). Expertise in this field has also grown exponentially with a vibrant community of experts such as the Ecosystem Services Partnership. In addition to building and growing expertise in the field, other success stories include the integration of ecosystem services in various policies around the world such as the Convention on Biological Diversity (CBD), the creation of the Intergovernmental Platform for Biodiversity and Ecosystem Services (IPBES) and the successful completion of various IPBES assessments. As the CBD prepares for its post-2020 framework and with the implementation of the IPBES assessments, it is time to take stock. In this presentation I will explore the following questions: Is the concept of “ecosystem service” still a worthwhile argument for biodiversity conservation? Are the current global targets adequate in securing biodiversity and human well-being? What gaps in implementation remain between the MA and IPBES? What types of targets will work for socio-ecological systems in different geographical regions?

### A Two-Level Utilitarian Perspective on “Compassionate Conservation”

**Gary Varner**
Texas A& M University, United States of America; g-varner@exchange.tamu.edu

The idea of “compassionate conservation” is receiving increasing attention in the field of conservation biology. In 2018, an essay by Wallach et al. was published in *Conservation Biology* with the title: “Summoning Compassion to Address the Challenges of Conservation,” and the August 2019 edition devoted a “Conservation Focus” section to six essays on the topic, all of them responding (to some extent) to that 2018 essay. In 2008, I myself published an essay in *Science and Engineering Ethics* arguing, from a utilitarian ethical perspective, that the Ecological Society of America should incorporate the virtue of compassion into its code of professional ethics. In this presentation, I will emphasize how the particular kind of utilitarianism that I endorse: the *two-level* utilitarianism of R.M. Hare, offers a new and—I think—insightful perspective on the controversy over compassionate conservation.

I will begin by reviewing the concept of “compassionate conservation,” which has been variously described as incorporating the ethical theories of utilitarianism, virtue theory, and/or rights theory. Conservation biologists have been generally critical of the call for compassionate conservation, in part for value-theoretic reasons: “compassion” operates only towards sentient beings, and the objects of primary concern to conservation biologists are species and ecosystems, neither of which are sentient (on the assumption that only individual organisms are sentient); and in part for practical reasons: they assume that placing a premium on compassion for individual animals will render conservation programs ineffective, because it would rule out various methods commonly used today, including (but not limited to) lethal control of exotics and overpopulated species.

I will then give an overview of Hare’s two-level utilitarianism, emphasizing the following: (1) the theory is ***far*** more nuanced than as presented in many discussions of utilitarian ethics, including in published discussions of compassionate conservation; (2) the theory incorporates elements of both virtue theory and rights views, but in a single moral theory for application in all aspects of life; and (3) it addresses some of the general objections to utilitarianism in traditional ethical theory.

Finally, I will describe some of the implications it may have for, in particular, the debate over compassionate conservation. These include the following: (1) various professions, including conservation biologists and ecologists, should include in their codes of professional ethics rules conducive to the cultivation of the virtue of compassion for sentient animals; however, (2) the theory may also imply that conservation biologists and others should cultivate a belief in the intrinsic value of endangered species and various threatened ecosystems, despite the fact that neither species nor ecosystems are sentient; and (3) that means that the implications of a two-level utilitarian conception of compassionate conservation may converge with those of conservation biologists who are currently most sharply critical of calls for an emphasis on compassion in conservation.

# 003GS-3: Biodiversity in the Anthropocene

*Time:* Friday, 28/Feb/2020: 10:15am - 12:15pm · *Location:* Dischma

**10:15am - 10:30am**

## "Sustaining Native Biodiversity In The Face Of Aquaculture, Climate Change, Anthropogenic Activities, And Non-Native Species"

**Kristine Idda Pontillas Del Rosario, Romeo Sumayo**
University of Nueva Caceres, Philippines; kipontillas@gmail.com

The Philippines is dubbed “Galapagos times ten” and “Second to Madagascar” due to its overwhelming biodiversity concerning the land area. In terms of plant diversity, the country is home to 15,000 species, where 8,120 are flowering plants. With the increasing rates of anthropogenic activities as well as natural disturbances, the country continues to face losses in its biodiversity resources. Aside from anthropogenic habitat alteration, climate change has been identified as one of the significant threats facing biodiversity worldwide. The Philippines is considered among the most vulnerable countries in Southeast Asia climatically, based on high exposure frequencies of droughts, cyclones, landslides, and floods. The destruction of forests and severe losses of biodiversity significantly affects the rural communities, as a large portion of the rural population depends on these resources for their livelihood. Lakes are also highly diverse ecological communities. Lakes and rivers only comprise 1% of the earth’s total area but are home to 10% of all animals and 35% of all vertebrates. Thus, the urgency to conduct primary research and related thrusts such as comprehensive plant inventories and cataloging is necessary, as it is attributed to the rapid habitat loss persisting in the country for years, and ultimately the sixth wave of mass extinction the world is currently facing. Biodiversity monitoring, assessment, and implementation are conducted to address these gaps in our knowledge in the Philippine biodiversity. Results show positive effects of establishing an arboretum that houses native, endemic, and endangered trees in the Philippines, producing monographs and guidebook to this flora and assessing its conservation status based on the IUCN criteria within the selected forested areas of the Philippines. Furthermore, it added solutions to delineate problems in the freshwater, its conservation and mitigation measures apart from the challenges that it has been encountering.

**10:30am - 10:45am**

## A Synthesis On The Ecology, Biogeography and Conservation Impacts Of Biological Invasions In The Anthropocene

**Franz Essl[1], GloNAF Core Team[2], Alien Scenarios Project Team[3]**
[1]University Vienna, Austria; [2]https://glonaf.org/index.php/core-researchers/; [3]https://alien-scenarios.org/; franz.essl@univie.ac.at

Biological invasions have become a defining feature of global environmental change. However, the global patterns and underlying factors that determine variation in invasions world-wide are still insufficiently understood. Similarly, future trajectories of biological invasions and the consequences for biodiversity conservation are not fully appreciated.

Progress in data coverage and availability, supplemented by new tools for data integration and analyses have facilitated the compilation of comprehensive databases of world-wide alien species distributions such as GloNAF (https://glonaf.org/) for vascular plants (van Kleunen et al. 2015). Similarly, the compilation of the Alien Species First Record-database provides a backbone for analysing spatio-temporal patterns of alien plant species accumulation (Seebens et al. 2017). Further, data on human pressures, on the exchange routes of goods and people, and on a large range of environmental factors have increasingly become available. Combined, these novel data sources have substantially advanced the understanding of the (macro)ecology and biogeography of biological invasions, and they provide the foundation for exploring future trends of alien species spread and impacts.

In this talk, I will synthesize key insights into global patterns and drivers of biological invasions. I will introduce the Alien Scenarios-Project (https://alien-scenarios.org/), which for the first time develops long-term scenarios and models for biological invasions worldwide (Lenzner et al. 2019). I will highlight likely future consequences of invasions, and discuss the human dimension in alien species spread and impacts. Finally, I will provide a perspective on priority questions for biodiversity conservation, society and science related to biological invasions.

**References**

Lenzner B et al. (2019) A framework for global 21st century scenarios and models of biological invasions. BioScience 69: 697-710.

Seebens H et al. (2017) No saturation of the global accumulation of alien species. Nature Communications, 9, 14435.

van Kleunen M et al. (2015) Global exchange and accumulation of non-native plants. Nature, 525, 100-103.

**10:45am - 11:00am**

## Plasticity, Dispersal Or Decline – Strategies For Coping With Climate Change In Lepidoptera

**Maria Helena Hällfors[1], Janne Heliölä[2], Mikko Kuussaari[2], Juha Pöyry[2], Marjo Saastamoinen[1]**
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Biodiversity is threatened by a multitude of anthropogenic factors, including climate change. Understanding how species have responded to the changes is crucial for anticipating their abilities to cope with increased changes in the future. When the environmental conditions of species change, two avenues for avoiding decline and consequent extinction are available: (i) adapting in situ through evolutionarily or plastic responses, or (ii) dispersing to more favorable areas. Insect populations have recently been reported to suffer substantial declines caused by anthropogenic environmental change. The role of climate change and the ability of insects to adjust to temperature changes across time and within seasons remains elusive, especially in boreal areas. Shifts in the (i) phenology and (ii) distribution area of species belong to the most conspicuous reactions of species to climate change. Therefore, large-scale patterns on species’ abilities to make use of one or both of these strategies could shed light on the vulnerability of and future reactions of species. Here, we use long-term data on Lepidoptera, both as (i) temporal observations over the vegetative season and as (ii) large-scale spatial occurrences, to gauge the main modes of response under climate change. For 46 butterfly and >200 moth species in Finland, we quantify shifts over time in (i) phenology and (ii) distribution. In this talk, we present our preliminary results testing our hypothesis that there is a tendency for species to be either responsive or passive. That is, we hypothesize that species tend to either adjust through both (i) advancing their phenology and (ii) shifting their distributional area towards the north, or they do not show any signs of either adaptive response that we measure. Effectively, this may divide species into winners and losers under continued climatic warming and have large impacts on future community composition and regional species richness.

**11:00am - 11:15am**

## Co-extinctions Annihilate Planetary Life Resilience to Global Environmental Change

**Giovanni Strona[1], Corey A Bradshaw[2]**

[1]Research Centre for Ecological Change, P.O. Box 4, FI-00014 University of Helsinki, Finland; [2]ARC Centre of Excellence for Australian Biodiversity and Heritage, Global Ecology, College of Science and Engineering, Flinders University, Adelaide, Australia; giovanni.strona@helsinki.fi

Rapid change in environmental conditions can drive species to extinction in the same way as a broken thermostat can kill fish in an aquarium tank. This simple mechanism is often considered as a major culprit of global biodiversity loss, together with other direct causes of species extinction such as habitat destruction, overkill and biological invasions. Yet, these could be just the tip of a huge iceberg. Species loss can propagate across networks of ecological interactions, in hardly predictable ways, and even bring entire ecosystems to collapse under certain conditions. In particular, as our understanding of the importance of ecological interactions in shaping ecosystem identity advances, it is becoming clearer how the disappearance of consumers following the depletion of their resources — a process known as 'co-extinction' — might be the lead actor in the ongoing biodiversity crisis. Understanding the intricacies behind extinction drivers, as well as assessing their relative importance in the current scenario of rampant diversity loss is a priority for science and management. Available data permit, to some extent, to explore and simulate local processes, but multiple theoeretical and practical challenges severely limit our understanding of what is going on – and what to expect – at the planetary scale. Here we will show how integrating computer simulations with empirical data allows us to overcome some of those limitations, and yields important insights on the issue, revealing that: (i) the relative effect of co-extinctions on planetary diversity loss could be more than ten times that of extinctions triggered by environmental change alone; (ii) ecological networks are intrinsically robust enough to withstand co-extinction when subjected to 'natural' patterns of species loss, but are doomed to rapid collapse as a result of global change; (iii) global warming is the worst possible scenario of environmental change from an ecological network perspective.

**11:15am - 11:30am**

## Turning Back the Clock On Biodiversity Loss: Past and Future Impacts of Land Use and Population on Biodiversity Intactness and Species Richness.

**Samantha L.L. Hill[1,2], Ricardo E. Gonzalez[2], Andy Purvis[2,3]**

[1]UNEP-WCMC, United Kingdom; [2]Natural History Museum, London, United Kingdom; [3]Imperial College London, United Kingdom; samantha.hill@unep-wcmc.org

Land-use change and intensification have been the dominant global drivers to date of terrestrial biodiversity change. We use data from the PREDICTS database to model impacts of land use and human population on the Biodiversity Intactness Index (BII) and local species richness. Historical impacts are inferred through projecting model results onto maps of historical land-use (LUH2) and human population density (HYDE3.1). Future impacts to 2100 are explored using gridded driver estimates from six combinations of Shared Socio-economic Pathway (SSP) and Representative Concentration Pathway (RCP) scenarios. Here we show 1) that around 75% of all loss in both BII and species richness occurred after 1800, 2) how plausible futures defined by alternative socio-economic scenarios predict stark regional differences in biodiversity futures, with greater losses of biodiversity in African regions, and 3) how far the most optimistic scenario can turn back the clock on the loss of community biodiversity with global averages in 2100 predicted to be the same as 1960-1970. Our results suggest that a concerted global shift to a more sustainable path can indeed halt – and even partially reverse – the global loss of biodiversity from ecological communities.

**11:30am - 11:45am**

## Biodiversity Futures And Pathways Towards Sustainability

**Michael Harfoot[1], Sam Hill[1], Calum Maney[1], Neil Burgess[1], Derek Tittensor[1,2]**

[1]UNEP WCMC, United Kingdom; [2]University of Dalhousie, Canada; mike.harfoot@unep-wcmc.org

Projections of the future state of biodiversity show that without major societal transformations declines will continue in both the terrestrial and marine realms. However, projections vary depending on the facet of biodiversity and the modelling approach. Here we present and compare projections from two very different biodiversity models, the phenomenological PREDICTS model, and the process-based Madingley General Ecosystem Model. We find that even under sustainable scenarios biodiversity declines are likely. As a result we conclude that pathways need to be identified that demonstrate how society can move to a sustainable future. As a first step to fill this gap, we present research to identify what the likely effect on the state of biodiversity would be if the actions committed to in current national biodiversity strategies and action plans are implemented.

**Biodiversity futures and pathways towards sustainability**

# 106S: Making ecosystem service assessment operational in environmental management

*Time:* Friday, 28/Feb/2020: 10:15am - 12:15pm · *Location:* Flüela
*Session Chair:* Martin Pusch, Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB), Germany

The principle of sustainability and the ecosystem service concept are now both widely known and accepted in many sectors of society, and this even in many parts of the world. However, there are still huge implementation gaps of this knowledge between the scientific sphere and the practice of environmental management: a) There are social and political mechanisms lacking that support the implementation of sustainability criteria on land use. b) The protection or development of ecosystem services has so far not be entered into decision-making processes in any kind of environmental management, as e.g. land use in urban agglomerations.

In this session, approaches will be presented how knowledge and assessments of ecosystem services may be made operational in environmental management. Thereby, the provision of habitats for biodiversity represents an ecosystem service of special importance, as well as regulating services relevant to adaptation and mitigation of climate change.

## Operationalizing ecosystem services for decision making with the River Ecosystem Service Index (RESI)

**Martin Pusch, Simone Podschun**
Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB), Germany; pusch@igb-berlin.de

There are huge implementation gaps between available knowledge on sustainability limits and the ecosystem services between the scientific sphere and the practice of environmental management, as i) Social and political mechanisms are lacking that support the implementation of sustainability criteria on land use, and ii) The protection or development of ecosystem services has so far not been entered into decision-making processes in any kind of environmental management, as e.g. land use in urban agglomerations.

We present the River Ecosystem Service Index (RESI) as a promising example how knowledge and non-monetized assessments of ecosystem services may be made operational in environmental management. Thereby, the provision of habitats for biodiversity represents an ecosystem service of special importance, as well as regulating services relevant to adaptation and mitigation of climate change.

Rivers and their floodplains represent interesting model systems for such operationalization, as they are focal sites of ecosystem service availability but which are intensely used, e.g. for hydropower, navigation, agriculture, drinking water supply, or recreation and tourism. Nowadays, these intense uses are often competing for the same area and water body, and produce significant trade-offs. In addition, the management of rivers is regulated by several EU directives.

In order to assess such effect on the ecosystem services provided by rivers and floodplains, we developed a novel non-monetized approach to quantify a wide array of ecosystem services. The novel River Ecosystem Service Index (RESI) (www.resi-project.info) first collects and collated suitable geographic indicator data, and then applies algorithms to calculate scores of the availability of single ecosystem services ranging from 1 to 5. This already allows visualizing the distribution of specific ecosystem services , and analyzing their trade-offs.

Furthermore, the availabilities of all studied ecosystem services may be summarized to an integrative index .The RESI may be used to compare complex river and floodplain management scenarios, including transparent inter-sectoral visualization, and may hence serve as a decision support tool for inter- and transdisciplinary communication.

The RESI has been already been implemented in practice in the framework of an official regional planning prioritization procedure for a 80-km section of the Danube River in Bavaria (Germany).

## Does Process Matter? Citizen's Participation and Perceptions of Environmental and Social Impact Assessment Process for Development Corridor Projects in Kenya

**Tobias Ochieng Nyumba**[1,2]
[1]African Conservation Center, Nairobi; [2]Institute for Climate Change and Adaptation, University of Nairobi;
tobias.nyumba@acc.or.ke

An Environmental and Social Impact Assessment (ESIA) is one of the recognized tools for project planning particularly for large and environmentally sensitive projects. Since its introduction in the United States in the 1970s, many countries have passed legislation making ESIA mandatory. Kenya's ESIA is fairly comprehensive, creating regulations designed to protect both the social and environmental systems, and implemented by the National Environmental Management Authority (NEMA). The legislation empowers communities and other actors such as the civil society and non-governmental actors to participate and demand accountability from project proponents on the impacts and mitigation of the impacts of their proposed projects. Kenya is currently implementing the Standard Gauge Railway (SGR) and the Lamu-Port South Sudan-Ethiopia Transport (LAPSSET) corridors, the potential impacts of which have highlighted the need for effective environmental assessment procedures. This paper aimed to explore broadly the recommended ESIA process and its implementation in practice within the SGR and LAPSSET corridors. We reviewed the ESIA process for the two corridors, surveyed 927 community members living within a 10km buffer along the corridors, conducted in-depth interviews with 17 key informants and reviewed the current environmental legislation. This paper reveals that although Kenya's ESIA framework has good ambitions and is anchored on sound legislative and institutional set-up, it lacks public confidence, participation and effectiveness in mitigating both social and environmental impacts associated with the development corridors. The system is faced with a lack of funding, corruption, gaps or duplications of regulations and a misunderstanding by society-at-large of the benefits of the ESIAs. The system has little oversight of development projects with potentially serious environmental impacts. There is a need for improvements in ESIA practice to include capacity building, transparency and stakeholder engagement.

## Identification, Prioritization and Mapping of Ecosystem Services in the Panchase Mountain Ecological Region of Western Nepal

**Shankar Adhikari**
Ministry of Forests and Environment, Nepal; adhikarishankar@gmail.com

Ecosystem services (ES) are critical to human well-being, especially in developing countries. Improved understanding of the status of ES is required to help people improve their quality of life. The status of ES is largely unknown in many regions of Nepal. This study was carried out in one of Nepal's biodiversity hotspots, the Panchase Mountain Ecological region (PMER), to identify, prioritize and map the major ES in the region. Primary data for the study were collected through key informant interviews, focus group discussions, a transect walk, and field observations. Similarly, secondary data were obtained from published and

unpublished reports and satellite images of the study area. The data were analyzed both qualitatively and quantitatively. Thirty-seven ES were identified from the study landscape. Among them, nine were provisioning services, thirteen regulating services, nine cultural services, and six supporting services. Interestingly, the prioritization of ES among stakeholders differed on the basis of their background, particular features of their landscape, professional engagement, and individual interests. For instance, forest users prioritized provisioning services for their daily needs whereas forest managers prioritized regulating and cultural services for overall ecosystem management and aesthetic values. Mapping of the ES from the landscape for 1995 and 2015 identified that forest area and associated ES have likely increased, especially in the upland regions, while agricultural land and their associated ES have decreased. The study can be used as a reference by planners and policy makers in managing ES in the PMER to increase synergies and reduce trade-off among various services

## Saving Ecosystems to Protect Services: Towards an Ecosystem Services Valuation in Portugal

**Felipe Campos, João David, Pedro Cabral**
NOVA Information Management School (NOVA IMS), Universidade Nova de Lisboa, Portugal; fcampos@novaims.unl.pt

The concept of ecosystem services defines nature in an anthropocentric term. Beyond the anthropocentrism, the monetization of ecosystem services has been proposed as a practical pathway to support decision-making in environmental planning. In this context, the economic valuation of ecosystem services is key for applying conservation decisions at national scales. To calculate the ecosystem services valuation for Portugal, we design an innovative strategy showing that prioritization models focused on ecosystem services can include cost-effectiveness–based assessments of land values. Based on the CORINE land cover and the Economics of Ecosystems and Biodiversity (TEEB), we map seven ecosystem categories. According to the economic values obtained from 72 studies at European level, we apply a benefit transfer approach for 17 ecosystem services types. Through a meta-analysis based on response ratios, we assess the role of benefit transfer in ecosystem service valuation. To evaluate the conservation status of the ecosystems, we use the InVEST habitat quality model as an ecological indicator for the biodiversity responses to human-induced landscape changes. Integrating economic and ecological values into a landscape modelling approach, we develop three priority scenarios for cost-effective conservation strategies. Our literature review reveals 167 monetary values estimated for biophysical, socio-cultural and ecological features. Comparing the ecosystem services valuation in EUR/ha/year, we find the lowest values for cultural services (8.58 EUR/ha/yr) and the highest values for regulating services (12,165.44 EUR/ha/yr). Through mapping and calculating the trade-offs between ecosystem gains and economic benefits, our research introduces the first attempt for valuing ecosystem services in Portugal. We highlight the importance of maintaining the forest cover remnants to provide a maximum representation of habitat quality and natural capital in conservation planning. This work has advanced knowledge of the analytical methods that can also be applied in other European countries aimed to protect multiple ecosystem services with limited resources.

# 135S: Enhancing biodiversity to support sustainabie crop production

*Time:* Friday, 28/Feb/2020: 10:15am - 12:15pm · *Location:* Seehorn
*Session Chair:* Christian Schöb, ETH Zurich, Switzerland
*Session Chair:* Johan Six, ETH Zurich, Switzerland
*Session Chair:* Rob Brooker, The James Hutton Institute, United Kingdom

In areas dominated by modern intensive farming practice, arable crop fields are highly impoverished in biological diversity. Current mainstream agricultural practices focus on monocultures of single cultivars. These highly depauperate systems are susceptible to pests and diseases and become zones of intense competition between plants for available resources. Such crop production systems therefore often require costly and environmentally harmful external inputs to sustain production, thereby aggravating the damage to wider biodiversity within these ecosystems and making them unsustainable from both a production and environmental perspective.

At the heart of the problem is that this type of crop production suffers from a lock-in effect, with farmers being trapped into these detrimental practices by issues arising from a range of sources including markets, technologies, and policy. Agroecological research however provides potential solutions to overcome at least some of the lock-ins by means of biodiversity. Increasing crop diversity through intercropping has been demonstrated to enable increased production with less external inputs, higher resilience against environmental perturbations, and improved livelihoods. In other words, biodiversity in cropping systems can increase environmental, social and economic sustainability. Nevertheless, the land dedicated to intercropping in comparison with monoculture cropping is marginal, e.g. less than 0.5% in Switzerland. Stakeholder surveys demonstrate that the barriers against the uptake of intercropping are manifold (demonstrating the lock-in effect), including the practical challenges associated with the complexity of production and harvest, as well as the lack of markets, information, and advice. In this session, we aim at bringing together researchers covering ecological and socioeconomic aspects of intercropping with practitioners and policy makers from around the world. This session will provide insight into the latest developments concerning intercropping from across these fields. It will discuss current and future challenges and potential ways forward, exploring the possibility that intercropping systems might deliver a genuine win-win by which we can promote biodiversity conservation in farmed landscapes while helping to support (and possibly also improve) rural livelihoods and wellbeing.

**10:15am - 10:30am**

## Diversified Agroecological Systems That Deliver Multiple Benefits

**Emile A. Frison**
International Panel of Experts on Sustainable Food Systems (IPES-Food), Italy; e.frison@cgiar.org

Today's food and farming systems have succeeded in supplying large volumes of foods to global markets, but are generating negative outcomes on multiple fronts: wide- spread degradation of land, water and ecosystems; high GHG emissions; biodiversity losses; persistent hunger and micronutrient deficiencies, the rapid rise of obesity and diet-related diseases; and livelihood stresses for farmers around the world.

These problems are tied to the industrial model of agriculture that is increasingly dominant around the world. The uniformity at the heart of these systems leads systematically to negative outcomes and vulnerabilities, and particularly the use of an increasingly narrow pool of animal breeds and plant species and varieties.

The low-diversity industrial model is locked in place by a series of vicious cycles. Highly compartmentalized approaches to research, education and policymaking allow one-dimensional productivity-focused solutions to prevail, and obscure the links between healthy ecosystems, a healthy planet and healthy people. Meanwhile, the way food systems are currently structured allows value to accrue to a limited number of actors, reinforcing their economic and political power, and thus their ability to influence the governance of food systems.

To break these cycles, a fundamentally different model of agriculture is required, based on diversifying farms and farming landscapes, replacing chemical inputs, optimizing biodiversity and stimulating interactions between different species, i.e. "diversified agroecological systems". There is growing evidence that these systems keep carbon in the ground, support biodiversity, rebuild soil fertility and sustain yields over time, providing a basis for secure farm livelihoods and diverse healthy diets.

**10:30am - 10:45am**

## Integrating Biodiversity into Agricultural Policy: Opportunities and Limitations

**Eva Reinhard, Felix Herzog**
Agroscope, Switzerland; eva.reinhard@agroscope.admin.ch

In 1996, Switzerland introduced elements into its agricultural legislation that aim to improve and strengthen biodiversity. The core element is the requirement for each farm to manage at least 7% of its land for biodiversity; e.g. without fertilizer and without pesticides. Furthermore, voluntary incentives, such as result oriented payments for 15 different types of Ecological Focus Areas EFA with high ecological quality are provided, for example if a certain set of plant indicator species is present. Several in situ and ex situ conservation programs are dedicated to the conservation of genetic diversity. Today, 16% of the Swiss farmland accounts for biodiversity payments, significantly more than the minimal requirement of 7%; one third thereof is compensated for ecological quality. Monitoring data show that EFA count more species than control areas and on EFA with quality payments, the species diversity is even higher. This applies for the number of plants and butterflies and tends to hold also for birds. Although these results are encouraging, the ecological quality is still insufficient and below the expectations and the goals, the government formulated. The share of EFA is particularly high in mountain regions where grassland is traditionally worked with low-intensity. In the lowlands, the shares of EFA are much lower. In arable regions, most farmers manage the minimal 7% of their land as EFA and the ecological quality is generally lower. Further efforts are needed to stabilize or even increase farmland biodiversity. The ongoing revision of the agricultural policy aims to further reduce nitrogen, plant protection and fertilizer input. The types and management of the Ecological Focus Areas should be better adopted to the local conditions and farmers need to be better informed, trained and supported. In addition, more scientific work is needed to understand and strengthen biodiversity functions such as crop pollination services and natural pest control services.

**10:45am - 11:00am**

## Enhancing Belowground Biodiversity To Support Sustainable Crop Production: Learning From Nature

**Wim van der Putten**
Netherlands Institute of Ecology, Netherlands, The; w.vanderputten@nioo.knaw.nl

Sustainable crop production starts with well-functioning soil, but what does this really mean? And to what extent is a well-functioning soil depending on belowground biodiversity? In this presentation, I will take you to soils in nature, starting with early succession soils colonized by plant species that closely resemble the parents of current crop species. Then, we move along the succession gradient where fast growing plant species are being replaced by species that grow slower, but that develop soils with enhanced sustainability characteristics. We will explore the diversity of these soils, as well as other (e.g. foodweb) properties. Then, I use this approach in nature to evaluate belowground biological properties of agricultural soils and discuss how soil and plant characteristics, as well as plant cropping systems may need to be altered in conjunction in order to enhance the sustainability of crop production systems. Finally, I will discuss that sustainable crop production ultimately depends on a combined approach of belowground and aboveground biodiversity measures, and propose how to achieve such situations in the field.

**11:00am - 11:15am**

## Organic at the Heart of the Agroecological Transition

**Charlotte April Bickler**
The Organic Research Centre, United Kingdom; charlotte.b@organicresearchcentre.com

Increasing crop diversification is one of the main components of the transition to agroecological food and farming systems. In the field this can be achieved on several scales from (micro-) habitats to species to genes. In my presentation I will give an overview of how these different elements of crop diversification are being realised on organic farms in the UK, with a particular focus on intercropping and agroforestry. The Organic Research Centre is celebrating its 40$^{th}$ anniversary in 2020 and has been extolling the benefits of diversity – rooted in the principle of ecology and that “nature abhors a monoculture” – since its formation. Our crops research aims to explore how best to quantify the benefits of biodiversity, how it can begin to be integrated into existing systems, what the barriers to achieving this are and collective solutions to these barriers. Ultimately, we aim to understand if and how diversification practices, and associated ecological interactions and processes, can be optimised in agroecosystems. This is embedded in a real-life context via engagement with farmers and other stakeholders throughout the research process. As well as increasing the likelihood of uptake of agroecological practices, supporting human diversity within the research environment adds to the richness of our work and is integral to truly realising more sustainable food and farming systems.

**11:15am - 11:30am**

## The Practice of Intercropping And Agroforestry - Benefits And Challenges From African Perspectives

**David Warambo Odee**
Kenya Forestry Research Instutute, Kenya; The UK Centre for Ecology & Hydrology; dwodee@gmail.com

Agroforestry in the broad sense is an ancient practice in sub-Saharan, but it is only until 30 years ago that agroforestry science and practice took centre stage to address decreasing productivity of agricultural lands due to increasing population, land degradation, fragmentation and decline in soil fertility. In practise, agroforestry and intercropping enhances biodiversity. One of the key developments was to domesticate and advocate the integration of legume $N_2$-fixing tree, shrub and herbaceous species and within cropping systems for soil fertility improvement in N-deficient soils, and provide other valuable goods and services (e.g. fuelwood, fruits and vegetable, medicine, fodder, timber, shade, pest control, etc.). Various agroforestry technologies have been developed and in the region and tested that include improved fallows, crop rotation, push and pull, to name a few. These technologies have been shown to significantly increase productivity, especially in the predominantly legume-cereal agroforestry systems, and are widely practised by smallholder farmers, but universal adoption is still out of reach due to various socio-ecological and economic factors. Many past and recent socio-economic surveys/studies in the region indicate persistent challenges, including in western Kenya (East Africa), a region that was at the centre of smallholder of agroforestry innovations considered to be one of region’s ‘incubator’ of these technologies. Why? This presentation highlights the benefits, and provide insights to stimulate questions or ideas on how these challenges can be effectively addressed.

**11:30am - 11:45am Warning: The presentations finish prior to the end of the session!**

## A Breeder’s Perspective On Intercropping

**Agata Leska**
GZPK, Switzerland; a.leska@gzpk.ch

gzpk (Getreidezüchtung Peter Kunz) is a non-profit association that has been active in organic plant breeding in Switzerland and Germany for 35 years. There are 11 full time employees with an annual budget of around 1 million EUR to breed organic cereals (wheat, spelt, triticale, and emmer), legumes (peas and lupins), sunflowers and maize. 35 years of breeding work has resulted in almost 20 varieties which are being marketed in Europe today (CH, D, F, CZ, IT, A, P), with a bio market share for Switzerland of 65 percent. With its legume breeding programme, gzpk contributes to food security and the preservation and enhancement of agrobiodiversity.

Cultivating two or more crops in mixtures increases the productivity of the farming system by making more efficient use of resources such as nutrients, water, light and helps to prevent weeds, improve yield quality and ensure more stable yields for farmers. Intercropping is very popular and important especially in organic agriculture, where the entire mixture is generally fed directly to the farm animals. gzpk investigates the optimal mix of seeds in test experiments of pea and lupin with barley, oat, camelina, wheat and triticale. In our breeding program, intercropping helps to compensate for low stability, slow youth development and low soil cover of pea and lupine i.e. properties where breeding can only have a limited influence. In our breeding project we use the classical crossing method, while cultivation and selection are done under conditions that are as practical as possible.

Based on our experience, we suggest that the official variety tests (some of our varieties are bred for mixed cultivation) should also be conducted under organic conditions and in mixtures rather than only in monocultures and conventional farming as is the case today.

# 167W: Response and Effect of plant-trait diversity to climate and climate change

*Time:* Friday, 28/Feb/2020: 10:15am - 12:15pm · *Location:* Wisshorn
*Session Chair:* Kirsten Thonicke, Potsdam Institute for Climate Impact Research (PIK), Germany
*Session Chair:* Boris Sakschewski, Potsdam Institute for Climate Impact Research (PIK), Telegrafenberg A31, Potsdam, Germany
*Session Chair:* Jeremy Lichstein, Department of Biology, University of Florida Gainesville, FL 32611, United States of America
*Session Chair:* David Schimel, JPL, United States of America
*Session Chair:* Michael E. Schaepman, University of Zurich, Switzerland

Plant morphological and functional traits describe structural and functional diversity of our ecosystems. Plant traits are related and some of them form trade-offs, thereby opening a multi-dimensional trait space which can help to describe how biodiversity interacts with multiple ecosystem functions (B-EF).

We still have a limited understanding of how the relationships between plant trait diversity, or aggregated as functional diversity, change along environmental gradients as well as how these relationships might change under climate and land-use change. Trait-based ecology can now be advanced by combining process-based ecosystem models with field and remotely-sensed data to gain new insights into B-EF in a changing world.

This workshop aims at establishing a dialogue between ecologists, remote-sensing experts, and B-EF modelers to explore how various methods could be combined to gain a better understanding of the relationships between plant traits and terrestrial ecosystem function.

**10:15am - 10:45am**

## Preserving Global Biodiversity - Help from Hi-Tech Mapping

**Greg Asner**
Arizona State University, United States of America; gregasner@asu.edu

Earth is undergoing a mass extinction of biological diversity due to the human-driven dismantling and disruption of natural ecosystems. Low-to-middle income countries, with high natural capital and greater development needs, suffer the most from ongoing data gaps on land use, reef use, biodiversity, carbon storage, and other critical environmental decision-making factors. Our airborne imaging spectroscopy program has successfully mapped rainforest canopy and coral reef biodiversity, empowering organizations to take a more proactive tactical role in preserving nature. Now a partnership between Arizona State University, Planet Labs, and One Earth is making it possible to take the airborne approach to operational Earth orbit. Called the Global Biodiversity Observatory, the program will employ Earth-orbiting satellites with miniaturized Imaging Spectrometers connected through artificial intelligence to drive a new internationally accessible decision-support system; empowering a rapid reversal of biodiversity loss; providing cost effective data solutions through our global partners to maximize decision impact; and improving public knowledge.

**10:45am - 11:00am**

## Dynamics of the Amazon Forests and the Role of Forest Structure - Linking Vegetation Modelling and Remote Sensing

**Nikolai Knapp[1], Andreas Huth[1,2], Rio Fischer[1], Franzika Taubert[1], Friedrich Bohn[1], Edna Roedig[1]**
[1]Helmholtz Centre for Environmental Research - UFZ, Germany; [2]iDiv - German Centre for Integrative Biodiversity Research; nikolai.knapp@ufz.de

Precise descriptions of forest productivity, biomass, and structure are essential for understanding ecosystem responses to climatic and anthropogenic changes. However, relations between these components are rarely investigated, in particular for tropical forests.

We developed an approach to simulate forest dynamics of around 410 billion individual trees within 7.8 Mio km² of Amazon rainforest (using the FORMIND forest model). We then integrated remote sensing observations from Lidar (forest height map) in order to detect different forest states and structures caused by small-scale to large-scale natural and anthropogenic disturbances.

Under current conditions, we identified the Amazon rainforest as a carbon sink, gaining 0.56 Gt C per year. We also estimated other ecosystem functions like gross primary production (GPP) and woody aboveground net primary production(wANPP), aboveground biomass, basal area and stem density.

We found that successional states play an important role for the relations between productivity and biomass. Forests in early to intermediate successional states are the most productive and carbon use efficiencies are non-linear. Simulated values can be compared to observed values at various spatial resolutions (local to Amazon-wide, multiscale approach). Notably, we found that our results match different observed patterns (e.g., MODIS GPP).

We conclude that forest structure has a substantial impact on productivity and biomass. It is an essential factor that should be taken into account when estimating current carbon budgets or analyzing climate change scenarios for tropical forests.

**11:00am - 11:15am**

## Changes In South American Plant Functional Traits And Diversity Under Climate Change.

**Liam Jude Langan[1], Simon Scheiter[1], Mirjam Pfeiffer[1], Thomas Hickler[1,2], Carola Martens[2], Camille Gaillard[1], Dushyant Kumar[1], Steven Higgins[3]**
[1]Senckenberg Biodiversity and Climate Research Institute (SBiK-F), Georg-Voigt-Straße 14, 60325 Frankfurt am Main; [2]Goethe University Frankfurt am Main, Germany; [3]Plant Ecology, University of Bayreuth, Universitaetsstraße 30. 95447, Bayreuth, Germany; llangan@tcd.ie

Earth's biodiversity is being rapidly lost, yet, how plant functional traits and diversity are distributed across geographical space, as well as how these distributions may change as climate changes, remains uncertain. The Amazon remains one of the Earth's major terrestrial reservoirs of carbon and biodiversity. Across Amazonia, climate models suggest that reductions in precipitation amount and increases in precipitation event sizes are likely in the coming decades. Such changes will increase the risk of drought throughout Amazonia, potentially impacting on the region's carbon and biodiversity stocks.

Using a trait and individual based vegetation model, aDGVM2, we show that the model can reproduce the outcomes of drought experiments conducted at two Amazonian sites. Specifically, we found that the model could reproduce both the magnitude and timing of observed reductions in biomass caused by experimental droughts. Examination of relationships between drought

response and modelled plant diversity revealed that simulations exhibiting higher diversity incurred lower biomass losses. Scenario analysis of vegetation development under different RCP scenarios for the broader Amazon region revealed that large changes in the trait composition of the simulated plant communities are likely by 2100.

Our analyses reveal that how vegetation models represent plant diversity critically influences projections. Specifically, the biomass predicted in simulations with higher diversity were less impacted by drought. Taken together these results suggest that existing plant diversity and the severity of climatic changes will interact to influence the extent to which the boundaries of the rainforest shifts and the extent to which the character of the communities that constitute the rainforest change.

**11:30am - 11:45am Warning: The presentations finish prior to the end of the session!**

## A Belowground Dimension Of Plant Functional Diversity Dynamics – Response of Plant-Fungal Symbiotic Interactions to Climate

**Nadia Soudzilovskaia**

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Belowground symbiotic relationships of plants, such as mycorrhiza and a symbiosis with nitrogen fixing bacteria, represent important but yet underappreciated dimension of plant functional diversity. While nearly all plant species on Earth possess one or multiple types of such relationships, our understanding of their spatial dynamics and response to environmental change is still in its infancy. Recent research has convincingly demonstrated that these symbioses constitute a critical part of plant trait suits representing plant nutrient acquisition and conservation strategies. Especially the differences in the type of mycorrhizal association, and the related differences in plant and fungal traits, greatly impact carbon allocation patterns in plants and soil, and therewith drive the dynamics of terrestrial carbon pools, with ultimate knock-off impacts on climate.

Till resent, absence of global datasets describing geographic distribution of mycorrhizal types retarded research aimed to quantify global variation in plant traits related to mycorrhizal symbiosis, and their response to global change. However, in the past few years a large progress has been achieved in creation of large datasets describing plant symbiotic relationships, especially the mycorrhizas. I will discuss the recent developments in our understanding the of global variation in intensity and types of mycorrhizal symbiosis and environmental drivers thereof, and will present the new, currently being in press, database of plant mycorrhizal types and root colonization intensity by mycorrhizal fungi, (11.000 species; above 27.000 records in total). Using this unique data, we constructed the first global maps of distribution of mycorrhizal plants and quantified global patterns of the relationships between environment, and type and intensity of mycorrhizal root colonization. We have shown that climate and land use change are paramount drivers of variation in multiple aspects of mycorrhiza-related plant traits, suggesting that climate change is likely to affect distribution of mycorrhizas, with a potentially strong impact on terrestrial carbon pools, as well as functional diversity of Earth ecosystems.

Finally, I will discuss the next urgently needed steps to quantify the carbon consequences of human-induced vegetation shifts between different mycorrhizal types from plot to global scale.

# Closing: Closing Plenary

*Time:* Friday, 28/Feb/2020: 12:15pm - 1:15pm · *Location:* Davos (2/3)
*Session Chair:* Michael E. Schaepman, University of Zurich, Switzerland

## Andrew Light, George Mason University and World Resources Institute

**12:15pm - 1:00pm Warning: The presentations finish prior to the end of the session!**

### From COP 21 to COP 15: Lessons from Paris for Post-2020 Global Biodiversity Governance

**Andrew Light**
George Mason University and World Resources Institute, United States of America; alight1@gmu.edu

I will revisit the approach to and outcome of the 21st Conference of the Parties (COP) of the UN Framework Convention on Climate that produced the Paris Agreement on Climate Change, with an eye toward lessons that could be learned for the upcoming 15th COP of the UN Convention on Biodiversity. CBD COP 15 will attempt to not only update the Aichi Targets, but perhaps more importantly identify mechanisms for achieving them. I will break down some possible lessons from Paris into *features* of the agreement – including the structures created by Paris and the form of the country commitments – *dynamics* that developed among the parties resulting in higher ambition than many, and *tactics* that helped the features and dynamics of Paris emerge.