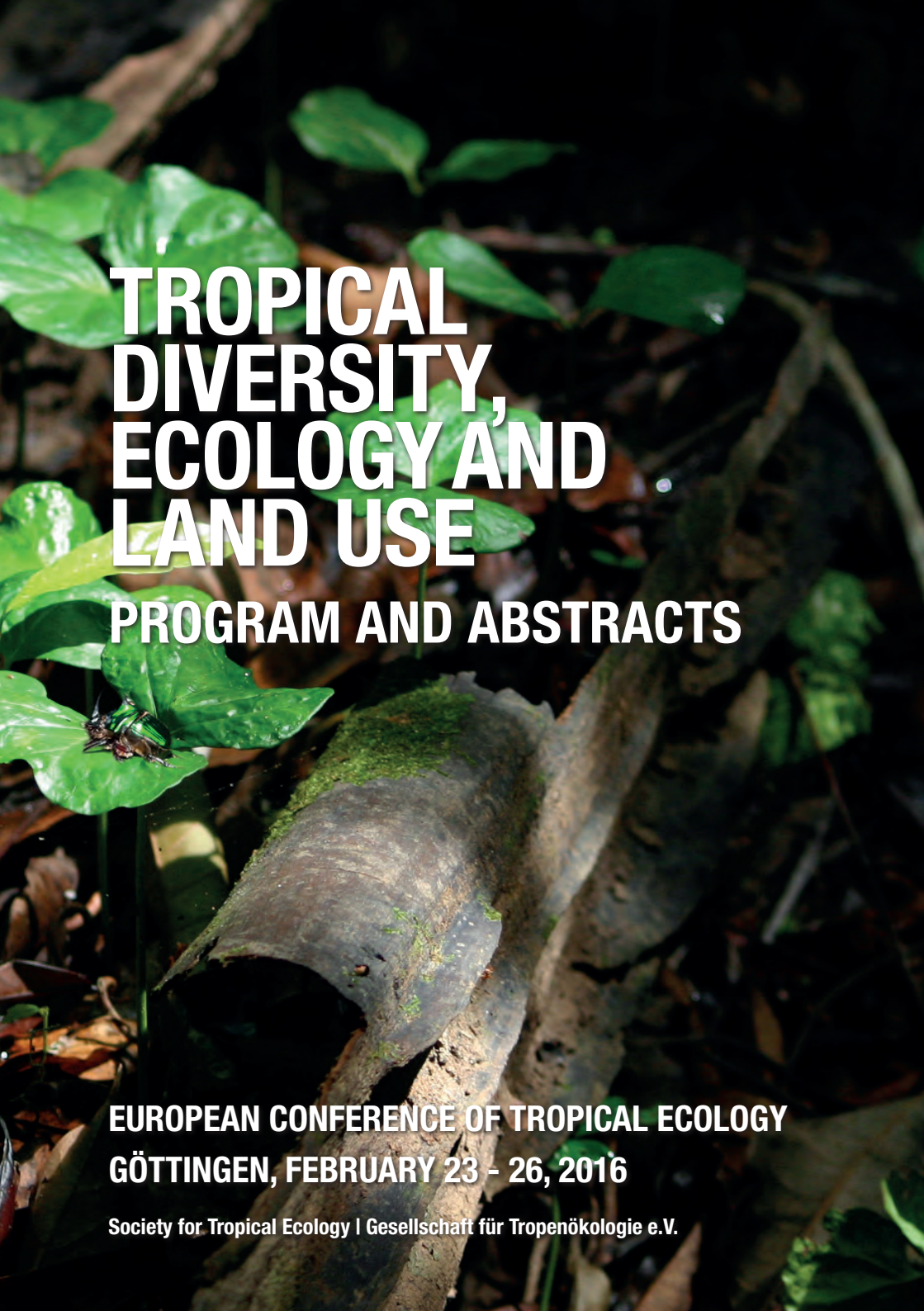


TROPICAL DIVERSITY, ECOLOGY AND LAND USE

PROGRAM AND ABSTRACTS

EUROPEAN CONFERENCE OF TROPICAL ECOLOGY

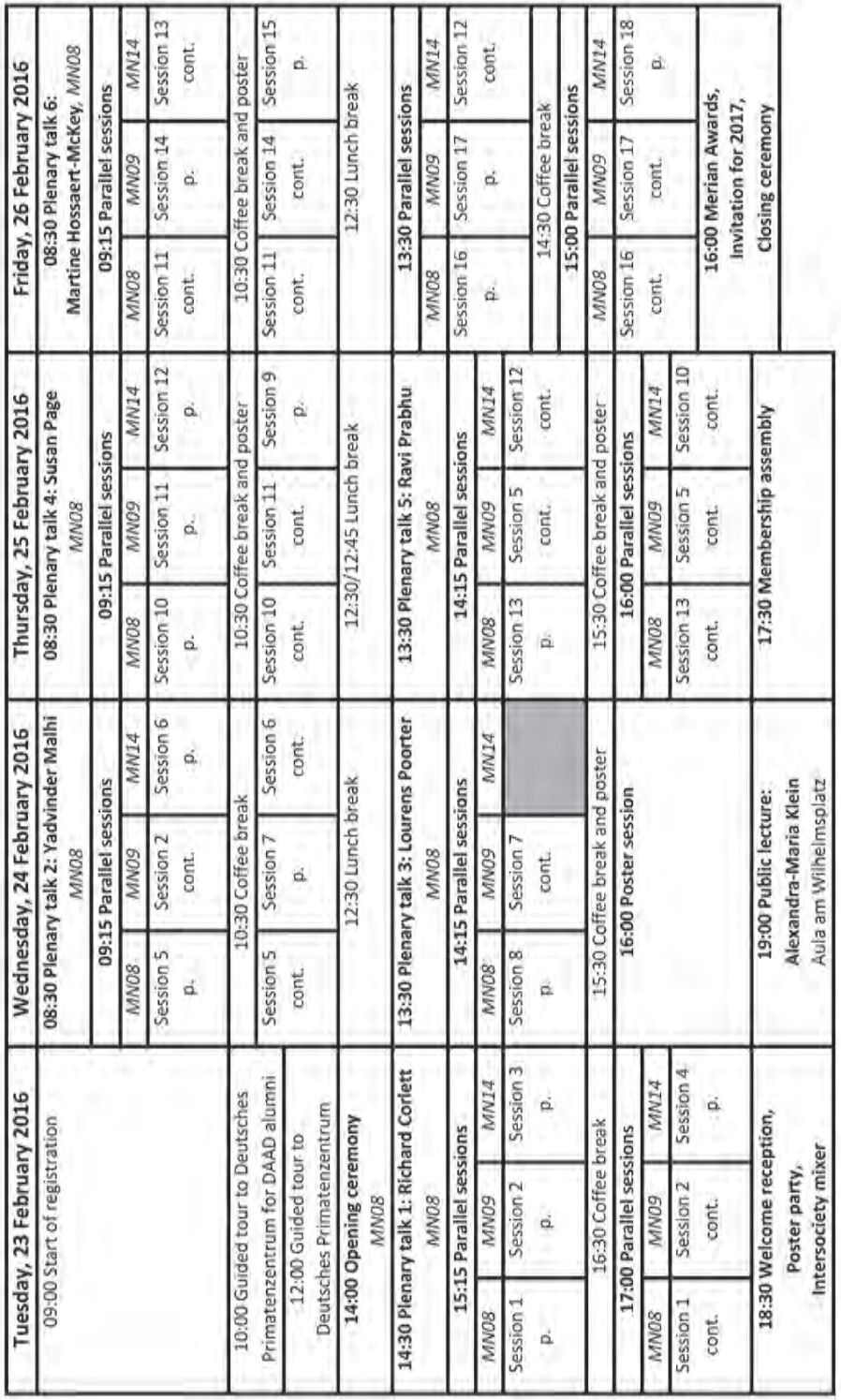
GÖTTINGEN, FEBRUARY 23 - 26, 2016

Society for Tropical Ecology | Gesellschaft für Tropenökologie e.V.

TROPICAL DIVERSITY, ECOLOGY AND LAND USE

EUROPEAN CONFERENCE OF TROPICAL ECOLOGY AND
ANNUAL CONFERENCE OF THE SOCIETY FOR TROPICAL ECOLOGY
(GESELLSCHAFT FÜR TROPENÖKOLOGIE E.V. – GTÖ)

Göttingen, February 23-26, 2016



Tuesday, 23 February 2016	Wednesday, 24 February 2016	Thursday, 25 February 2016	Friday, 26 February 2016
09:00 Start of registration	**08:30 Plenary talk 2: Yadvinder Malhi** *MN08*	**08:30 Plenary talk 4: Susan Page** *MN08*	**08:30 Plenary talk 6: Martine Hossaert-McKey,** *MN08*
	09:15 Parallel sessions	**09:15 Parallel sessions**	**09:15 Parallel sessions**
	MN08 / *MN09* / *MN14*	*MN08* / *MN09* / *MN14*	*MN08* / *MN09* / *MN14*
	Session 5 p. / Session 2 cont. / Session 6 p.	Session 10 p. / Session 11 p. / Session 12 p.	Session 11 cont. / Session 14 p. / Session 13 cont.
10:00 Guided tour to Deutsches Primatenzentrum for DAAD alumni	10:30 Coffee break	10:30 Coffee break and poster	10:30 Coffee break and poster
12:00 Guided tour to Deutsches Primatenzentrum	Session 5 cont. / Session 7 p. / Session 6 cont.	Session 10 cont. / Session 11 cont. / Session 9 p.	Session 11 cont. / Session 14 cont. / Session 15 p.
14:00 Opening ceremony *MN08*	12:30 Lunch break	12:30/12:45 Lunch break	12:30 Lunch break
14:30 Plenary talk 1: Richard Corlett *MN08*	**13:30 Plenary talk 3: Lourens Poorter** *MN08*	**13:30 Plenary talk 5: Ravi Prabhu** *MN08*	**13:30 Parallel sessions**
			MN08 / *MN09* / *MN14*
15:15 Parallel sessions	**14:15 Parallel sessions**	**14:15 Parallel sessions**	Session 16 p. / Session 17 p. / Session 12 cont.
MN08 / *MN09* / *MN14*	*MN08* / *MN09* / *MN14*	*MN08* / *MN09* / *MN14*	
Session 1 p. / Session 2 p. / Session 3 p.	Session 8 p. / Session 7 cont. /	Session 13 p. / Session 5 cont. / Session 12 cont.	14:30 Coffee break
			15:00 Parallel sessions
16:30 Coffee break	15:30 Coffee break and poster	15:30 Coffee break and poster	*MN08* / *MN09* / *MN14*
17:00 Parallel sessions	**16:00 Poster session**	**16:00 Parallel sessions**	Session 16 cont. / Session 17 cont. / Session 18 p.
MN08 / *MN09* / *MN14*		*MN08* / *MN09* / *MN14*	
Session 1 cont. / Session 2 cont. / Session 4 p.		Session 13 cont. / Session 5 cont. / Session 10 cont.	**16:00 Merian Awards, Invitation for 2017, Closing ceremony**
18:30 Welcome reception, Poster party, Intersociety mixer	**19:00 Public lecture: Alexandra-Maria Klein** Aula am Wilhelmsplatz	**17:30 Membership assembly**	

IMPRESSUM

Editors
Eckhard Heymann
German Primate Center,
Dirk Hölscher, Hermann Behling,
Ingo Grass, Jürgen Homeier,
Simone Pfeiffer und Janina Schäfer
Georg-August-University Göttingen
KCS Kuhlmann Convention Service

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Simone Pfeiffer

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LOCAL ORGANIZERS & SPONSORING INSTITUTIONS

The organizing committee and the Society for Tropical Ecology would like to thank the following institutions for their support

DFG

DAAD Deutscher Akademischer Austauschdienst German Academic Exchange Service

Niedersächsisches Ministerium für Wissenschaft und Kultur

GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN

CBL Centre of Biodiversity and sustainable Land Use

DPZ Deutsches Primatenzentrum Leibniz-Institut für Primatenforschung

Ecomatik

TABLE OF CONTENTS

WELCOME AND FOREWORD

Dear participants, dear colleagues, dear friends,

It is our great pleasure to welcome you all to the first European Conference of Tropical Ecology & 29th Annual Meeting of the Society for Tropical Ecology-Gesellschaft für Tropenökologie (gtö) in Göttingen. This conference is jointly hosted by the Georg-August-University and the German Primate Center) and organized by members of four faculties (Agriculture, Biology, Forestry and Geosciences), the Center for Biodiversity and Land Use (CBL) of the university, and from DPZ. This diversity of organizers, and institutions to which they belong, reflects the broad spectrum of tropical and subtropical research that is done on the Göttingen Campus. The title of the conference – Tropical diversity, ecology and land use – also mirrors this broad spectrum of research and at the same time highlights the interface between basic and applied scientific approaches.

Located near the geographical center of Europe, Göttingen is the right place for a European conference. The 2015 conference in Zürich had already attracted a broad European and international audience and raised the profile of the Society for Tropical Ecology. We are proud that we can further contribute to making the society's annual conference THE event where tropical ecologists from all over Europe meet. By the time of writing these lines, delegates from 15 European countries have registered. Furthermore, the conference is attracting scientists and students from around 40 nations outside Europe.

The conference program includes a diverse spectrum of sessions where the latest achievements in tropical ecology research will be presented. We hope and are confident that the conference will contribute to not only advancing tropical research, but will also sent out a strong conservation message, as tropical ecosystems continue to be under heavy anthropogenic pressure that is now aggravated by the effects of global climate change.

We hope that you will find the conference inspiring, and fostering existing and building new partnerships in research and conservation. We wish you a very good time in Göttingen and a successful and productive participation in the conference.

Eckhard W. Heymann

On behalf of the Local Organizers
Hermann Behling
Ingo Grass
Eckhard W. Heymann
Dirk Hölscher
Jürgen Homeier
Stefan Hohnwald
Simone Pfeiffer

Dear conference participants,

The Centre of Biodiversity and Sustainable Land Use (CBL), Göttingen University is pleased that the Society for Tropical Ecology has chosen Göttingen as the venue for the joint event of the European Conference of Tropical Ecology and the 29th Annual Conference of the Society for Tropical Ecology. The general topic of the conference "Tropical Diversity, Ecology and Land Use" is a very timely one. It reflects the huge challenges we are facing to maintain the diversity of tropical ecosystems which are under pressure due to unsustainable land use and climate change. There is a strong need for joint research activities that are aimed at a better understanding of tropical ecosystems, their diversity and response to human interference and land use. This topic is in the core of the research agenda of the CBL. Only four years ago, Göttingen University established this interdisciplinary centre to concentrate research and teaching activities as well as the fostering of alumni networks in biodiversity, ecology and land use which are scattered across several faculties and departments within the Göttingen Campus. Collaborative interdisciplinary projects such as the DFG CRC 990 "Ecological and Socioeconomic Functions of Tropical Lowland Rainforest Transformation Systems (Sumatra, Indonesia)" illustrate these efforts.
The CBL has a strong interest in capacity building. The topics of tropical ecology and land use are covered by a set of teaching activities in several faculties and study programmes. Students of the Master programme "Biodiversity, Ecology and Evolution" will participate in the conference as part of their scientific and event management training.
CBL contributes not only to the organization of this year's conference, but is also hosting one of two DAAD Alumni Seminars which takes place for the first time in connection with the annual conference. A group of 15 scientists and executives from developing countries just received a one-week training in Göttingen and will now attend this conference.

I wish you all a productive and inspiring conference and a pleasant stay in Göttingen.

Prof. Dr. Johannes Isselstein
Head, Centre of Biodiversity and Sustainable Land Use

Dear participants,

Welcome to the European Conference of Tropical Ecology and the Annual Conference of the Society for Tropical Ecology (Gesellschaft für Tropenökologie, gtö) in Göttingen. The conference last year was hosted by the Swiss Federal Institute of Technology (ETH) in Zurich. This year's conference is one of the largest on this topic and jointly hosted by the University of Göttingen and the German Primate Center. Several scientists from the faculties of Agricultural Sciences, of Biology & Psychology, of Forest Seiences & Forest Ecology and of Geoscience & Geography from the University of Göttingen are members of the local organizing committee. At the German Primate Center the Behavioral Ecology & Sociobiology Unit is involved in the organization. This interdisciplinary and intermural setting reflects what we call the "Göttingen Spirit" and the close interactions on the Göttingen Campus in an exemplary way.

The Iead topic of the conference is "Tropical diversity, ecology and land use" and encompasses very fascinating fields of research that are of great relevance across the globe. The conference's exciting and diverse program with its excellent speakers has attracted about 350 registered participants from 53 nations, incl. 15 European nations. We are thrilled to see the growing number of international participants as it is an indicator for the significance of these topics way beyond the boundaries of the tropics.

The human impact on the tropical ecosystems of our planet has been rapidly growing over the last several decades. This poses enormaus chailenges. In some areas the biodiversity is highly endangered due to human influence and many species are already extinct or highly endangered. So the local and global consequences for the ecosystem as weil the transitions of Iandscapes are subject to many studies and conservational efforts. Thus, it is very important to ail of us to understand how these changes influence nature and lastly the way we live. Only by properly understanding and managing the tropical biodiversity and extending sustainable land use will we be able to tackle the chailenges that lie ahead.

The conference will give you an overview on the current state of research on these topics and related issues. It provides a wonderful arena for discussions on research results, exchanging ideas, making future plans as weil as networking.

We invite you to explore the Göttingen Campus, wish you a pleasant time in Göttingen and great inspirations at the conference.

Prof. Dr. Ulrike Beisiegel
President, University of Göttingen

Prof. Dr. Stefan Treue
Director, German Primat Center (DPZ)

Dear participants, Welcome to Göttingen,

this is the 29th annual conference of gtö. It is a very special conference as it is also the first "European Conference of Tropical Ecology". Since a few years we are actively pursuing the aim of making gtö a truly international organization, with a clear focus on European membership and participation. We are also strengthening our ties with other international organizations, especially with ATBC, the Association for Tropical Biology and Conservation.

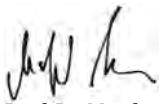
As ecological problems in the tropics are still on the increase with manmade fires devastating Indonesian forests during the last year, we need to join our efforts more than ever before. Not only the forests are burning, but much worse the layers of coal and peat under the surface are burning, so the recovery is close to impossible for the soil and the native vegetation. The reasons are known: plantations for oil palms and soy bean seem to be financially more attractive than natural forests, but only when you look at them from a merely financial short term perspective. These enterprises are far from being sustainable and they are disastrous also for our climate. The whole world, but especially the inhabitants of South East Asia, are suffering like never before from the consequences and I would say the least concern is that thousands of flights had to be cancelled because of the smog. The results achieved at the Climate Conference in Paris exceeded certainly and positively the expectations many of us had, good signals were sent out from Paris, but while politicians assembled in Paris finally started moving in the right direction, profit oriented, short sighted enterprises continued to destroy forests and to put our climate at risk.

So many studies are showing how dramatic the consequences of climate change are, and will be even more so in the future. We as tropical ecologists and conservation minded people can and must tell the world that we have to do something urgently and much of our research, our studies, our field work is not only describing and analyzing the situation but can provide a sound basis for counter measures, for solutions. We are not alone anymore! Human rights groups, development agencies, social and health organizations are increasingly becoming seriously concerned and are potential partners for us. Destruction of tropical ecosystems is not only an ecological problem anymore (and probably has never been!) but is affecting directly human health and welfare, and even human lives.

More than ever before do we have to work to save the species, habitats and ecosystems which are the objects of our studies.

I am convinced that in this endeavor also this conference here in Göttingen will bring us (at least a little bit) further on our way into a sustainable future.

I wish us all a successful conference.



Prof. Dr. Manfred Niekisch
President of gtö

SOCIETY FOR TROPICAL ECOLOGY (FORMERLY GESELLSCHAFT FÜR TROPENÖKOLOGIE E.V., GTÖ)

The Society for Tropical Ecology promotes and communicates new and emerging knowledge among tropical ecologists to advance the understanding of tropical ecosystems and their protection. It is currently Europe's largest scientific association in this field of research with about 500 members. The aim of the Society for Tropical Ecology, which was founded in 1987, is to further the study and understanding of all aspects of tropical ecology. A primary means toward this scope is through the organization of annual international congresses, usually four days in February in Central Europe. Invited international plenary speakers contribute papers and discussions on selected themes of either outstanding universal topicality or of special relevance to up-to-date issues in tropical ecology in order to promote scientific exchange with the participants, man of which usually are students. The conferences provide an international platform for the exchange of scientific ideas and the establishment of collaborations between members and their guests. The gtö is especially dedicated to fostering junior research and equitable cooperation projects. In 2012, the Elisabeth-Kalko-Memorial-Lecture was established in memory of our former vice-president and highly esteemed colleague Prof. Dr. Elisabeth Kalko. The lecture is open to the public and is given in the language of the hosting city in order to establish a link between the society and the public.

Our vision:
Understanding biodiversity and functions of tropical ecosystems drives decision making and management on all levels.

Our mission:
Promoting the conservation and rehabilitation of tropical biodiversity and ecosystems through research and its application.

MERIAN AWARD

In 2001 the gtö established the Merian Awards for the best contributions given by young scientists during the annual meeting. There are six Merian Awards annually, three for the best oral contributions and three for the best posters. ECOTROPICA – the society's journal – highlights these contributions by publishing the abstracts. The gtö has selected Maria Sibylla Merian as the patron of the award to commemorate her unique work as an outstanding artist and as the first female tropical naturalist who actually travelled to the tropics in order to study their fascinating diversity, in particular insects. She was the first scientist who recognized, and documented in her artistic work, that insects go through various developmental stages. This is particularly remarkable as the general public in her time still believed that, for instance, mosquitoes and caterpillars were generated in mud by the evil.

Who is eligible and how to apply

Eligible candidates are students and PhDs who are members of the gtö and finished their dissertation less than three years ago. If you are not a member yet, just apply at the registration desk before the conference starts.

The winners will be awarded during the closing ceremony on
Friday 26th February, 16:00 – 16:45.

DETAILED CONFERENCE PROGRAM

Talks and Posters shaded in this background color are eligible for the Merian Award

TUESDAY, 23 FEBRUARY 2016

09:00	Start of registration		
10:00	Guided tour to the Deutsches Primatenzentrum for DAAD alumni		
12:00	Guided tour to the Deutsches Primatenzentrum		
14:00	Opening ceremony, MN 08		
14:30	**Plenary talk 1:** **Richard Corlett** Pantropical similarities and differences in plant-animal interactions: origins and consequences Room: MN 08		
15:15	Parallel sessions		
Sessions	S1: PLANT-ANIMAL INTERACTIONS ACROSS NATURAL AND HUMAN-INDUCED ENVIRONMENTAL GRADIENTS, P. 44	S2: APPLIED MOLECULAR ECOLOGY IN THE TROPICS, P. 56	S3: ECOLOGICAL FACTORS INFLUENCING WILDLIFE HEALTH, P. 74
Chairs	Ingo Grass & Eike Lena Neuschulz	Emma Morgan	Marco Tschapka
Room	MN 08	MN 09	MN 14
15:15	**S1-O1: Marta Quitián** Interactions among frugivorous birds and fruiting plants: interaction networks and functional diversity	**S2-O1: Paulina Zigelski** Trees going underground: How genetics and environment shape the Zambezian Miombo Region	**S3-O1: Luis Viqez-R** Trypanosomiasis and leishmaniasis in bats: evaluating the environmental disturbance influence in the greater Lacandona ecosystem, Mexico
15:30	**S1-O2: Irene M. A. Bender** Feeding originality and flexibility of birds in plant-frugivore interaction networks	**S2-O2: Jennifer Brunke** The role of geographic barriers in shaping the genetic structure of Bornean small mammals	**S3-O2: Thomas Hiller** Anthropogenic factors shape TBHBV infection patterns in the Neotropical tent-making bat *Uroderma bilobatum*
15:45	**S1-O3: Matthias Schleuning** Changes in hummingbird specialization along a spatiotemporal gradient in resource abundance	**S2-O3: James Smith** How consistent is fine-scale genetic structure within tropical tree species? A dipterocarp case study	**S3-O3: Stefan Dominik Brändel** Host-specific traits as drivers of astrovirus infections in common Neotropical bats resilient to habitat alteration

16:00	**S1-O4: Sara Leonhardt** A matter of diversity: how landscape related resource diversity benefits tropical pollinators	**S2-O4: Sascha A. Ismail** What can population genetic investigations contribute to save the rarest of the rare?	**S3-O4: Julian Schmid** Does habitat disturbance increase Hepaci virus infection in a generalist rodent?
16:15	**S1-O5: Helena Maura Torezan-Silingardi** Do ant visitors to extrafloral nectaries of plants repel pollinators and cause an indirect cost of mutualism?	**S2-O5: Mercedes Thieme** Genetic resources in a changing environment - Baobab (*Adansonia digitata* L.) in Kenya	**S3-O5: Marco Marklewitz** Trends in mosquito infection rates at the rainforest edge - a multitaxa study on the dilution effect hypothesis
16:30	Coffee break		
Sessions	S1 CONTINUED	S2 CONTINUED	S4: TROPICAL WETLAND ECOLOGY, P. 80
Chairs	Ingo Grass & Eike Lena Neuschulz	Emma Morgan	Pia Parolin & Leandro V. Ferreira
Room	MN 08	MN 09	MN 14
17:00	**S1-O6: Kleber Del-Claro** Lycaenidae-ant mutualism in a tropical savannah: conditional outcomes depending on ant presence and identity.	**S2-O6: Ludwig Triest** *Cyperus papyrus* swamps of Lake Naivasha originate mainly from local seedling recruitment whereas mature stands maintain clonal diversity	**S4-O1: Rasmus Revermann** Linking land surface phenology and vegetation-plot databases to predict species diversity and distributions in the Okavango Basin
17:15	**S1-O7: Michael Staab** Ants at plant wounds - The relevance and structure of an underestimated food web	**S2-O7: Emma Morgan** Keeping it in the family: patterns of relatedness and mating in the dioecious palm Lodoicea maldivica, the largest-seeded plant in the world	**S4-O2: Addisie Geremew** Clonal and genetic diversity of *Cyperus papyrus* is structured by hydrological connectivity and vegetative spread in Lake Tana (Ethiopia)
17:30	**S1-O8: Felix Fornhoff** Tri-trophic interaction networks in an experimental tree diversity gradient in subtropical China	**S2-O8: Alexandra C. Ley** Spatially limited clonality, pollen and seed dispersal in a climber of Central African rain forests: *Haumania danckelmaniana* (Marantaceae)	**S4-O3: Esmaeil Kouhgardi** Water quality changes in Izeh Miangaran Wetland affected by wastewaters and surface waters

17:45	**S1-O9: Martin Volf** Divergent chemical syndromes in species rich plant genera: the case in *Ficus* local community in Papua New Guinea	**S2-O9: Andreas Wilting** Camera-trapping vs. iDNA for wildlife surveys; costs, efficiency and reliability	**S4-O4: Pia Parolin** Dam-induced forest fragmentation has extreme border effects on tree physiology
18:00	**S1-O10: Owen Lewis** Effects of pathogens and insect herbivores on plant dynamics and diversity across a natural rainfall gradient	**S2-O10: Jérémy Migliore** Understanding the history of African shade-tolerant and pioneer rainforest trees, applying new genomic tools to phylogeography	**S4-O5: Maria Tersa V. N. Abdo** An example of a riparian forest restoration in Pindorama, Brazil
18:15	**S1-O11: Anita Weißflog** Insect herbivory and predation pressure across a tropical rainfall and tree species richness gradient	**S2-O11: Magdalene Ngeve** Bidirectional gene flow on a river mangrove landscape and between-catchment dispersal of *Rhizophora racemosa* (Rhizophoraceae)	**S4-O6: Jean Hugé** Whose mangrove is it and what is it for?
18:30	Welcome reception, Poster party, Intersociety mixer		

WEDNESDAY, 24 FEBRUARY 2016

08:30	**Plenary talk 2:** **Yadvinder Malhi** New insights into the metabolism and carbon cycle of tropical forests from a global network of intensive monitoring plots Room: MN 08		
09:15	Parallel sessions		
Sessions	S5: DEVELOPING SUSTAINABLE LAND USE AND FUNCTIONAL MONITORING SYSTEMS FOR THE ECUADORIAN ANDES TO COPE WITH ENVIRONMENTAL CHANGE EFFECTS - TOWARDS ACCESS AND BENEFIT SHARING (ABS), P. 88	S2 CONTINUED	S6: DIVERSITY, ECOLOGY AND CONSERVATION OF MADAGASCAR'S UNIQUE NATURE, P. 110
Chairs	Jörg Bendix & Erwin Beck	Emma Morgan	Jasmin Mantilla Contreras & Ute Radespiel
Room	MN 08	MN 09	MN 14
09:15	**S5-01: Jörg Bendix** Platform for Biodiversity, Ecosystem Monitoring and Research South Ecuador - basic research goes knowledge transfer	**S2-O12: Khalid Khan** Diversity and antimicrobial activity of gut microbiota isolated from the native honey bee (*Apis mellifera jemenitica*) of Saudi Arabia	**S6-O1: Maholy Ravaloharimanitra** Linking conservation and sustainable development through building local management capacities in Madagascar
09:30	**S5-O2: Thomas Knoke** Optimizing ecosystem services suggests diversified restoration of abandoned tropical pastures	**S2-O13: Olivier Hardy** The prevalence of cryptic plant species in African rain forest trees - Insights from population genetics approaches	**S6-O2: Jan Barkmann** Sustainability challenges in protecting Marojejy National Park
09:45	**S5-O3: Carola Paul** Effects of extreme weather events under increased food demand on deforestation - an economic modelling approach for Ecuador	**S2-O14: David Boshier** Combining field and laboratory provide a fuller picture to differentiate management and conservation of two threatened Neotropical tree species	**S6-O3: Roman Fricke** Land use and plant diversity in the spiny forest biome - who will survive in a cultural landscape?
10:00	**S5-O4: Katja Trachte** Analysis of climate change effects on different ecosystems applying the high resolution Climate Indicator System (hrCIS) for South Ecuador	**S2-O15: Mathias Scharmann** Speciation in the tropics: joint demographic history of sympatric carnivorous *Nepenthes* pitcher plants in Borneo	**S6-O4: Marvin Luck** Open range and long legs - The morphology of ants in traditional land-use systems on the Mahafaly Plateau (Madagascar)
10:15	**S5-O5: Achim Bräuning** Tree growth and stable oxygen isotopes as indicators of ecosystem response to climate variability in different forest ecosystems in southern Ecuador	**S2-O16: Pablo Orozco-ter Wengel** The domestication history of sheep and goat	**S6-O5: Elizabeth Finch** The effect of land-use changes on ant communities in Madagascar
10:30	Coffee break		
Sessions	S5 CONTINUED	S7: HUMAN-MODIFIED TROPICAL FORESTS? IMPACTS OF FOREST DEGRADATION AND BIODIVERSITY LOSS ON TROPICAL ECOSYSTEM FUNCTIONING, P. 122	S6 CONTINUED
Chairs	Jörg Bendix & Erwin Beck	Yit Arn Teh & Rebecca J. Morris	Jasmin Mantilla Contreras & Ute Radespiel
Room	MN 08	MN 09	MN 14
11:00	**S5-O6: Andre Velescu** Response of the element budgets of a tropical montane forest to climate change and nitrogen deposition	**S7-O1: Rebecca J. Morris** Biodiversity, ecosystem functioning and policy across a tropical forest modification gradient: an overview of research by the LOMBOK consortium	**S6-O6: Pina Lena Lammers** Conservation in rural areas in developing countries - Park Bandro, a case study of a small-scale conservation project at Lake Alaotra, Madagascar
11:15	**S5-O7: Jürgen Homeier** Effects of continued N and P addition on Ecuadorian Andean forests	**S7-O2: Ute Skiba** The impact of landuse change from forest to oil palm on soil greenhouse gas and biogenic VOC fluxes	**S6-O7: Tsiry Fanilonirina Rakotoarisoa** Are water hyacinth fertilizers opportunities for agriculture at Lake Alaotra, Madagascar?
11:30	**S5-O8 Jhenny Salgado** Effects of moderate nutrient addition on below-ground carbon allocation in Andean forests	**S7-O3: Kate Parr** Do the 'little' things run the world? Exploring the functional importance of ants	**S6-O8: Torsten Richter** Evaluation of an environmental education comic distributed in primary schools at Lake Alaotra, Madagascar

WEDNESDAY

11:45	**S5-O9: Susanne Spannl** Nutrient-induced modification of wood anatomical traits of *Alchornea Lojaensis* Revealed by x-ray micro tomography and quantitative wood analyses	**S7-O4: Mohd Shahrul Mohd Nadzir** Preliminary study of Biogenic Volatile Organic Compounds emission from Sabah's termites during BALI project	**S6-O9: Lena M. Reibelt** Drivers and barriers to environmental education in the Alaotra primary schools, Madagascar
12:00	**S5-O10: Tessa Camenzind** Functionality of arbuscular mycorrhizal fungi in the tropical montane forest of southern Ecuador	**S7-O5: Steffen Mumme** Functional diversity and stability of litter-invertebrate communities following tropical land-use change	**S6-O10: Hantanirina Rasamimanana** Science and art!
12:15	**S5-O11: Laura Margarita Sanchez Galindo** Litter mixture effects on microbial biomass and microarthropod colonization in a tropical montane rain forest in Southern Ecuador	**S7-O6: Paul Luis Schmidt Yáñez** Effect of *Rubus* control on arthropod abundance and diversity of *Scalesia* forest sites on Santa Cruz, Galápagos	
12:30	Lunch		
13:30	**Plenary talk 3:** **Lourens Poorter** The potential of secondary forests: how fast do they recover in terms of carbon and biodiversity? Room: MN 08		
14:15	Parallel sessions		
Sessions	**S8: BIOGEOCHEMISTRY AND BIODIVERSITY OF TROPICAL FOREST ECOSYSTEMS IN A CHANGING CLIMATE: RELATING OBSERVATIONS TO MODELLING,** **P. 134**	**S7 CONTINUED**	
Chairs	Anja Ramig & Kirsten Thonicke	Yit Arn Teh & Rebecca J. Morris	
Room	MN 08	MN 09	MN 14
14:15	**S8-O1: Katrin Fleischer** Tropical forest response to elevated CO_2: Model-experiment integration at the AmazonFACE site	**S7-O7: Josephine Sahner** Fungal communities along a tropical land-use gradient (Sumatra, Indonesia)	

14:30	**S8-O2: Bart Kruijt** Sensitivity of Amazonia to climate change: the main uncertainties are effects of drought, elevated temperature and elevated CO_2	**S7-O8 Piotr Szefer** Fungi pathogens can increase plant richness and diversity in early stages of tropical forest succession	
14:45	**S8-O3: Stefan Kupers** The effect of soil moisture on seedling demography in Panama	**S7-O9: Johanna Toivonen** Variations in bryophyte cover in relation to forest structure and microclimate in tropical cloud forests of Andean Amazonia	
15:00	**S8-O4: Han Dolman** The Amazon rainforest: biomass stability, tipping points and early warning signals	**S7-O10: Mukhlish Jamal Musa Holle** Distribution and Abundance of Seedlings, Saplings and Trees: Case Study of Urban Forest in Malang City, Indonesia	
15:15	**S8-O5: Henry Hooghiemstra** Pleistocene ecological dynamics in the northern Andes	**S7-O11: Olivier Boissier** Human-induced modifications of the frugivore community translate into reduced seed removal at the community level in a Neotropical rainforest	
15:30	**S8-O6: Aster Gebrekirstos** The effect of changing climate conditions revealed by stable isotopes in tree rings in sub-saharan Africa	Coffee break	
16:00	Poster Session		
S1	SPECIES INTERACTIONS AND ENVIRONMENTAL GRADIENTS		
P1	Does baboon seed dispersal promote invasion by Opuntia? (p. 271)		
P2	Vegetation composition and functional diversity along environmental gradients in a southern African savanna (p. 272)		
S2	APPLIED MOLECULAR ECOLOGY		
P1	Trees going underground: How genetics and environment shape the Zambezian Miombo Region (p. 273)		
P2	Introducing a new method by applying molecular biology to the ecosystem damage assessment of the natural tropical forest of south of Iran (p. 274)		
P3	Change of genetic diversity of dominant plant species communities in tropical lowland rainforest transformation systems in Sumatra (Indonesia) (p. 275)		

S11	DIVERSITY AND INTERACTIONS ALONG ELEVATIONAL GRADIENTS
P1	Ecology of bird communities along an elevational tropical gradient in Papua New Guinea (p. 314)
P2	Diversity of vascular epiphytes along gradients of elevation and anthropogenic influence at Cofre de Perote, Veracruz, Mexico (p. 315)
P3	First plot based richness data of ferns and angiosperms along elevational gradients in Myanmar and the Himalayas (p. 316)
P4	Vegetation patterns on seven high-Andean summits: Results of two Venezuelan sites of the GLORIA climate change network (p. 317)
P5	Gradients and drivers of Amazonian tree bark and leaf litter beetle diversity (p. 318)
S12	FREE TOPICS
P1	Allometric scaling relationships in the morphology of temperate and tropical arthropods (p. 319)
P2	National Park Management in Africa - Protecting biodiversity in the framework of development cooperation (p. 320)
P3	Bat conservation in Cusuco: trends of annual monitoring of the cloud forest fauna (p. 321)
P4	A standard protocol for woody plant inventories and soil characterization using temporary 0.1-ha plots in tropical forests (p. 322)
P5	camtrapR: An R package for efficient camera trap data management (p. 323)
P6	Sampling for regression-based spatial prediction: Closing the gap between statistical desires and operational applicability (p. 324)
P7	The evolutionary history of central African rain forest plants: phylogeographic insights from sister species of the liana Haumania (Marantaceae) (p. 325)
P8	Taxonomic review of Hoffmannia Sw Genree. (Rubiaceae) in Veracruz State (p. 326)
P9	Reproductive biology of Spathiphyllum cochlearispathum and Spathiphyllum ortgiesii (Araceae) in Los Tuxtlas, Veracruz, Mexico (p. 327)
P10	Occurrence of Bacillus cereus in raw milk with reference to its molecular profile diversity (p. 328)
P11	Fire frequency and its effect on the habitat use of Four-horned Antelope and Sambhar in dry deciduous forest in India (p. 329)
S13	MANAGING OIL PALM FOR BIODIVERSITY AND PRODUCTION
P1	The appropriate technique for water quality assessment in oil palm plantations (p. 330)
P2	Spider diversity in the oil palm landscape (p. 331)
P3	Long-term effects of crop residue application on soil biota activities and functions in oil palm agroecosystems (p. 332)
P4	Ecological restoration in an oil palm landscape: early performance of trees planted in a biodiversity enrichment experiment (p. 333)

S14	TROPICAL FOREST LANDSCAPES
P1	A win:win tropical landscape restoration: Evidence from cocoa agroforestry system (p. 334)
P2	Bee diversity responses to landscape composition in the Andes of Colombia (p. 335)
P3	Impact of emerging charcoal production in the Miombo woodlands of Chitembo, south-central Angola (p. 336)
P4	Vegetation characterization by edaphic and phytosociological attributes, Pindorama Biological Reserve- SP- Brazil (p. 337)
S15	TROPICAL ECOLOGY AND BIODIVERSITY RESEARCH IN PERU
P1	Building communal capacities in the Amazon along FOCAL: A Strategy to halt and reverse deforestation (p. 338)
S16	SPECIES DOMINANCE IN TROPICAL FORESTS
P1	Evaluation of the abundance and frequency of the regeneration status of the primary forest in the Cuc Phuong National Park in Vietnam (p. 339)
S17	ENVIRONMENTAL GRADIENTS: TRAITS AND PROCESSES
P1	A comparison of biomass, productivity and leaf functional traits between terrestrial ferns and trees along an Andean tropical elevational gradient (p. 340)
P2	Paramo response to human influence: A trait-based approach (p. 341)
P3	Effects of altitude and time on arbuscular mycorrhizal fungal community dynamics: A case study from the south Andes of Ecuador (p. 342)
S18	KNOWING THE UNKNOWN
P1	From identification to floristic comparison of Caatinga-forests (p. 343)
DAAD	ALUMNI
P1	Potential long-term effect of farm herbicide application on arthropod diversity and abundance (p. 344)
P2	The effects of land use changes on belowground carbon loss in Tripa Peat Swamp Forest (p. 345)
P3	Guadalupe dam catchment, a forested and biodiverse rural to urban region near Mexico City (p. 346)
P4	Land use change and sustainability through Reciprocal Watershed Agreements in the Bolivian forests (p. 347)
P5	Carbon Stocks assessment of a reforestation site in marginal upland in Leyte (Philippines) (p. 348)

P6	Endangered species in endangered ecosystems: Assessment of endemic butterflies in Venezuela (p. 349)
P7	Drought forecasting, assessment and water allocation strategies under climate change: The 2011-2015 drougt period in northeast Brazil and the water crisis of the Cantareira System (São Paulo) (p. 350)
P8	Substitution of a traditional diet as a risk factor for socio-environmental health in rural areas of central Mexico (p. 351)
P9	Common resource management by different users with diverse interests: a sustainability (p. 352)
P10	Insect diversity conservation: status of the tropical ecosystem in Nigeria (p. 353)
P11	Plants suppress their emission of volatiles when growing with conspecifics (p. 354)
P12	Role of soil cover and wild vegetation in maintaining biodiversity and beneficial fauna in the olive groves (p. 355)
P13	Uses of trees in the Mexican tropics (p. 356)
P14	Cocoa production for sustainable development in forest regions? The case of a producers association in Satipo, Perú (p. 357)
P15	Progress in rice research activities in Eastern and Southern Africa (p. 358)
P16	The status of rare tree species following logging in a tropical limestone forest, Northern Vietnam (p. 359)
P17	Women and forest management in rural communities in the South West Region of Cameroon (p. 360)
P18	Reducing the pressure on the critically endangered blue-eyed black lemur by means of education and technical support to the population (p. 361)
P19	Challenges for planning and public management about the “Mother Earth” regulations (p. 362)
P20	Applying the Ecological Integrity (IE) concept for the management of the Bita River (Eastern Colombia) (p. 363)
P21	A model of sustainability analysis in La Amistad Panama Biosphere Reserve (p. 364)
P22	Black soldier flies driven-feed: Achieving the rising demand for protein through recycling organic waste (p. 365)
P23	Using stable isotopes in tree-rings to understand tree performance (p. 366)
P24	Challenges in conserving and managing coastal and marine ecosystems of Myanmar (p. 367)
P25	Indicators of Sustainable Forest Management in the tropics: Brazilian Amazon and the world scenery (p. 368)
19:00	Public lecture - Elisabeth Kalko Memorial Lecture Alexandra-Maria Klein Blütenbestäubende Tiere: faszinierende Vielfalt und große Bedeutung [Pollinating animals: fascinating diversity and high importance] Aula of the University of Göttingen, Wilhelmsplatz 1

THURSDAY, 25 FEBRUARY 2016

08:30	**Plenary talk 4:** **Susan Page** Swamped! The trials and tribulations of tropical peatland science Room: MN 08		
09:15	Parallel sessions		
Sessions	S10: PAST, PRESENT AND FUTURE OF TROPICAL (WETLAND) ECOSYSTEMS, P. 150	S11: BIODIVERSITY, BIOTIC INTERACTIONS AND ECOSYSTEM PROCESSES ALONG ELEVATIONAL GRADIENTS, P. 170	S12: FREE TOPICS, P. 194
Chairs	Hermann Behling & Katherine Roucoux	Katerina Sam & Marcell K. Peters	N.N.
Room	MN 08	MN 09	MN 14
09:15	**S10-O1: Siria Biagioni** What can be learned from the past? An introduction to the session "Past, present and future of tropical (wetland) ecosystems"	**S11-O1: Vojtech Novotny** Plant-insect food webs along altitudinal and latitudinal gradients in forest ecosystems	**S12-O1: Carlos Quiroz Dahik** Carbon sequestration in Pine plantations on Páramo sites
09:30	**S10-O2: William Gosling** Ecological baselines for the high Andes	**S11-O2: Simon Segar** Moths and mountains: the role of altitude and defensive chemistry in structuring insect herbivore communities on Ficus in Papua New Guinea	**S12-O2: Jyoti Kashyap** Fire frequency and plant diversity in tropical dry deciduous forest: A case study of Kumbhalgarh Wildlife Sanctuary, India
09:45	**S10-O3: Macarena L. Cárdenas** Araucaria forest, human land use, and climate change linkages in southern Brazil during the late Holocene	**S11-O3: Legi Sam** Beta-diversity and host-specificity of Lepidoptera feeding on *Ficus* (Moraceae) along a complete elevational gradient in Papua New Guinea	**S12-O3: Mahmoud Bayat** Physiographic control of spatial tree diversity in high-elevation, oriental beech (*Fagus orientalis*)-dominated forests in northern Iran
10:00	**S10-O4: Christina Ani Setyaningsih** Holocene vegetation dynamics of sub-montane rainforests following volcanic deposition in the Kerinci Seblat National Park, Sumatra (Indonesia)	**S11-O4: Katerina Sam** Elevational patterns in predation, herbivore performance and herbivory in hostile and enemy free space	**S12-O4: Delphine C. Zemp** Self-amplified Amazon forest loss with dry-season intensification
10:15	**S10-O5: Lisa Schüler-Goldbach** Tracing 25,000 years of vegetation dynamics in the savanna of south-eastern Kenya: the Lake Challa pollen record	**S11-O5: Jimmy Moses** A tropical elevational gradient in ants: Diversity patterns, food preferences and scavenging activities on Mt Wilhelm, Papua New Guinea	
10:30	Coffee break		
Sessions	S10 CONTINUED	S11 CONTINUED	S9: LAND USE CHANGE AND LAND MANAGEMENT: REGIONAL CONFLICTS AND SUSTAINABLE DEVELOPMENT OF TROPICAL ECOSYSTEMS, P. 142
Chairs	Hermann Behling & Katherine Roucoux	Katerina Sam & Marcell K. Peters	Gerhard Gerold & Stefanie Steinebach
Room	MN 08	MN 09	MN 14
11:00	**S10-O6: Paula A. Rodríguez-Zorro** Mid-Holocene shift from dry to wetter conditions in northwestern Amazonia, inferred from pollen and charcoal analysis, a regional overview	**S11-O6: Nichola S. Plowman** Network simplification and the breakdown of an ant-plant protective mutualism with elevation	**S9-O1: Jonas Hein** Transnationalized land conflicts in the context of REDD+, insights from Jambi, Indonesia
11:15	**S10-O7: Hermann Behling** Long-term dynamics of Amazonian rainforest and wetland ecosystems and the role of climate, sea-level, fire and human impact	**S11-O7: Ondřej Mottl** The effect of forest succession on arboreal ant communities in a tropical mountain forest in New Guinea	**S9-O2: Joëlle Mukungu** How to achieve effective participation of communities in the monitoring of REDD+ projects: A case study on the Democratic Republic of Congo (DRC)
11:30	**S10-O8: Viktoriia Radchuk** Learn from paleo-climates: semi-permeability of Isthmus of Kra for mammal movements during Pleistocene	**S11-O8: Alice Claßen** Integrating intraspecific variation in community ecology unifies contrasting theories on body size shifts along climatic gradients	**S9-O3: Olusola Adeoye** On land use and sustainable livelihood: Analyzing the drivers of degradation of grazed ecosystems in the Lake Chad Basin
11:45	**S10-O9: Katherine Roucoux** Long-term development of western Amazonian peatlands: patterns and processes	**S11-O9: David Hořák** Avian diversity along elevational gradient of Mount Cameroon, West-Central Africa	**S9-O4: Elena Mechik** Analysis of forest communities' economic activities based on a sustainable development concept

THURSDAY

12:00	**S10-O10: Thomas J. Kelly** The most carbon-dense ecosystems in Amazonia: the long-term development of a domed Peruvian peatland	**S11-O10: Ondřej Sedláček** Seasonality in singing activity of rainforest bird communities along elevational gradient of Mount Cameroon, West Africa	**S9-O5: Karabi Pathak** Are grasslands carbon negative?
12:15	**S10-O11: Freddie Draper** Understanding floristic patterns in time and space in West Amazonian peatlands	**S11-O11: Anna Humlova** Tropical birds can smell trees calling for help along an elevational gradient: An experiment with chemically and manually induced herbivory	**S9-O6: Ulf Schneidewind** Indicators for carbon cycling in organic and conventionally managed cacao production systems in Alto Beni, Bolivia
12:30	**S10-O12: Kamaleddin Alizadeh** Reconstructing 7000 years environmental change in Serra Sul dos Cara's, using palynology, soil chemistry and remote sensing: a new approach		**S9-O7: Romaric Vihotogbé** Explaining spatial pattern of the abundance of African bush mango trees in West Africa
12:30	Lunch		
13:30	**Plenary talk 5:** **Ravi Prabhu** Use it or lose it: Diversity and resilience challenges in managed tropical ecosystems Room: MN 08		
14:15	Parallel sessions		

Sessions	S13: MANAGING OIL PALM LANDSCAPES FOR BIODIVERSITY AND PRODUCTION: LESSONS FROM SE ASIA, P. 208	S5 CONTINUED	S12 CONTINUED
Chairs	Edgar Turner & Teja Tscharntke	Jörg Bendix & Erwin Beck	N.N.
Room	MN 08	MN 09	MN 14
14:15	**S13-01: Adham Ashton-Butt** What do we know about the impact of oil palm plantations on the environment?	**S5-O12: Christine Wallis** Spatial predictability of alpha- and beta-diversity of four taxa along an elevation gradient in a mountain rainforest ecosystem	**S12-O5: Minnattallah Boutros** Bridging the gap - Biodiversity conservation in the frameworks of research and development cooperation
14:30	**S13-O2: Furong Niu** Transpiration changes by transforming tropical rainforest to rubber and oil palm plantations	**S5-O13: Vinicio Santillan** Monitoring bird diversity across elevational and land-use gradients in Southern Ecuador	**S12-O6: Mona van Schingen** Linking ecological research with conservation: A case study on the endangered Crocodile Lizard in Vietnam
14:45	**S13-O3: Syahrul Kurniawan** Nutrient leaching and nutrient retention efficiency from lowland forest converted to oil palm and rubber plantations in Sumatra, Indonesia	**S5-O14: David Siddons** Matrix heterogeneity enhances bird movement in a fragmented High-Andes landscape	**S12-O7: Giorgia Camperio Ciani** Galapagos giant tortoises and farmers: coexistence or conflict?
15:00	**S13-O4: Sarah Luke** Impacts of logging and oil palm on freshwater macroinvertebrates and their potential as bioindicators to assess health of SE Asian streams	**S5-O15: Yvonne Tiede** Ants as functional indicators in megadiverse mountain rainforests in Ecuador	**S12-O8: Diogo Ferreira** Effects of seasonality on the responses of Neotropical bats to local- and landscape-scale attributes in a fragmented landscape
15:15	**S13-05: Marion Pfeifer** Mapping ecosystem functions in human-modified tropical landscapes	**S5-O16 Philipp Butz** Tree water use patterns at different topographic positions in a submontane tropical dry forest	**S12-O9: Thorsten Krömer** Nectarivorous bat *Anoura geoffroyi* as pollinator of the epiphytic bromeliad *Tillandsia macropetala* in Central Veracruz, Mexico
15:30	Coffee break		

Sessions	S13 CONTINUED	S5 CONTINUED	S10 CONTINUED
Chairs	Edgar Turner & Teja Tscharntke	Jörg Bendix & Erwin Beck	Hermann Behling & Katherine Roucoux
Room	MN 08	MN 09	MN 14
16:00	**S13-O6: William Foster** The Biodiversity and Ecosystem Function in Tropical Agriculture Project: investigating options for sustainable oil palm	**S5-O17: Simone Stobl** Carbon gain and diurnal water consumption strategies of trees in a Neotropical mountain rain forest	**S10-O13: Kartika Hapsari** Deglacial and Holocene environmental and peat-carbon accumulation dynamics of a peatland in the coastal area of Central Sumatra, Indonesia
16:15	**S13-O7: Yayan Wahyu Candra Kusuma** The impact of forest conversion on alien species invasion and the phylogenetic structure of understory plant communities in Sumatra (Indonesia)	**S5-O18: Brenner Silva** Water response in the tropical mountain forest using ground and satellite observations	**S10-O14: Erik de Boer** Impact of human arrival on the oceanic islands of Mauritius and Rodrigues
16:30	**S13-O8: Jake Snaddon** Effects of understory vegetation and soil management practices on soil biodiversity and ecosystem functions in oil palm plantations	**S5-O19: Julia Adams** Optimization of regeneration of abandoned pasture areas and subsequent sustainable pasture management in the Andes of South Ecuador	**S10-O15: Suzette G. A. Flantua** Human impact and climate reconstructions from South American pollen records during the last 2000 years
16:45	**S13-O9: Julie Hinsch** Wasps as biocontrol agents in oil palm - a potential way of increasing biodiversity in oil palm	**S5-O20: Mareike Ließ** Spatial prediction of soil organic carbon stocks by methodological specifications in machine learning approaches	**S10-O16: Crystal McMichael** Phytolith signatures along a gradient of ancient human disturbance in western Amazonia

17:00	**S13-O10: Evelyn Hassler** Fertilizer-induced soil N_2O and NO fluxes from smallholder oil palm plantations following deforestation in Sumatra, Indonesia	**S5-O21: Erwin Beck** Biodiversity research under complex control: A new era opens up	**S10-O17: Laura Macario Gonzalez** Linking altitudinal effects of current biota with modeled scenarios and paleo-records of freshwater ostracodes from the Neotropics
17:15	**S13-O11: Amanda Matson** Tree-stem emissions of N_2O increase with fertilizer application in lowland tropical oil palm plantations		**S10-O18: Sergio Cohuo** History of geographical parthenogenesis of Neotropical Ostracoda using fossil and molecular data - a consequence of climate fluctuations?
17:30	Membership assembly; MN 08		
20:00	Conference dinner Deutsches Theater		

FRIDAY, 26 FEBRUARY 2016

08:30	**Plenary talk 6:** **Martine Hossaert-McKey** Chemical mediators and mutualistic interactions in the tropics Room: MN 08		
09:15	Parallel sessions		
Sessions	S11 CONTINUED	S14: TROPICAL FOREST LANDSCAPES: FROM ECOLOGY TO SUSTAINABLE MANAGEMENT, P. 226	S13 CONTINUED
Chairs	Katerina Sam & Marcell K. Peters	Sven Günter	Edgar Turner & Teja Tscharntke
Room	MN 08	MN 09	MN 14
09:15	**S11-O12: Marcell K. Peters** Transformation of elevational diversity gradients by human impact	**S14-O1: Souleymane Konaté** Biodiversity conservation as facilitator of development in West Africa: deforestation, agriculture and sustainable development in Côte d'Ivoire	**S13-O12: Holger Kreft** Biodiversity enrichment in oil palm plantations - a large-scale, long-term experiment
09:30	**S11-O13: Maximilian Vollstädt** Effects of land-use and climate on seed-dispersal networks on Mt. Kilimanjaro, Tanzania	**S14-O2: Manfred Finckh** Tool or disaster - logics and trade-offs behind wildfires in the Okavango Basin	**S13-O13: Kevin Darras** The role of ants, birds and bats for ecosystem functions in oil palm plantations
09:45	**S11-O14: Friederike Gebert** Dung beetle assemblages and their contribution to decomposition along elevational and land use gradients on Mt. Kilimanjaro	**S14-O3: John Mathai** Conservation priorities for Borneo's diverse carnivore community	**S13-O14: Graham Prescott** Retaining biodiversity in intensive farmland: epiphyte removal in oil palm plantations does not affect yield
10:00	**S11-O15: Franca Marian** Decomposition of leaf and root litter in tropical montane rain forests along an altitudinal gradient in Southern Ecuador	**S14-O4: Bea Maas** Birds, bats and wildlife-friendly farming landscapes in the tropics - global patterns and remaining challenges	**S13-O15: Jennifer Lucey** How can we maximise biodiversity and ecosystem services in oil palm landscapes? Providing the evidence base to aid better policy-making
10:15	**S11-O16: Jeanette Whitaker** Indirect effects of climate change on soil carbon cycling in the Peruvian Amazon-Andes	**S14-O5: Jürgen Niedballa** Improving and applying occupancy models to assess the biodiversity co-benefits of forest certification	**S13-O16: John Garcia-Ulloa** The conservation scope of sustainability tools and initiatives in the oil-palm industry: Scales, synergies and gaps
10:30	Coffee break		
Sessions	S11 CONTINUED	S14 CONTINUED	S15: GERMAN AND EUROPEAN TROPICAL ECOLOGY AND BIODIVERSITY RESEARCH IN PERU, P. 238
Chairs	Katerina Sam & Marcell K. Peters	Sven Günter	Lily O. Rodriguez & Reiner Zimmermann
Room	MN 08	MN 09	MN 14
11:00	**S11-O17 Dietrich Hertel** Changes in the fine root system of neo- and paleotropical forests along elevational gradients – results from a meta-analysis and case studies	**S14-O6: Fritz Kleinschroth** Roadless space and logging in intact forest landscapes of the Congo Basin	**S15-O1: Maximilian Weigend** Pattern and process in Andean biodiversity
11:15	**S11-O18: David Schellenberger Costa** Epiphyte trait space compared to terrestrial vascular plants at Mt Kilimanjaro, Tanzania	**S14-O7: Marion Karmann** Forest management certification: Management of Intact Forest Landscapes; HCV and other new approaches & research needs	**S15-O2: Armin Niessner** Annual tree growth dynamics and water use along an altitudinal gradient at the isolated West Amazon Mountain Range „El Sira" in Peru
11:30	**S11-O19: Dirk Nikolaus Karger** Global evolution of elevational gradients of fern species richness	**S14-O8: Claudia Armijos-Ojeda** Social network analysis of the governance framework in Ecuador as a basis for sustainable management of forest genetic resources	**S15-O3: Eckhard W. Heymann** Estación Biológica Quebrada Blanco – research opportunities in the Peruvian Amazon lowlands
11:45	**S11-O20: Jorge Antonio Gomez Diaz** Species richness and distribution of herbaceous angiosperms along gradients of elevation and human disturbance in central Veracruz, Mexico	**S14-O9: Sven Günter** Putting the pieces together: Landscape forestry in the tropics	**S15-O4: Katherine Roucoux** Amazonian peatlands: vulnerability and opportunities for conservation and long-term carbon storage

12:00	S11-O21: Fabian Brambach Relationships between elevation and the biogeography of tree species in Malesia - insights from plot-based inventories		S15-O5: Alejandro Guarin Global carbon markets, deforestation and the livelihoods of smallholders in the Peruvian Amazon
12:15	S11-O22: César Isidro Carvajal-Hernández Conservation value of disturbed and secondary forests for ferns and lycophytes along a subtropical elevational gradient		S15-O6: Lily O. Rodriguez Tropical ecology and biodiversity research in Peru: an overview
12:30	Lunch		
13:30	Parallel sessions		
Sessions	S16: PATTERNS AND PROCESSES OF SPECIES DOMINANCE IN TROPICAL FORESTS, P. 246	S17: LINKING FUNCTIONAL TRAITS WITH ECOSYSTEM PROCESSES ALONG TROPICAL ENVIRONMENTAL GRADIENTS, P. 256	S12 CONTINUED
Chairs	Gabriel Arellano & Manuel J. Macía	Imma Oliveras & Masha van der Sande	N.N.
Room	MN 08	MN 09	MN 14
13:30	S16-O1: Kyle Dexter Patterns of dominance in tree communities vary across the major biomes of lowland tropical South America	S17-O1: Yadvinder Malhi Traits and processes along an environmental gradient in the Andes: new insights from the CHAMBASA project	S12-O10: Erik Frank The helping triage: selective aid depending on injury severity in *Megaponera analis*
13:45	S16-O2: Sophie Fauset Hyperdominance in Amazonian forest carbon cycling	S17-O2: Masha van der Sande Does trait diversity insure the long-term stability of biomass and productivity in tropical dry and wet forest?	S12-O11: Mirkka Jones Broad-scale spatial patterns in fern genus composition across the Amazon basin
14:00	S16-O3: Florian Wittmann Why rivers make the difference: a review on the phytogeography of river wetlands in the Amazon basin	S17-O3: Martyna Kotowska Linking hydraulic architecture, aboveground tree growth and sap flow velocity in tropical lowland and mountain forests in Indonesia	S12-O12: Glenda Cardenas Can ferns and lycophytes tell us something about the habitat use of monkeys?
14:15	S16-O4: Pia Backmann Monodominance in tropical forests: Modelling reveals emerging clusters & phase transitions		S12-O13: Tran Thi Hoa Pollinators of *Micromelum minutum* in Vietnam
14:30	Coffee break		
Sessions	S16 CONTINUED	S17 CONTINUED	S18: KNOWING THE UNKNOWN, MAKING THE MOST OF SCANT DATA ON RARE SPECIES AND ECOSYSTEMS, P. 264
Chairs	Gabriel Arellano & Manuel J. Macía	Imma Oliveras & Masha van der Sande	Alice C. Hughes
Room	MN 08	MN 09	MN 14
15:00	S16-O5: Gabriel Arellano Oligarchicity or co-dominance across scales in tropical forests	S17-O4: Marielos Peña Claros The effect of diversity, traits and environment on biomass dynamics across Neotropical forests	S18-O1: Alice C. Hughes Understanding endemism
15:15	S16-O6: Christoph Leuschner The tree diversity-productivity relationship in tropical forests - a plot-level study in Ecuador and a comparison of biomes	S17-O5: Imma Oliveras What is the role of inter- and intraspecific variation across different environmental gradients?	S18-O2: Bo Dalsgaard Knowing the unknown of species interaction networks
15:30	S16-O7: Encarni Montoya Long-term forests composition and diversity change on the eastern Andean flank in western Amazonia (Ecuador)	S17-O6: Alexander Shenkin Detecting carbon cycle processes from above: first steps towards scaling to landscapes and beyond	S18-O3: Bruno Leles The effect of landscape and rock type in the genetic structure, population demography and phenotypic divergence of Neotropical montane orchid
15:45	S16-O8: Teresa Schwarzkopf Tree structure, species composition, and dominance along a succession gradient in a cloud forest in the Venezuelan Andes		S18-O4: Wiebke Feindt Four in one: cryptic species in the genus *Megaloprepus* (Odonata: Zygoptera)
16:00	Merian Awards Invitation for 2017 Closing ceremony MN 08		

FRIDAY

PLENARY SESSIONS – ABSTRACTS

PLENARY TALK 1

Tuesday 23th February
Plenary talk 1 14:30 Room: MN08

PANTROPICAL SIMILARITIES AND DIFFERENCES IN PLANT-ANIMAL INTERACTIONS: ORIGINS AND CONSEQUENCES.

Richard Corlett[1]

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Many features of both plants and vegetation types can be understood as predictable responses to the physical environment, irrespective of biogeography. This explains why physiognomy, structure, phenology, and plant functional types are useful for describing and classifying vegetation on a global scale. There are exceptions, however, even for plant traits that might be expected to be under strong environmental control, so that the biogeographical distributions of, for example, cacti, bromeliads, and dipterocarps have impacts on the appearance of vegetation that are partly independant of the environment. Animals evolve faster than plants and animal families have more restricted distributions, so biogeographical differences are greater for plant traits that have co-evolved with animals than those that have been molded largely by the physical environment. Pollination and seed dispersal exemplify these interactions and are expected to show a strong infuence of biogeography. This influence should be particularly strong in the tropics, where most modern lineages of plants and animals evolved during a period when the major tropical forest regions were isolated from each other by oceanic barriers. I will review the evidence for similarities and differences in forest mutualisms across the tropics and discuss the possible consequences for ecosystem functions and responses to climate change.

PLENARY TALK 2

Wednesday 24th February
Plenary talk 2 8:30 Room: MN08

NEW INSIGHTS INTO THE METABOLISM AND CARBON CYCLE OF TROPICAL FORESTS FROM A GLOBAL NETWORK OF INTENSIVE MONITORING PLOTS

Yadvinder Malhi[1]

[1]*University of Oxford, Oxford, UK, yadvinder.malhi@ouce.ox.ac.uk*

In recent years substantial advances have been made in gaining a whole carbon budget perspective on the metabolism and functioning of tropical forests, a perspective that attempts to quantify all major components of net primary production (NPP) and respiration. Such a perspective helps us better understand the links between tree growth, photosynthesis and biomass, and the influences of climate, soils and disturbance. Here I present results from the GEM (Global Ecosystems Monitoring) network, examining the carbon budgets of forests along climate gradients in Amazonia and West Africa, along an elevation gradient in the Andes, and along disturbance and human use gradients in Malaysia and Africa.

We use these new data to revisit some fundamental hypotheses in tropical forest ecology. We see little evidence of clear links between plot-level photosynthesis and woody growth rates, showing that other factors such as plant respiration and allocation of NPP are more important in determining woody growth rates. Spatial patterns in tropical forest biomass are more driven by tree mortality rates that by growth rates. Disturbance through logging seems to greatly increase NPP, but also varies the allocation of NPP in favour of woody growth at the expense of leaf growth. Overall, we demonstrate that a whole carbon budget perspective can give us mechanistic insights into spatial variation in tropical forest function, and also temporal variation in response to drought and disturbance.

PLENARY TALK 3

Wednesday 24th February
Plenary talk 3 13:30 Room: MN08

THE POTENTIAL OF SECONDARY FORESTS: HOW FAST DO THEY RECOVER IN TERMS OF CARBON AND BIODIVERSITY?

Lourens Poorter[1]

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Over half of the world's tropical forests are secondary. These secondary forests play an important role in human-modified landscapes, may act as reservoirs of carbon and diversity, and provide forest resources and other important ecosystem services to local people. Here I present results of 2ndFOR, a collaborative research network on secondary forests. The network encompasses 45 sites and ca. 1500 forest plots covering the major environmental gradients in the lowland Neotropics.

Using a chronosequence approach, we show that above-ground biomass (AGB) recovers quickly over time and that AGB recovery rate increases with the water availability of the sites. Tree species richness increases rapidly over time, highlighting the value of secondary forest as biodiversity reservoirs. In contrast, it takes a long time for species composition to recover to values of neighbouring old-growth forest, indicating the importance of conserving old-growth forest. The land scape context determines the speed of forest recovery.

We present a biomass resilience map for the Neotropics, indicating where the potential of natural forest regeneration and reforestation is high. Although secondary forests are not a substitute for old-growth forests, they have a tremendous potential for carbon sequestration and biodiversity conservation in human-modified tropical landscapes.

PLENARY TALK 4

Thursday 25th February
Plenary talk 4 8:30 Room: MN08

SWAMPED! THE TRIALS AND TRIBULATIONS OF TROPICAL PEATLAND SCIENCE

Susan Page[1]

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Peatlands are important terrestrial carbon stores and vital components of global carbon soil-atmosphere exchange processes. In this regard, tropical peatlands are important because they are some of the planet's most carbon-dense ecosystems. Knowledge of the extent of tropical peatlands across the globe is still uncertain, nevertheless there is growing recognition of their significance for biodiversity support, carbon storage, climate mitigation and other ecosystem services and of the ecological and biogeochemical consequences of land use change. In Southeast Asia, where the largest area of tropical peatland is located, there is almost no intact peat swamp forest remaining. Over the last two decades, rapid socio-economic development has been accompanied by the transformation of vast areas into plantations producing palm oil and pulpwood, while remnant fragments of forested peatland have been degraded by logging, drainage and fire. Simultaneous with these developments, scientific knowledge of the consequences of peatland development has strengthened, providing a narrative that links the deforestation and drainage of peatlands to: loss of carbon storage potential; high emissions of greenhouse gases; increased risk of fire, resulting in extreme air pollution episodes that adversely impact on human health and economic activity; increased risk of flooding; loss of habitat for vulnerable, rare and endemic species; and reduced human livelihood opportunities. My presentation reviews this scientific narrative using examples from my own research journey to explore the disjunct between those promoting the benefits of short-term socio-economic development against those advocating for longer-term maintenance of ecosystem resilience. It concludes by outlining recent opportunities for improved peatland management practices that attempt to integrate scientific, land use practice and policy aspirations to mitigate negative ecological and economic consequences of peatland development.

PLENARY TALK 5

Thursday 25th February
Plenary talk 5 13:30 Room: MN08

USE IT OR LOSE IT: DIVERSITY AND RESILIENCE CHALLENGES IN MANAGED TROPICAL ECOSYSTEMS

Ravi Prabhu[1]

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Across tropical landscapes the twin challenges of feeding burgeoning populations and delivering development are resulting in large scale conversions of natural ecosystems - forests, savannas, grasslands and wetlands - into agricultural landscapes. This is a phenomenon that has been well described in literature and for which statistics are collected regularly. Less well understood and potentially more insidious is the conversion of species rich agricultural landscapes, often characterized by smallholder agriculture, into ‚simpler' landscapes dominated by a few agricultural commodities - annuals or perennials. These reductions in diversity (agricultural and natural) often go hand in hand with an over-exploitation of water and soil fertility with serious threats to resilience; degraded land- and lifescapes are often the outcome. Drawing on recent agroecological research, especially from the work of the World Agroforestry Centre (ICRAF) and its partners on tree-based systems, the presentation explores how contributions of such systems can deliver economic benefits while at the same time delivering systems that are more resilient. It explores how such systems support diversity while building on fine scale variation and heterogeneity that is a natural feature of these landscapes. There is growing evidence that such agroecological approaches are helping to restore productivity and resilience of previously degraded landscapes while at the same time contributing to goals of food, nutrition and income security of smallholders and other vulnerable groups of society. Using examples from tropical agricultural practice the presentation will make the case that only by using diversity in an economically meaningful way in such landscapes can we ensure that further erosion of species diversity does not take place with adverse impacts on resilience and sustainability of ecosystems and livelihoods.

PLENARY TALK 6

Friday 26th February
Plenary talk 6 8:30 Room: MN08

CHEMICAL MEDIATORS AND MUTUALISTIC INTERACTIONS IN THE TROPICS

Martine Hossaert-McKey[1]

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The tropics harbor particularly intricate mutualisms, and these are crucial to the functioning of tropical ecosystems. Mutualisms are interspecies interactions in which each participant gains net benefits from interacting with its partner, and chemical mediation plays a major role in mediating these interactions. Understanding how mutualisms function, and how they might evolve, depends on deciphering the chemical information transmitted between mutualists, for example, those that guide one partner to the resources offered by the other in exchange for services. In the case of nursery pollination mutualisms, thanks to quantitative and qualitative variations in volatile organic compounds, the complexity and diversity of floral scents offer a virtually infinite number of combinations. These olfactory signals are crucial cues for maintaining the high specificity of partner encounter in these specific interactions. First, unique combinations of chemical compounds emitted by flowers provide the templates for fine-tuned recognition, which is required for the specificity of interactions and can evenlead to odor-mediated reproductive isolation. Second, fine-tuned timing of interactions also requires tight coordination and synchronization between the plant's phenology and the visits of mutualistic partners. Changes in the chemical composition of compounds emitted by the plant can advertise the precise stage of receptivity—often associated with rewards—signaling thereby the optimal time for visits of the specific pollinator.
We will examine chemical mediation in a nursery pollination mutualism, the interactions between fig and fig wasps. We will document the proximate mechanisms in chemical mediation of specific plant-pollinator interactions, and show how they are coupled to the selective forces driving these interactions.

SESSION 1

S1: PLANT-ANIMAL INTERACTIONS ACROSS NATURAL AND HUMAN-INDUCED ENVIRONMENTAL GRADIENTS

Chairs: Ingo Grass & Eike Lena Neuschulz
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INTERACTIONS AMONG FRUGIVOROUS BIRDS AND FRUITING PLANTS: INTERACTION NETWORKS AND FUNCTIONAL DIVERSITY

Marta Quitián[1,2], Vinicio Santillán[1,3], Carlos Iván Espinosa[2], Matthias Schleuning[1], Katrin Böhning-Gaese[1], Eike Lena Neuschulz[1]

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Human-induced global change has impacts on biodiversity and ecosystem functions. Various monitoring programs have been developed to assess the effects of human impact on different taxonomic groups. These structural indicators of biodiversity, however, are not sufficient to also assess the functioning of ecosystems. In this project, we aim to assess the impact of human disturbance on the interactions between frugivorous birds and fruiting plants and on the functional trait diversity of the fruiting plant community. We studied fruit-frugivore interactions in a tropical montane forest in Southern Ecuador across an elevational and human disturbance gradient. Over two years we recorded plant-frugivore networks at three elevations (1000, 2000 and 3000 m a. s. l.) and two habitat types (natural and disturbed forest) in both wet and dry season. We measured four morphological traits of each fruiting plant (tree height and weight, length and width of the fruit). In general, we found a high number and complexity of plant-frugivore interactions at low elevations and in disturbed forests.This might be explained by the high availability of fruit resources at these sites. We also found changes in the functional trait space of the fruiting plant community across elevational and disturbance gradients that elucidated the changes in plant-frugivore networks. These first results suggest that network interactions and measures of functional diversity together are valuable indicators to monitor the consequences of human disturbance.

Merian Award Applicant

FEEDING ORIGINALITY AND FLEXIBILITY OF BIRDS IN PLANT-FRUGIVORE INTERACTION NETWORKS

Irene M.A. Bender[1], D. Matthias Dehling[3,7], W. Daniel Kissling[4], Isabell Hensen[2], Ingolf Kühn[5], Thorsten Wiegand[6], Katrin Böhning-Gaese[3], Matthias Schleuning[3]

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Aim
A fundamental ecosystem function in tropical forests is seed dispersal by frugivorous birds. Bird species differ fundamentally in their feeding niches, but little is known on the variability of these niches over time. We use two plant-frugivore networks the tropical Andes to test the seasonal variation in the foraging preferences of frugivorous birds, employing a trait-based analysis of interaction networks.

Main results
To quantify the foraging preferences of frugivorous birds, we projected interactions between birds and plants into a multi-dimensional plant trait space and calculated the seasonal and overall interaction centroids for each bird species in plant trait space. We then measured functional originality (the distance of the interaction centroid of a bird species to the community centroid) and functional flexibility (theminimum distance connectingthe bird species' four seasonal interaction centroids). We found that functional originality varied systematically between bird species, and was phylogenetically conserved. There was a positive relationship between functional originality and functional flexibility, suggesting that the functionally most original species were also the most flexible in their foraging choices.

Conclusions
Our results suggest that species that forage in a more original area of the plant trait space tend to be most flexible in switching to alternative fruit resources. This finding challenges the notion that specialized species have a low capacity to respond to changes in functional community composition, for instance due to climate change. The finding is also important for inferring unknown interactions in potential future communities of plants and frugivores.

CHANGES IN HUMMINGBIRD SPECIALIZATION ALONG A SPATIOTEMPORAL GRADIENT IN RESOURCE ABUNDANCE

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Specialization of species in interaction networks influences network stability and ecosystem functioning. Spatial and temporal gradients in resource availability may provide insight into how different ecological factors, such as resource abundance, and evolutionary factors, such as phylogenetically conserved morphological traits, influence specialization within mutualistic networks. We used independent measures of hummingbird abundance and resources (nectar), information on hummingbird traits and plant-hummingbird interactions to examine how resource availability and species morphology influence the specialization of hummingbirds in three habitat types (forest, shrubs and cattle ranch) across two years in the Andes of Ecuador. We found that hummingbird specialization generally decreased when resource abundance increased. Variability in Blüthgen's d', a measure of niche partitioning among hummingbird species, depended on the interactive effects between resource abundance and bill length: hummingbirds with a long bill switched from being more specialized than other species when resource abundance was low to being similarly specialized when resource abundance was high. Our results demonstrate that ecological gradients in resource availability cause substantial changes in hummingbirds' specialization on nectar plants. Such changes in avian foraging behavior have important impacts on pollen deposition and the quality of pollination functions by hummingbirds.

A MATTER OF DIVERSITY: HOW LANDSCAPE RELATED RESOURCE DIVERSITY BENEFITS TROPICAL POLLINATORS

Sara Leonhardt[1], Benjamin Kaluza[1,2,3], Nora Drescher[2], Mohammad Katouli[3], Tim Heard[4], Helen Wallace[3]

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Social bees are highly important pollinators in temperate and tropical ecosystems. In both ecosystems, they are threatened by anthropogenic activities, mainly habitat conversion and agricultural intensification, which directly or indirectly affect the availability and diversity of flowering plants and hence the bees' resources (pollen, nectar and resin).

To better understand how resource availability and diversity and particularly their interaction with nutrient quality and functional efficiency affect bees, we established a long-term bee hive monitoring experiment in Australia. Over several years and seasons, we record(ed) resource intake and storage in relation to landscape and resource diversity in the stingless bee *Tetragonula carbonaria* (Apidae: Meliponini). We additionally performed laboratory experiments on the functional efficiency of resin diversity.

Our results show that bees collect larger amounts and a higher diversity of resources in suburban gardens than in their natural habitats (forests) or in agricultural landscapes, while the nutritional quality of honey and pollen storages were similar across landscapes. Moreover, our laboratory experiments revealed that bees benefit from a variety of resin sources, which agrees with field results showing that resin diversity and composition determine the functional efficiency of resin mixtures accumulated in hives. We further demonstrate that high resource abundance, diversity and quality are not necessarily associated with large proportions of natural habitats within the bees' foraging range, but depend on overall plant species richness and composition and thus year-long resource availability, which can even be provided by diverse semi-natural habitat fragments in intensively managed areas.

DO ANT VISITORS TO EXTRAFLORAL NECTARIES OF PLANTS REPEL POLLINATORS AND CAUSE AN INDIRECT COST OF MUTUALISM?

Helena Maura Torezan-Silingardi[1,2], Mariana Assunçao[1], Kleber Del-Claro[1,2]

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Plants and ants have widespread relationships that are commonly mediated by the offer of extrafloral nectar (EFN) to ants that protect plants against herbivores. However, these ant–plant interactions are highly facultative and vary in time and space, mainly depending on the characteristics of the ant species, such as density and aggressiveness. In general, the outcomes of these relationships are positive, but in some cases, the presence of ants is neutral or negative to plants. Some studies suggest that aggressive attacks or merely the presence of ants might reduce the visitation rate of insect pollinators, such as bees, to flowers. We used experimental manipulation in natural conditions to test the hypothesis that ants on flowers of EFN-bearing plants might be recognized as a danger by pollinators (bees) and reduce the plant fitness (fruit-set). Our results show that the avoidance that ant bodyguard species feeding on EFNs of the Malpighiaceae Heteropterys pteropetala cause in pollinators, is not enough to decrease plant fruit-set. However, ants were indeed identified as a danger to pollinators as hypothesized and as suggested for other plant–pollinator relationships: flowers with plastic ants on the petals produced significantly fewer fruits than other treatments (with a plastic circle) or the control (natural condition). Indirect costs of facultative mutualisms are the focus of few studies and are rare in those performed in the Neotropics; our results show that mutualism must be considered in multitrophic interactions studies for a better understanding of the functioning of the system.

LYCAENIDAE-ANT MUTUALISM IN A TROPICAL SAVANNAH: CONDITIONAL OUTCOMES DEPENDING ON ANT PRESENCE AND IDENTITY.

Kleber Del-Claro[1,2], Alexandra Bachtold[1,2], Estevao Alves-Silva[1,3]

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In Lycaenidae-ant mutualisms, ovipositing adult females are expected to select plants based on ant presence in order to maximize the survivorship of immature stages. Usually, larvae feed ants with honey-like solutions and, in turn, ants ward off parasitoids. Nonetheless, immatures may as well suffer severe parasitism even in the presence of ants, what eventually leads to considerable mortality rates. We experimentally investigated whether the occurrence of facultative myrmecophilous lycaenids was based on ant presence and identity. We hypothesized that lycaenid abundance would differ according to the different ant species, and that most immatures would be found mainly in association with aggressive ants. Field work was conducted in a tropical savannah (cerrado) reserve in central Brazil. Eggs and mid-aged caterpillars were collected and reared in the laboratory to investigate parasitism rates. Stems of the extrafloral nectaried host shrub *Peixotoa tomentosa* were either assigned as ant-present (control) or excluded (treated - using Tanglefoot resin). Of the eight lycaenid species found, *Allosmaitia strophius* was the most abundant (75% of the sampling). Its occurrence in ant-present stems was five-fold greater than in treated stems. Most larvae were associated to the aggressive ants *Camponotus blandus* and *Ectatomma tuberculatum*. Egg parasitism rate was 9%, and all parasitized eggs were found in ant-present stems. Pupal parasitism in ant-present and ant-excluded stems was of 23% and 7%, respectively. Our study provides experimental evidence that the oviposition pattern of the lycaenid butterfliesis ant-related in cerrado vegetation. We suggest that, by protecting the plant from other herbivores, ants might provide a free-competitor environment for species like *A. strophius*, what can explain the high abundance of immatures in plants with aggressive ant species. The influence of ants on the parasitism of lycaenid immatures is a promising field, as to the best of our knowledge, evidence for ant protection is far from universal.

ANTS AT PLANT WOUNDS - THE RELEVANCE AND STRUCTURE OF AN UNDERESTIMATED FOOD WEB

Michael Staab[1], Felix Fornoff[1]

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Ants are abundant and functionally important arthropods in tropical and subtropical forests. The vast majority of vegetation-foraging ants were thought to be omnivorous, until studies of stable isotopes showed that those ants are essentially feeding as herbivores, mostly by visiting extrafloral nectaries and by tending Hemiptera for honeydew. Additionally, there are anecdotal records of wound feeding, i.e. the consumption of plant sap from wounds created by sucking or chewing herbivorous insects. However, to our surprise, no study has investigated and quantified wound feeding at the level of entire ant communities.

We conducted over several years an exhaustive survey for wound-feeding ants in the experimental tree plantations of the BEF-China experiment, located in subtropical South-East China. In total, we observed wound-feeding ants on 23 out of 40 planted tree species. There was a strong bias towards Fagaceae species; 90% of all observations occurred on eleven species of Fagaceae, albeit Fagaceae species accounted for less than 50% of all surveyed tree individuals. Almost all trophobiotic ant species known from the study area were also found at wounds. Our data indicate that wound feeding is an unspecific, opportunistic and facultative behavior, as shown by null-model analyses and the low specialization (H2') and high complementarity (e^H) of plant-ant networks. Albeit less common by an order of magnitude when compared to trophobioses, feeding on wound sap might be an important but underestimated food source that contributes to fuel the diversity and abundance of vegetation foraging ants, for example in cases when herbivorous insects are abundant or trophobiotic Hemiptera are scarce. Interestingly, increasing tree diversity decreased the specialization while increasing the complementarity of plant-ant networks. Both effects were independent of network size and sampling effort, and support recent theoretical and experimental studies, which demonstrated a structuring and stabilizing effect of tree diversity on species interaction networks.

TRI-TROPHIC INTERACTION NETWORKS IN AN EXPERIMENTAL TREE DIVERSITY GRADIENT IN SUBTROPICAL CHINA

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Many ecosystem functions and services are altered by interactions between trophic levels, e.g. pollination, herbivory and predation. Plants, the most important primary producers and lowest trophic level of terrestrial ecosystems are heavily affected by herbivores. In turn herbivores are suppressed by predators, but also supported by mutualisms like for example Hemiptera-tending ants, so-called trophobioses.

Today forest ecosystems vary greatly in tree diversity ranging from planted monocultures to natural old growth forests with high tree diversity. Investigating tri-trophic interactions in forests of varying tree diversity and over longer timespans can help to increase understanding of the dynamics of multitrophic foodwebs; when and why foodwebs change in their interaction specialisation and generality affecting the stability and resilience of food web communities, as suggested by recent network studies.

We studied tri-trophic interactions between subtropical tree species, sap-sucking Hemiptera and their mutualistic interaction partners within both field sites (Site A and Site B) of the BEF-China Experiment in South East China. The experimental tree plantation included 40 native tree species from which 400 saplings were planted in each of 566 plots (25.83 x 25.83 m in size) in 2009 (Site A) and 2010 (Site B). Plot species richness levels range from 1 to 2, 4, 8, 16 and 24 species. Of 300 plots the central tree individuals (36, 36, 81, 144 & 144) of species mixtures (1, 2, 4, 8, 16 & 24, respectively) were sampled in summer 2011 and summer and autumn 2014 at Site A and in summer 2012 and summer and autumn 2014 at Site B. Sampling resulted in 32000 tree investigations and a total of 3500 observations of tri-trophic interactions over an increase in forest age (25, 49, 52, 61 and 64 months after planting).

This large and long-term data set in combination with the BEF-China framework offers, for the first time, the unique opportunity to statistically test the effect of forest age and forest diversity on the specialization and complementarity and therefore food web stability of two connected trophic interactions. The data have the potential to reveal whether antagonistic and mutualistic networks concur in the direction and strength of their response to manipulations in tree diversity and how their response changes with increasing forest age.

DIVERGENT CHEMICAL SYNDROMES IN SPECIES RICH PLANT GENERA: THE CASE IN FICUS LOCAL COMMUNITY IN PAPUA NEW GUINEA

Martin Volf[1,2], Simon Segar[1,2], Brus Isua[4], Emol Isua[4], Gibson Aubona[4], Legi Sam[5], Juha-Pekka Salminen[3], Petr Simek[1], Martin Moos[1], Jan Zima[1], George Weiblen[6], Vojtech Novotny[1,2]

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[6]College of Biological Sciences, University of Minnesota, St. Paul, US

Large, speciose tropical plant genera harbour a large diversity of insect herbivores and such systems are therefore important in understanding the generation of tropical diversity. Here we extend previous food web studies across *Ficus* to include not only insect herbivore data from several guilds but also detailed trait and plant chemistry data in a phylogenetic context. We generated a comprehensive multi-gene phylogeny of 21 species representing a sympatric lowland rainforest community in Papua New Guinea. We then investigated the trade-offs between several key defensive traits (triterpene diversity and content, cysteine protease activity, trichome density) and palatability (represented by specific leaf area, Nitrogen content and Carbon content) as well as studying the influence of all of these traits on caterpillar abundance and diversity. We tested for phylogenetic signal in each trait, and found that all traits apart from total triterpene content and specific leaf area, showed significant levels of phylogenetic signal. Using phylogenetic least squares regression we found several significant negative correlations between traits, notably between triterpene diversity and total triterpene content. The most effective trait in reducing caterpillar abundance was the activity of cysteine proteases found in *Ficus* latex; we suggest that other traits may have a more important role in influencing caterpillar community structure. Furthermore, we show that traits are generally labile at the tips of the phylogenetic tree, with the major influence of phylogeny occurring at mid-level nodes and that sister species tend to be more divergent in trait space than expected by chance. In combination with the fact that we found limited evidence for trait escalation across our phylogeny these results suggest that the evolutionary dynamics of herbivore pressure acting in local communities may force divergence in defensive traits between closely related species. This situation, with labile suites of defensive traits being adopted at a community level suggests a system in flux, which may be a more realistic hypothesis for species rich plant communities growing in sympatry than a constant escalation of defensive traits across time.

EFFECTS OF PATHOGENS AND INSECT HERBIVORES ON PLANT DYNAMICS AND DIVERSITY ACROSS A NATURAL RAINFALL GRADIENT

Owen Lewis[1], Lars Markesteijn[1]

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Density-dependent seed and seedling mortality caused by pests and diseases has been implicated in maintaining high plant diversity in tropical forests. To investigate how these Janzen-Connell effects vary with rainfall we monitored seed arrival and seedling recruitment for 18 months at eight sites spanning a natural precipitation gradient across the Isthmus of Panama. Seedling plots were treated with either a fungicide, an insecticide or used as a control. Seedling recruitment was negatively density-dependent in control plots, but this density-dependence was greatly reduced in the insecticide-treated plots. Insecticide treatment also largely eliminated the increase in diversity observed in control plots when comparing seedlings to seeds. The positive effects of insects on plant diversity increased significantly with rainfall. Our results suggest a mechanistic explanation for well-documented positive relationships between rainfall and (i) the strength of negative density dependence and (ii) overall tropical forest plant diversity.

INSECT HERBIVORY AND PREDATION PRESSURE ACROSS A TROPICAL RAINFALL AND TREE SPECIES RICHNESS GRADIENT

Anita Weißflog[1], Lars Markesteijn[2,3], Owen T. Lewis[3], Bettina M.J. Engelbrecht[1,2]

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The extraordinarily high tree α-diversity of tropical lowland forests has been suggested to be shaped and maintained by specialist insect herbivores that preferentially attack the most abundant tree species in a distance- and density-dependent manner, giving rare species an advantage. Insect populations and herbivory might further be enhanced by more stable and favorable climates of more humid tropical forests, driving an increase of tree species richness with rainfall. Conversely, intensified top-down control in wetter, aseasonal forests could reduce the impact of herbivore imposed control on tree species. Studies measuring insect herbivory in relation to host plant abundance, and its regulation by predators across gradients of tree species richness are lacking. We hypothesized herbivory to be higher on more abundant species, and increase with rainfall. Insect herbivory was quantified in six forest sites across a Neotropical rainfall and tree species richness gradient, in relation to local abundances of 42 focal tree species. Predation pressure on insect herbivores was also measured. More abundant tree species experienced a higher risk of herbivory, but the amount of damage caused by herbivores decreased with tree abundance. Overall, insect herbivory strongly decreased with increasing rainfall. In contrast, predation pressure was higher at the wetter site. Insect herbivores might thus contribute to local tree species coexistence, but seem unlikely to drive the increase in tree species richness with rainfall. The unexpected and contrasting patterns of herbivory and predation support the need for studies on multi-trophic interactions across environmental gradients to understand the processes contributing to tree diversity and ecosystem functioning, predict ecosystem responses to future climate change, and develop effective conservation strategies.

Merian Award Applicant

SESSION 2

S2: APPLIED MOLECULAR ECOLOGY IN THE TROPICS

Chair: Emma Morgan
Contact: emma.morgan@usys.ethz.ch

TREES GOING UNDERGROUND: HOW GENETICS AND ENVIRONMENT SHAPE THE ZAMBEZIAN MIOMBO REGION

Paulina Zigelski[1], Barbara Rudolph[1], Manfred Finckh[1]

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An undulating mosaic of forests and grasslands characterizes the Zambezian region in southern Africa that gave space to the stunning evolution of woody species pairs from many tropical plant families. These pairs have in common being of similar morphology, except for one aspect: while one species is growing as a tree in forests, the sister taxon grows as dwarf shrub with huge underground biomass (suffrutex) in open grasslands, forming a kind of underground forest.

To investigate this phenomenon we chose *Syzygium guineense* Wall. complex (Myrtaceae) as model. This species occurs as tree, shrub or suffrutex in various habitats of the Zambezian region. A total of 33 populations were sampled in Angola, Namibia, Zambia and Botswana to analyze the relatedness of these forms. This study aims to characterize the genetic structure of the *S. guineense* complex in different environments. The analyses will show how far the phenotypes are genetically fixed or if they are local adaptive responses to ecological drivers such as soil conditions, frost and fire regimes, or herbivory.

The genetic relatedness of the populations is being estimated by sequencing and haplotype analyses of the chloroplast *trn*K region. Additionally their genetic profile is compared to a profile of selected functional traits to assess how plants morphology responds to the interplay of genetic and environmental drivers.

First results suggest that the populations of *S. guineense* can be assigned to at least six distinct haplotypes. Some of those are shared by populations with rather uniform morphology, yet the major haplotype is widely distributed across Angola and Zambia and exhibits high phenotypic plasticity, depending on the environment it is exposed to. Underground as well as aboveground phenotypes share this haplotype.

Thus *S. guineense* is an exciting example of how both genetic and ecological factors affect growth traits and produce extreme phenotypes as a result of adaptation to a complex tropical ecosystem.

THE ROLE OF GEOGRAPHIC BARRIERS IN SHAPING THE GENETIC STRUCTURE OF BORNEAN SMALL MAMMALS

Jennifer Brunke[1], Michael W. Bruford[2], Benoit Goossens[2,3], Ute Radespiel[1]

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As a result of large-scale logging activities and habitat conversion 20% of Bornean small mammals are already listed as endangered, vulnerable, or near threatened by the IUCN. The more it is important to know how habitat characteristics and the ability of species to cope with habitat changes influence their abundance and viability.

Recent phylogeographic studies suggest an important role of rivers in shaping ecological and genetic variation among tropical species. Especially in fragmented habitats, geographical barriers such as rivers might represent an important additive factor restricting migratory capabilities, leading to a reduction of gene flow and an increased genetic differentiation among subpopulations. However, due to variations in species dispersal capacities, rivers should not act as barriers to gene flow for all species equally.

The Kinabatangan River in north-eastern Borneo is the longest river in Sabah, Malaysia. It has been shown to represent a major barrier for dispersal in Bornean Orangutans but not for Proboscis monkeys or the Bornean elephant. Respective knowledge, however, is still lacking for other species. The aim of this study is to assess the importance of rivers in phylogeographic structuring for a variety of small mammals (Rodentia, Scandentia, and Eulipotyphla) along the Kinabatangan. Here numerous woodlands have been converted to anthropogenic landscapes and forest is restricted to isolated patches.

In forest patches along both sides of the Kinabatangan small mammals were systematically surveyed, captured and sampled. Using population genetic techniques we examined the variations in cytochrome b sequences of nine different taxa across both river sides.

Based on high pairwise ϕ_{ST}, AMOVA results, and a clear separation of the haplotypes of both riversides in haplotype networks, complete genetic isolation between riversides could be observed in two species. A moderate isolation was detected in two other taxa, and no barrier effect of the river could be detected in the remaining small mammal species. Rivers therefore seem to act as barriers for gene flow only in a subset of small mammal species for which fragmentation effects should also be aggravated.

HOW CONSISTENT IS FINE-SCALE GENETIC STRUCTURE WITHIN TROPICAL TREE SPECIES? A DIPTEROCARP CASE STUDY

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Many tropical tree species show pronounced fine-scale genetic structure (FSGS), the non-random distribution of genotypes across the landscape. Documenting the scale and intensity of FSGS, and understanding the processes that shape it, is critical if we are to sustainably manage timber tree species as logging and forest fragmentation might disrupt such processes and lead to an erosion of genetic diversity. Such considerations are relevant to the Dipterocarpaceae, and economically important family of timber trees which dominate the tropical lowland forests of SE Asia both numerically and in terms of biomass, but which have poor seed dispersal and strong spatial aggregation, traits hypothesized to generate strong FSGS. Here we present the results of an analysis of FSGS in three dipterocarp species from the Danum Valley 50 Ha CTFS plot in Sabah, Malaysian Borneo. We discuss the scale and intensity of FSGS observed, with particular reference to the traits above. We compare our results from the Danum valley species to the same species located in different forests in the Malesiana region, to assess the consistency of results between sites. Confirming consistency of species' FSGS amongst sites is an important step in managing the genetic diversity of dipterocarp timber trees, as it provides confidence that logging protocols designed to maintain genetic diversity from the limited number of studies available can be applied more generally.

WHAT CAN POPULATION GENETIC INVESTIGATIONS CONTRIBUTE TO SAVE THE RAREST OF THE RARE?

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Our understanding of the ecological processes which ultimately push extremely rare tree species to extinction is very limited. To better understand and hopefully avoid extinction we conducted a population genetic analysis of the extremely rare dipterocarp species *Dipterocarpus lamellatus* endemic to Sabah, Borneo. The species was thought to be extinct but in 2011 eleven trees were discovered based on an ecological niche modeling. After 4 years of phenology survey the two largest individuals fruited in 2015 suggesting that the other remaining trees did not yet reach reproductive age. Based on genotyping at 10 microsatellite loci of all adult trees, poles, nursery grown seedlings and seed we present preliminary population genetic analyses. In particular we investigate if we find with paternity analysis more unknown trees in this difficult to survey fire affected forest reserve. Furthermore we analyse the expected genetic erosion, which occurred in recent years. We discuss how this extremely low number of flowering individuals might undermine successful reproduction and therefore species recovery.

GENETIC RESOURCES IN A CHANGING ENVIRONMENT - BAOBAB (*ADANSONIA DIGITATA* L.) IN KENYA

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Drylands of sub-Saharan Africa are highly threatened by climate and land-use changes. Species persistence is thus depending on genetic resources available in populations. One of the most important indigenous fruit tree species is baobab *(Adansonia digitata* L.) which is a significant species for food and nutrition security of local communities. The knowledge of intra-specific morphological variation is increasing while investigations on the genetic diversity of the tetraploid species are rare, especially in East African populations. In our study, we observed genetic and morphological variation patterns of baobab in Kenya to identify important gene pools and causes for the distribution of variation in this part of East Africa. In general, large genetic resources were found using microsatellite markers (SSR) which represent a geographical pattern. Thus, coastal and inland populations are genetically differentiated, whereas populations within regions cannot be separated. Morphological diversity patterns may reflect its habitat diversity and differ from genetics, while reasonable factors were not yet identified. However, both genetic and morphological variation patterns will be combined to identify gene pools especially adapted to several environmental conditions. Furthermore, the significance of humans for its distribution and diversity patterns will be discussed. Detailed knowledge of local gene pools of the valuable tree species is a prerequisite for conservation programs and the development of sustainable management strategies in the view of climate and environmental changes.

CYPERUS PAPYRUS SWAMPS OF LAKE NAIVASHA ORIGINATE MAINLY FROM LOCAL SEEDLING RECRUITMENT WHEREAS MATURE STANDS MAINTAIN CLONAL DIVERSITY

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Cyperus papyrus occurs in isolated habitats surrounded by land masses acting as barriers to gene flow. Isolation and life history processes greatly influence genetic diversity and structure. We assessed clonal diversity, genetic variation and structure of Cyperus papyrus at large geographic scale in freshwater wetlands of Kenya using microsatellite markers. Genetic diversity measures varied widely among populations, with Lakes Naivasha and Victoria displaying higher allelic and gene diversity than isolated wetlands. Monoclonal wetlands suggested recent founder effects and variation in clonal diversity referred to different levels of sexual and asexual reproduction. AMOVA revealed strong genetic differentiation among lakes. PCoA and Bayesian analysis of individuals grouped drainage basins. Similarities among wetlands within Lakes Victoria and Naivasha implicated hydrochorous dispersal.

Three regions within Lake Naivasha were investigated for their fine-scaled structure, including two sites subject to recent dynamic changes, a seedling and harvested zone. At lake level a PCoA separated lakeward from landward sites. Higher inbreeding levels were observed in landward zones but only the harvested site had all loci significantly deviating from equilibrium implicating the impact of a 6-monthly harvesting regime.

A regeneration event of papyrus in a drawdown-flooding cycle in Lake Naivasha allowed to infer their establishment. Seedlings in the drawdown zone and neighboring stands of mature and juvenile shoots revealed high overall gene diversity. More private alleles and higher allelic diversity were detected in seedlings than in the parent individuals, showing their contribution to an increase in the local gene pool. Fine-scaled spatial genetic structuring was detected at about 100 m distance in mature stands indicating their earlier establishment from local seed rain.

Summarizing, papyrus swamps are highly differentiated between lakes, whereas highly diverse swamps of Lake Naivasha are hypothesized to originate mainly from seedling recruitment at short distances. Such mature stands can maintain high clonal diversity. The latter can be negatively impacted by regular harvesting practices.

KEEPING IT IN THE FAMILY: PATTERNS OF RELATEDNESS AND MATING IN THE DIOECIOUS PALM *LODOICEA MALDIVICA*, THE LARGEST-SEEDED PLANT IN THE WORLD

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The distances over which seeds disperse influence the spatial genetic structure of plant populations, as well as having evolutionary implications. In general, we would expect fine-scale genetic structure (FSGS) to be most strongly developed in species with restricted seed dispersal, with such structures being intensified by habitat fragmentation. Using 12 microsatellite loci, we explored seed dispersal patterns and the resulting FSGS in *Lodoicea maldivica*, an endangered palm endemic to Praslin and Curieuse islands in the Republic of Seychelles. We observed a strong FSGS across all groups (populations, age cohorts and sexes in the adults), which was presumably a consequence of the very short-distance average seed dispersal (8.7 ± 0.7 m). Genetic diversity was uniform across all groups, yet inbreeding was consistently high, despite varying degrees of habitat disturbanceand fragmentation among sub-populations and age cohorts. Male and female trees separated by less than 500 m apart had significantly higher pairwise kinship coefficients (*F*) than would be expected by chance. Pairs of trees up to 10 m apart were (on average) as related to each other as somewhere between first and second cousins. We discuss the genetic consequences of restricted seed dispersal and the high relatedness of neighbouring trees in this dioecious, monodominant species.

Merian Award Applicant

SPATIALLY LIMITED CLONALITY, POLLEN AND SEED DISPERSAL IN A CLIMBER OF CENTRAL AFRICAN RAIN FORESTS: *HAUMANIA DANCKELMANIANA* (MARANTACEAE)

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Gene dispersal and clonality are important aspects of plant evolution affecting the spatial genetic structure and the long-term survival of species. In the tropics these parameters have mostly been investigated in trees and some herbs but rarely in climbers which frequently (i) show clonal growth leading to a patchy distribution pattern similar to that of understorey herbs and (ii) flower in the canopy where they may have access to long distance pollen dispersal like canopy trees. We thus hypothesize for climbers an intermediate genetic structure between herbs and trees. The study aims at assessing breeding system and spatial extent of clonality and gene dispersal in *Haumania danckelmaniana* (Marantaceae), a common climber in the tropical rain forests from western Central Africa. In eastern Cameroon, 330 ramets were sampled at three spatial scales and genotyped at seven microsatellite loci. Clonality was moderate (clonal extend: 15 to 25 m, clonal diversity 0.4 to 0.65) indicating the importance of recruitment from seeds at this locality. The low inbreeding (F_{IS}) suggested predominant outcrossing. The rate of decay of the relatedness between individuals with distance indicated limited gene dispersal distance (σ_g = 9 to 50 m, neighbourhood sizes Nb = 23 to 67) in accordance with narrowly gravity dispersed seeds and restricted pollen transfer distance in densely flowering populations. The marked spatial genetic structure (*Sp* = 0.011 to 0.026) was similar to that reported in tropical trees but might increase with increased clonality as in many herbs, especially under increased disturbance regimes.

CAMERA-TRAPPING VS. IDNA FOR WILDLIFE SURVEYS; COSTS, EFFICIENCY AND RELIABILITY

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Camera-trapping is a very popular method to study wildlife, as camera-traps work independently of the observer, and thus can accumulate survey effort over extended areas and periods of time with comparatively little effort. Camera-traps are further known to record even the most elusive terrestrial mammals. However, reliable camera-traps are costly, and as camera-traps represent a highly directional and point-based sampling method, even species in the immediate vicinity of the trap will be missed if they do not pass through the camera's sensor field. Recently, a new and promising non-invasive method to study wildlife populations has emerged; the use of invertebrate-derived DNA (iDNA) of vertebrate host species. Invertebrate parasites such as leeches, mosquitos or ticks are generally abundant and easily collected without costly equipment or extensive training, and joint screening of multiple individuals limits lab costs. Although this method is still largely unexplored, first results indicated that it could become a powerful tool to study a wide range of wildlife species. Here, we present first iDNA sequencing results of terrestrial leeches from the Central Annamite Mountains in Vietnam. We analyzed leeches both individually and in pools of up to almost thirty individuals, and compare the results in terms of costs, efficacy and reliability to detect target species. We further compare iDNA data with camera-trap datasets from an adjacent area in Vietnam and discuss costs, breadth of the target community sampled, and taxonomic resolution of the approaches.

UNDERSTANDING THE HISTORY OF AFRICAN SHADE-TOLERANT AND PIONEER RAINFOREST TREES, APPLYING NEW GENOMIC TOOLS TO PHYLOGEOGRAPHY

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Palaeoecological research revealed that the equatorial African rainforest has undergone drastic floristic, structural and phytogeographical changes during the Quaternary period. Drawing up the geographical distribution of genetic lineages of rainforest trees and their filiations through the development of phylogeography appears as a key complementary approach to better understand the response of biodiversity to past climate oscillations. Especially, the development of next generation sequencing and bioinformatic tools support new genomic challenges to reconstruct whole genomes, and therefore to infer the temporal dynamics of forest vegetation, including species belonging to distinct functional groups.

The capture and sequencing of chloroplast genomes at deep multiplexing levels have been undertaken on 96 individuals of the rainforest long-living and shade-tolerant tree *Greenwayodendron suaveolens* (Annonaceae), which is characteristic of Central African mature forests. In parallel, 80 individuals of the emblematic pioneer and short-living tree *Musanga cecropioides* (Urticaceae) have been also analyzed. The polymorphism found on almost whole chloroplast genomes (several hundreds of SNPs along *c.* 130,000 bp) provides a very detailed phylogeographical signal to infer the evolutionary history of populations, while previous single marker sequencing suffered limited polymorphism. Both forest populations of *Greenwayodendron* and *Musanga* are characterized by distinct cpDNA phylogroups, mainly in Upper Guinea and in northern, eastern and western parts of the Lower Guinean and Congolian forests. Populations could have been fragmented into a restricted number of refugial areas in the past that seems display diverse demographic signatures. But ongoing molecular dating should provide a more precise temporal framework for comparing the diversification of each phylogroups, and the role of their life history traits in terms of resilience during glacial/interglacial oscillations.

BIDIRECTIONAL GENE FLOW ON A RIVER MANGROVE LANDSCAPE AND BETWEEN-CATCHMENT DISPERSAL OF *RHIZOPHORA RACEMOSA* (RHIZOPHORACEAE)

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Understanding how landscape structure shapes genetic structure of populations of keystone species is very crucial for their long term management. We tested both the unidirectional dispersal hypothesis on the linear river landscape of the Wouri River and the one catchment-one gene pool hypothesis on the red mangroves (*Rhizophora racemosa*) populations of the Cameroon Estuary complex (CEC).

We obtained samples were obtained from 21 transects (649 adults trees) from the CEC and used 11 polymorphic microsatellite markers to study both hypotheses. Additionally, we compared the genetic diversity of protected and unprotected sites within this estuary. Overall genetic diversity was moderate (mean Ho = 0.306, mean Ar = 2.5), as usually found in *Rhizohora* spp. Genetic diversity was highest in populations of a downstream river site, likely due to input from upstream as well as from propagules reaching the delta from other areas. Estimates of contemporary dispersal rates and directionality, PCoA, and Bayesian clustering analysis of individuals revealed bidirectional dispersal along this river channel. This was confirmed by recent migration rates assessment. Downstream genetic diversity was not significantly different from upstream and the molecular variance of populations did not correlate with their position on the linear landscape. Bayesian clustering analysis assigned all individuals into two clusters, none unique to any particular catchment and with high admixtures. This indicates high inter-catchment connectivity.

These results emphasized the role of river flow currents, tidal fluxes, and wind, in facilitating bidirectional gene flow on the river as well as the entire estuary. The lowest genetic diversity was observed in transects from a protected area, thereby highlighting the impact of historical pressures on this recently protected area and or reduced gene flow into this area. This is relevant for the management of these systems in the future.

DIVERSITY AND ANTIMICROBIAL ACTIVITY OF GUT MICROBIOTA ISOLATED FROM THE NATIVE HONEY BEE (*APIS MELLIFERA JEMENITICA*) OF SAUDI ARABIA

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Bacteria residing in the alimentary tract of honey bees are very important as they protect the host from several pathogens and add in nutrition. In this study bacterial diversity was enumerated from the gut of worker *Apis mellifera jemenitica*, a native honey bee of Saudi Arabia as this important ecological niche was unexplored previously. The incoming workers from five different bee colonies were collected from an apiary located at Bee Research Unit, College of food and Agriculture Sciences, King Saud University Riyadh. Whole gut of a randomly selected bee from each colony were aseptically dissected and homogenized in phosphate-buffered saline. A culture dependent approach was applied to characterize the gut microbiota. The 16S rRNA gene sequences from extracted DNA of pure bacterial colonies revealed that these bacteria belonged to the phyla firmicutes, actinobacteria and gammaproteobacteria. The *in vitro* antimicrobial activity of these isolates was assessed against *Paenibacillus larvae*, the causal agent of American foulbrood (AFB), by disc diffusion method. Bacteria belonging to genus *Bacillus* showed significant inhibitory effects against *P. larvae*. The results of this study illustrated the structural diversity of gut microbiota associated with the local honey bees and demonstrated the shielding effects of *Bacillus* bacteria against AFB. These bacteria can be incorporated in apiculture as biological control agents.

Merian Award Applicant

THE PREVALENCE OF CRYPTIC PLANT SPECIES IN AFRICAN RAIN FOREST TREES - INSIGHTS FROM POPULATION GENETICS APPROACHES

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Tropical forests are renowned for hosting a remarkable diversity but the estimation of their species richness depends on the species concept used for their delimitation. Plant taxonomy is essentially based on morphological characters and the outcome of species delimitation can vary according to the 'splitter' versus 'lumper' tendency of taxonomists. Moreover, speciation may sometimes occur without significant morphological changes, leading to the occurrence of cryptic species. Hence, species richness can be underestimated by the occurrence of cryptic species or overestimated by taxonomical oversplitting.

Phylogenetic approaches are increasingly used to help decipher species delimitation. However, reciprocal monophyly at gene trees requires that the number of generations since speciation largely exceeds the effective population sizes of the sister species. Alternatively, population genetics methods allow to assess reproductive isolation, which is at the basis of the 'biological species concept'.

Using the latter species concept, we relied on large-scale genotyping using nuclear microsatellite markers to evaluate species delimitation in several African tree taxa (*Carapa*, *Entandophragma*, *Erythrophleum, Greenwayodendron, Lophira*, *Milicia*, *Santiria*). To this end, we considered that distinct species can be recognized when well differentiated gene pools occur in sympatry.

Main results: (i) We found no case of oversplitting: even when phenotypically very similar, species distinguished by taxonomists formed distinct gene pools, although some genetic introgression was occasionally detected. (ii) By contrast, we found several examples of taxonomical species made of several sympatric gene pools, indicating that cryptic species are not uncommon. (iii) Interestingly, a re-examination of morphological traits associated to each gene pool can reveal diagnostic characters. Hence, taxonomy can greatly benefit from population genetics approaches to resolve species complexes, although the biological species concept has also its own limitations. (iv) In some cases, large-scale genotyping showed that the documented geographical distributions of species were erroneous due to the confusion between similar species in parts of their ranges. (v) Finally, we found that markers from the chloroplast genome were not always reliable to distinguish closely related species, limiting the usefulness of plastid-based DNA barcodes.

COMBINING FIELD AND LABORATORY PROVIDE A FULLER PICTURE TO DIFFERENTIATE MANAGEMENT AND CONSERVATION OF TWO THREATENED NEOTROPICAL TREE SPECIES

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Habitat fragmentation is extensive throughout the world, converting natural ecosystems into fragments of varying size, density and connectivity. The potential value of remnant trees in agricultural landscapes as seed sources and in connecting fragments has formed a fertile area of debate. We show why combining a range of research techniques, including molecular and field studies, is essential to provide a full understanding of the complex and varied responses of different tree species to human disturbance and developing effective conservation and management solutions.

SPECIATION IN THE TROPICS: JOINT DEMOGRAPHIC HISTORY OF SYMPATRIC CARNIVOROUS NEPENTHES PITCHER PLANTS IN BORNEO

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Ecological speciation describes speciation mechanisms in which gene flow between diverging populations is controlled by environmental factors other than space, e.g. by adaptation to patchy heterogenous habitats or along gradients. It is unclear how common and relevant adaptation - as opposed to dispersal-limitation or neutral evolution - is in generating species diversity and its feedbacks through ecology. Theoretical work on adaptive diversification with the opportunity for gene flow suggests that diversifying selection would leave an observable signature as heterogeneity in migration rates along the genome.

In this case study, we investigate the joint demographic history and phenotypic divergence among the sister species *Nepenthes hemsleyana* and *N. rafflesiana* typical form in Borneo. Both of them are carnivorous pitcher plants, and they co-occur in the same habitats (kerangas, peat swamp forest) in mixed communities.

We genotyped wild populations of *Nepenthes* for thousands of markers using ddRAD-seq, and fit demographic models by coalescent simulations and Approximate Bayesian Computation. Population genetic data were most consistent with models using locus-specific migration rates, while models of sympatric speciation and old secondary contact had similar support. We argue that such long-term differential introgression is to be explained by long-term diversifying selection, while the geographic situtation under which speciation was initiated might have little effect on that process. Hence, we propose that divergence of these two *Nepenthes* is stronlgy influenced by adaptations. One target of diversifying selection may be trap morpholgy, as it was significantly more diverged than expected for neutral traits (Pst - Fst comparison).

In conclusion, novel population genomic approaches can be used to distinguish adaptive and neutral species divergence, and hence improve our understanding of the generation of biodiversity.

Merian Award Applicant

THE DOMESTICATION HISTORY OF SHEEP AND GOAT

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Collecting large genetic datasets (i.e. large sample sizes and number of molecular markers) is becoming an easier and cheaper issue. Moreover, with the advancement in sequencing technologies it has become possible to sequence whole genomes from multiple samples at a not too expensive cost (e.g. ~£2,000 per genome). Making use of these technologies, the NextGen consortium sampled sheep and goats, and their wild ancestors in the Zagros Mountains (Iran) in order to attempt to understand the domestication process of these important livestock species. Sheep and Goat were domesticated in the Middle East around 10,000 years ago, with sheep having been domesticated from wild Mouflon and goats from Bezoars. The analyses of this whole genome data enabled reconstructing the demographic history of these species in relation to ecological changes over the last million years, as well as identify signatures of selection reflecting the domestication process and adaptation to the local environment.

SESSION 3

S3: ECOLOGICAL FACTORS INFLUENCING WILDLIFE HEALTH

Chair: Marco Tschapka
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TRYPANOSOMIASIS AND LEISHMANIASIS IN BATS: EVALUATING THE ENVIRONMENTAL DISTURBANCE INFLUENCE IN THE GREATER LACANDONA ECOSYSTEM, MEXICO

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Habitat loss and forest fragmentation have proven to be two major threats to bats in the tropics, as fragmentation increases, the diversity decreases. The dilution hypothesis states that as the species richness decreases due to habitat loss or disturbance, the incidence of parasites becomes higher. Since bats are known reservoirs of *Trypanosoma* and *Leishmania*, two pervasive zoonotic parasites, the primary objective of our study was to determine the prevalence of *Trypanosoma* sp. and *Leishmania* sp. in bats on conserved and disturbed conditions in the Lacandona forest in southern México. The disturbed area is dotted by human communities extracting forest resources and causing fragmentation and deforestation. Our hypothesis is that in conserved ecosystems bats will have a lower prevalence of the parasites due to the dilution effect. We worked with 2 common tropical rain forest species (*Carollia sowelli* and *Sturnira parvidens*). Bats were captured using mist nets in 6 sites (3 under conserved conditions and 3 within the agricultural matrix of the surrounding areas) and tissue samples (heart and spleen) were taken from the bats. We obtained the prevalence of both pathogens through direct detection by PCR. We found several positive individuals for both parasites with an overall prevalence of 8.87% for *Leishmania* and 1.60% for *Trypanosoma.* We also found preliminary evidence that *Leishmania* prevalence decreased as the number of bat species in the site increased. The prevalence of both parasites was lower than suggested by other authors in other tropical regions, therefore, a larger sample size is needed to unravel the true relationship between the species richness of a site and the parasite prevalence. Results of this study are crucial to secure conservation efforts and keep low incidences of pathogens through forest conservation for the benefit of neighboring human communities.

ANTHROPOGENIC FACTORS SHAPE TBHBV INFECTION PATTERNS IN THE NEOTROPICAL TENT-MAKING BAT *URODERMA BILOBATUM*

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Characteristics such as longevity, roosting in groups of sometimes thousands of individuals and being highly mobile, moved bats over the last years more and more in the focus of virological studies all over the world. Bats were identified as carrier or source of various emerging viruses like Nipah, Hendra or SARS. In this study we explored links between prevalence and diversity of TBHBV, a hepadnavirus closely related to human HepatitisB virus, and ecological and social characteristics of the frugivorous bat *Uroderma bilobatum* (Chiroptera: Phyllostomidae). Between July 2010 and September 2015 we collected blood samples from 541 bats in the protected rain forest of the Panama Canal area and at degraded sites of central and west Panama. 25 of these bats tested positive for TBHBV, resulting in local prevalences between 0 and 12.5% per sampling site (total prevalence 4.6%). Local prevalence was best explained by the grade of deforestation of the sampling habitats and showed a higher prevalence in habitats with lower forest cover. *Uroderma bilobatum* also showed a strong infection bias towards adult females, coinciding with a sexually transmitted disease in a polygynous social structure. We did not detect any phylogenetic structure between viruses from different sample sites, but a high genetic diversity suggests an ancient association between *U. bilobatum* hosts and TBHBV in Panama.

HOST-SPECIFIC TRAITS AS DRIVERS OF ASTROVIRUS INFECTIONS IN COMMON NEOTROPICAL BATS RESILIENT TO HABITAT ALTERATION

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Habitat loss and fragmentation are serious threats to biodiversity, especially in the tropics, where biodiversity is high. Habitat alteration impacts local species richness, changes species abundance, and ultimately may affect fitness and health of animals.

Neotropical forests host extremely diverse bat assemblages, with more than half of the species richness represented by the Leaf-nosed bats (Phyllostomidae). In response to habitat alterations, these assemblages often experience drastic changes, resulting in the persistence of the most adaptable species, while bat species more susceptible to environmental change often go locally extinct. Some frugivorous species may even benefit and thrive in modified environments, as a result of an increase of early successional fruit plants, their main food source.

Studying the impact of bat population dynamics and specific host traits on infection status in natural populations of reservoir species is crucial to understanding virus ecology, as bats are increasingly being identified as natural reservoir hosts for emerging viral pathogens. Using a diverse Panamanian bat community as a model system we aim at understanding the impact of local habitat alterations on virus prevalence patterns in abundant reservoir species. Based on more than 6800 bats sampled over two years of consecutive mistnetting efforts our study establishes links between local abundance of two common frugivorous bats (*Artibeus jamaicensis, Carollia perspicillata*) and their astrovirus infection and multi-infection status patterns.

Merian Award Applicant

DOES HABITAT DISTURBANCE INCREASE HEPACI VIRUS INFECTION IN A GENERALIST RODENT?

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Emerging infectious diseases pose a substantial threat for both, human and animal health, and have been added to the list of factors that drive biodiversity loss. Especially viruses are responsible for a variety of fatal diseases in mammals such as HIV, Ebola, dengue, rabies and, to name a special case, infectious facial cancer in Tasmanian Devils. Organisms that are resilient to habitat disturbance show strong fluctuations in population demography and densities due to high reproductive rates and play a prominent role in the amplification and distribution of pathogens in ecosystems. In the tropics, habitat disturbance still occurs on a large scale, often resulting in a mosaic of habitat patches of varying sizes embedded in a matrix used for agriculture or other human activities. In the present study we tested whether such habitat transformation leads to changes in population density in a generalist rodent species and ultimately to differences in infection status with a putatively directly transmitted virus. We also include life history traits like sex, age and reproductive status as possible explanatory variables for infection status.

TRENDS IN MOSQUITO INFECTION RATES AT THE RAINFOREST EDGE - A MULTITAXA STUDY ON THE DILUTION EFFECT HYPOTHESIS

Marco Marklewitz[1], Anne Kopp[1], Hanna Heidemann[1], Kyra Hermanns[1], Daniel Hobelsberger[2], Innocent B. Rwego[3,4], Alejandro Estrada[5], Fabian H. Leendertz[2], Lars Podsiadlowski[6], Thomas R. Gillespie[7,8], Christian Drosten[1,9], Sandra Junglen[1,9]

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Disturbance of tropical ecosystems may alter virus abundance and prevalence patterns via changes in host species assemblages. Diverse host communities are hypothesized to dilute the prevalence of specific pathogens, whereas biodiversity loss can increase infection rates in target species. Experimental studies as yet mainly focused on the effects of epidemic human and livestock pathogens using single-host and single-pathogen systems.

Here we studied the effects of ecological disturbance on virus abundance and diversity patterns in naturally infected mosquitoes collected along anthropogenic disturbance gradients in East and West Africa and in Central America using an undirected multiple-pathogen and multiple-species approach. Habitats included primary rainforest, deforested areas, villages and a metropolis with more than 2 million inhabitants. In total, 15.055 mosquitoes belonging to 29 species were analysed. Species diversity (H') decreased on average from 2.17 in primary habitats to 1.37 in the metropolis and the evenness decreased from 0.73 to 0.43, respectively. Mosquitoes were found to be infected with 21 insect-specific viruses of the family *Bunyaviridae* of which 19 were previously unknown. Virus species were mostly associated with mosquito subgenera or genera. Viral infection rates were under 20% in primary habitats, whereas infection rates increased up to 50% in deforested habitats and villages and up to 94% in the metropolis. We found evidence that host infection rates and species diversity were negatively correlated for two viruses. Interestingly, for one of the viruses even host switches to five species that were not infected in the primary habitat were observed in disturbed habitats.

Our data suggest that biodiversity can have a strong impact on infection rates. However, the dilution effect seems not to be a general phenomenon and only applies to specific viruses.

SESSION 4

S4: TROPICAL WETLAND ECOLOGY

Chairs: Pia Parolin & Leandro V. Ferreira
Contact: piaparolin@gmx.de

TUESDAY 17:00

SESSION 4-O1 - TROPICAL WETLAND ECOLOGY

LINKING LAND SURFACE PHENOLOGY AND VEGETATION-PLOT DATABASES TO PREDICT SPECIES DIVERSITY AND DISTRIBUTIONS IN THE OKAVANGO BASIN

Rasmus Revermann[1], Manfred Finckh[1], Marion Stellmes[2], Vera de Cauwer[3], David Frantz[2], Ben Strohbach[3], Jens Oldeland[1]

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The Okavango Basin is a hot spot of accelerated land use change. However, baseline information on ecosystem properties such as species diversity and distribution is missing. In this contribution we used the Okavango Basin as a study area to show how information stored in vegetation-plot data bases can be linked to MODIS land surface phenology (LSP) metrics to extrapolate plot based ecological data to unsurveyed areas.

LSP metrics describe temporal changes of vegetation development, biomass and seasonal aspects. Vegetation types exhibit unique combination of LSP metrics hence making them suitable predictor variables for spatial modelling. We derived response variables on alpha diversity and species occurrences from the vegetation-plot database of The Future Okavango project (www.future-okavango.org). Using species distribution models and predictive modelling of species density we compared the predictive power of climatic predictors with LSP metrics.

Although climate based models showed better statistical performance, LSP only models delivered more realistic maps on species density. Maps of climate based models showed artefacts and predicted homogenous belts of species density. In contrast, LSP models provided realistic large scale trends and even revealed local patterns of the landscape mosaic. The Miombo woodlands of the upper reaches of the Okavango River harbour highest species density. Values decreased southwards with lowest values reached in the thornbush savannas surrounding the Okavango Delta. Furthermore, the information of modelled distributional ranges of all frequent woody species offers an important data source for further ecological analysis such as regionalization of tree communities and maps for forest management.

Our framework demonstrates the high potential of LSP metrics in conjunction with the information stored in vegetation-plot data bases to generate the much needed spatial information for conservation planning and natural resource management.

CLONAL AND GENETIC DIVERSITY OF *CYPERUS PAPYRUS* IS STRUCTURED BY HYDROLOGICAL CONNECTIVITY AND VEGETATIVE SPREAD IN LAKE TANA (ETHIOPIA)

Addisie Geremew[1], Tim Sierens[1], Ludwig Triest[1]

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Tropical papyrus swamps dominated by papyrus (*Cyperus papyrus*) as a keystone species provide various regulatory ecosystem and provisional services. However, over the past three decades, this important ecosystem has been devastated by human-driven wetland modifications that alter biological connectivity. Connectivity is a decisive conservation issue that reshuffles the extent of genetic differentiation among populations.The aim of this study is to determine clonal and genetic diversity, population structure and connectivity of the emergent macrophyte *C. papyrus* in Lake Tana (Ethiopia). Considering the mixing processes and a strong discharge system of Lake Tana hydrochory and vegetative spread in shaping the clonal and genetic diversity is hypothesized. A total of 402 *C. papyrus* individuals sampled from 13 swamps in and bordering Lake Tana (Ethiopia) were genotyped using 15 microsatellite markers. Overall, moderate clonal (R =0.48) and genetic diversity (H_E = 0.40; A_r = 2.5) of papyrus populations were attributed to the mixed reproduction system. Within the Lake, significant genetic differentiation (F'_{ST} = 0.16) revealed three non-panmictic clusters of *C. papyrus* populations (K=3).Along the surface flow pattern, there was a weak but significant isolation-by-distance (IBD). The contemporary migration rate between populations was asymmetrical in magnitude and dominantly directed towards south and southwest Tana.Between most sites, 1 to 4 individuals sharing identical multilocus genotypes (MLGs) could be identified, few spanning the maximum distance (75 km). The contemporary asymmetric migration could be explained by strong discharge, weak clockwise circulation and blockage by islands. The number of shared individuals with identical MLGS between/among populations inferred that clonal and genetic diversity of *C. papyrus* is structured by both hydrological connectivity and vegetative spread.

WATER QUALITY CHANGES IN IZEH MIANGARAN WETLAND AFFECTED BY WASTEWATERS AND SURFACE WATERS

Esmaeil Kouhgardi[1], Sekineh Maqsoudi[1], Abdorahom Pazira[1]

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Wetlands are amongst the most prolific ecosystems. Miangaran Wetland is located in the South-West of Zagros foothills of Iran, covering 2718 acres in North-East of Khuzestan with a sub-tropical climate. In the study, 10 samples in 3 repetitions were obtained in each sampling points to measure the turbidity, nitrate, phosphate, BOD5, COD, dissolved oxygen, sulfate, pH, and TDS parameters to investigate the quality changes in wetland due to the entrance of wastewater and surface waters. Results showed that in all stations there was significance difference at level 0.01 based on one-way ANOVA, and at level 0.05 based on Tukey test. It can be seen the highest concentration of pollution relates to the southern part of the wetland, specifically where the wastewater from Izeh enters, and also to the points closer to the villages at the border of the wetland. The level of nitrate, sulfate, and phosphate are too high in the wetland, and this pollution can be attributed to the entry of domestic and agricultural wastewater to the wetland. Besides, the rapid growth of algae can be related to the high level of water pollution by micro-organisms formed due to the entrance of domestic wastewater and of domestic animals to the wetland. Reduction in elimination of suspended materials in water, absorption of pathogens and making environmental conditions contributing to outbreak of different diseases, toxic effects on living beings such as aquatic creatures and plants, and eutrophication, shows its density is higher than standards of drinking and aquatic life preservation; and too much entrance of phosphate leads it to eutrophic and gradually to dystrophy or the final stages of sequence and causing extermination of this aquatic ecosystem.

DAM-INDUCED FOREST FRAGMENTATION HAS EXTREME BORDER EFFECTS ON TREE PHYSIOLOGY

Pia Parolin[1,2], Leandro V. Ferreira[3]

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In Amazonia, many large rivers have been dammed or are in various stages of planning in order to provide energy from hydroelectric reservoirs. Once dammed, rivers turn into huge lakes which flood the vegetation, mountains are left as islands. The former vegetation suffers from the strong impacts of microclimatic changes, e.g., artificial edge habitats, erosion, dessication from wind, and altered rainfall patterns as well as effects of flooding on previously unflooded soils. These conditions lead to high mortality rates of indigenous trees. In this presentation we analyze the short-term responses in artificial islands of the Tapajós, Xingu and Tocantins Rivers in Amazonia. We analysed plot pairs of 5 x 40 m on 17 islands of 8-100 hectares. The plot pairs comprised one plot 30 m from the margin and one more than 100 m from the margin. No significant differences of tree density, basal area, density of regeneration and canopy cover were found between island border and interior in all sampled islands in the Tucuru‘ dam reservoir. This gives evidence that the whole islands - and not merely the borders - are heavily affected by abiotic changes. Alterations of species composition, richness and diversity, and a substitution of the original species result even in the central area of 100 ha islands. Forests lose diversity and are shifted towards more open vegetation forms. Analyses of the tree species composition of the highly specialized pioneering formations show that there are distinctions between the three river basins although they are not very distant from each other and environmental constraints are very similar. With only six out of 74 species occurring in all three inventories, the majority of tree and shrub species was restricted to each one of the rivers, indicating a high degree of local endemism in these regions. Different species occupy similar environmental niches, alternative designs of equal fitness occur in similar environments making these fragile ecosystems of pioneering formations highly valuable. Conservation plans must therefore consider the complementarity of species when decisions on where to place conservation units are taken. If this is not considered for conservation strategies, the original biodiversity will be lost irreversibly, and it is impossible to compensate for it in other places.

AN EXAMPLE OF A RIPARIAN FOREST RESTORATION IN PINDORAMA, BRAZIL

Maria Teresa Vilela Nogueira Abdo[1], Sidney Rosa Vieira[2], Antonio Lucio Mello Martins[1], Luis Claudio Patterno Silveira[3]

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In Brazil, mixed reforestation with native tree seedlings from different floristic groups is accepted as an effective way to recover native revegetation. The planted trees will then result in a dynamic interaction between plants and animals inducing natural regeneration going beyond vegetation improvements restoring fauna and flora biodiversity and soil and water balance. The experimental area is located in the *Polo Centro Norte -APTA,* a 532 ha Agriculture Research Unit in Pindorama, Brazil with 144 hectare of Tropical Forest remnants considered Biological Reserve by São Paulo State law 4960/86. Located on Kandiustalf soils with sandy texture in the surface layer and clay loam in the subsurface very susceptible to erosion minimized by vegetation cover. A dam linking two forest remnants had no arboreous vegetation in the edges and difference of soil humidity and vegetation due to drainage system in its edges. Near the water the vegetation was typical of heath; at higher altitudes the vegetation was typical of dry area what demanded a meticulous choice of the appropriate native species with flooding tolerance in wet area and different planting techniques. In an area of 1 ha, native forest and fruit species had been planted with to recover vegetation and to attract birds and other animals to help in seed dispersion and restoration. In the wet heath area, flood resistant species were planted and provisory drains had been made with dugs with 30 cm deep and 10 m apart from each other in “fish spine” shape. In dry area the seedlings had been planted in conventional hollows and in wet area they were planted on small soil elevations to prevent rotting stems. The pioneer species were planted in September 1998 and the second phase of planting with 1560 seedlings of secondary and climax species started on February 2nd, 1999 and finished on March 22nd. The ratio of seedlings planted was: 60% Pioneer, 30% Secondary, and 10% Climax and 1700 seedlings of native species were planted with 3.0m between rows and 2.5 m between plants. Each hollow received calcareous, superphosphate, mulching, manual irrigation and chemical and manual weed control 150 days after plantation. The different species chosen and the appropriated handling of the planting and drainage made the recovery of the heath forest possible resulting on a forest corridor between remnants.

WHOSE MANGROVE IS IT AND WHAT IS IT FOR?

Jean Hugé[1], Katherine Vande Velde[1], Francisco Benitez-Capistros[1,2], Satyanarayana Behara[1,3], Farid Dahdouh-Guebas[1,2], Nico Koedam[2]

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[3]Universiti Malaysia Terengganu (UMT), Kuala Terengganu, MY

Conservation of tropical ecosystems is influenced by scientific evidence and by peoples' perceptions and values. Multifunctional mangrove ecosystems are particularly threatened by conversion and encroachment in south-east Asia, although some areas, like Matang mangrove in peninsular Malaysia, have retained much of their forest area. A better understanding of the reasons why people in particular contexts do manage mangroves in a particular way is needed, in order to acknowledge multiple stakeholders' perspectives and knowledge claims. This could contribute to support decision-making. This study focuses on the identification of stakeholder discourses regarding the management of Matang. We characterized the diversity of stakeholder perspectives by using the semi-quantitative Q methodology. The diversity of views can be summarized into three main discourses: 'the multifunctional mangrove', 'change for the better' and 'business as usual'. We reflect on the possible consequences of the diversity of perspectives for the future management of mangroves, by focusing on possible points of connection between the three discourses regarding resource systems, resource units, users and governance systems. The three discourses (and their 'hybrids') provide sources of inspiration and knowledge on how to embody and assess the sustainability of mangroves as a socio-ecological system.

SESSION 5

S5: DEVELOPING SUSTAINABLE LAND USE AND FUNCTIONAL MONITORING SYSTEMS FOR THE ECUADORIAN ANDES TO COPE WITH ENVIRONMENTAL CHANGE EFFECTS - TOWARDS ACCESS AND BENEFIT SHARING (ABS)

Chairs: Jörg Bendix & Erwin Beck
Contact: bendix@staff.uni-marburg.de

WEDNESDAY 09:15

PLATFORM FOR BIODIVERSITY, ECOSYSTEM MONITORING AND RESEARCH SOUTH ECUADOR - BASIC RESEARCH GOES KNOWLEDGE TRANSFER

Joerg Bendix[1]

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The platform project can rely on 16 years of integrative biodiversity research in the biodiversity hotspot of the south Ecuadorian Andes which is threatened by global environmental changes (mainly climate and land use change). The current, trans-disciplinary research and knowledge transfer program has mainly three aims: (1) To unveil the impact of atmospheric nutrient deposition on the nutrient-poor ecosystem regarding the biogeochemical cycle, species composition and ecosystem functions (as e.g. carbon partitioning); (2) The assessment, development and implementation of a sustainable land use portfolio based on ecological, economic and social indicators; and (3) the development and implementation of suitable indicators for a global change monitoring system with special reference to functional indicators. The talk will give an introduction to the program and thus, to the session.

OPTIMIZING ECOSYSTEM SERVICES SUGGESTS DIVERSIFIED RESTORATION OF ABANDONED TROPICAL PASTURES

Thomas Knoke[1], Carola Paul[1]

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Restoration of abandoned pastures in the tropics is an important opportunity to re-direct agriculture and forestry to already cleared lands. To reduce environmental problems the restored areas should form complex and balanced land-use mosaics, rather than landscapes covered by one single land-use option. This aim requires consideration of multiple ecosystem services when allocating the abandoned lands to new land-use options. Here we present a new approach which combines multiple-objective optimization with uncertainty modelling using ecosystem service indicators. The new method is illustrated witha unique data set of 22 ecosystem service indicators for abandoned pastures in Ecuador based on five feasible restoration land-use options, including two afforestation, two pasture rehabilitation as well as abandoned systems. The results suggest diversified portfolios of land-use options for restoration, even without allowing for uncertainty of the indicators. Remarkably, the obtained land-use portfolios retain a notable proportion of abandoned areas, left unmanaged for natural succession (between 19% and 31%). In contrast, single-objective optimization leads to less diversified restored landscapes and inferior minimum levels of individual indicators. Not all indicators had the same importance. Ignoring soil quality and payback periods in our study led to the greatest changes in land allocation. Using an example from the Eastern Andes of southern Ecuador we show how the optimized land-use options may be distributed in a real landscape. We conclude that restoration planning should directly incorporate various indicators and apply multiple-objective optimization to obtain a balanced mosaic of land-use options that provide satisfactory levels of various ecosystem services.

EFFECTS OF EXTREME WEATHER EVENTS UNDER INCREASED FOOD DEMAND ON DEFORESTATION - AN ECONOMIC MODELLING APPROACH FOR ECUADOR

Carola Paul[1], Diana C. Barros[1], Santiago Ochoa M.[1,2], Martin Döllerer[1], Thomas Knoke[1]

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Ecuador suffers one of the highest deforestation rates in Latin America. This trend is mainly driven by an increased demand for food and energy. Producing more food is, however, increasingly impeded due to the occurrence of extreme weather events such as the “El Niño” phenomenon and the resulting agricultural losses. This study takes an economic perspective to test how an increase in the probability and intensity of extreme weather events could affect deforestation. By understanding these relationships, the study aims to contribute to designing effective conservation policies. The study applies a land-use optimization model that allocates land to selected land-use options according to the objective function of balancing financial returns and risks. By including updated maps of current land-use on the national level for Ecuador, as well as information on the suitability of land for agricultural uses, the model can be used to investigate trends in land-use allocation, and more specifically the sites on which these trends are likely to be observed. Results show that an increased food demand would lead to a complete conversion of natural ecosystems to productive uses on the best sites, while forest would only be retained on very poor sites. A higher probability and intensity of extreme weather events and related agricultural losses would make permanent crops, agroforestry and forest management more important as they reduce financial risks. However, this trend would increase the use of natural ecosystems, even on low productive sites. Forest conservation (without use) would become only feasible under a compensation scheme. Our study reveals that the probability and intensity of extreme weather events strongly affect the effectiveness of compensation payments. Promoting diversification, sustainable use of natural ecosystems and the use of robust agricultural systems will be important measures to reduce trade-offs between food security and conservation.

Merian Award Applicant

ANALYSIS OF CLIMATE CHANGE EFFECTS ON DIFFERENT ECOSYSTEMS APPLYING THE HIGH RESOLUTION CLIMATE INDICATOR SYSTEM (HRCIS) FOR SOUTH ECUADOR

Katja Trachte[1], Rütger Rollenbeck[1], Jörg Bendix[1]

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The Andes Mountains of South Ecuador are characterized by a highly diverse ecologically richness making this region one of the hottest hotspots for biodiversity. Particularly the complex structure of the terrain causes a variety of ecosystems across small scales, which are strongly related to zonal and altitudinal gradients in climate dynamics. At the eastern slopes mountain rain forest dominates due to impinging trade winds advancing warm-moist air from the Amazon to the Andes leading to extensive rain amounts. In contrast, the western slopes are under the influence of a strong seasonality leading to distinct rainy and dry seasons which is reflected in the deciduous forest / dry forest. In addition to the zonal gradient due to the height of the Andes Mountain chain, paramo occurs above the timberline generating an elevational gradient in ecosystems.

In the light of recent and future climate changes as an indicator for loss of biodiversity these ecosystems are strongly endangered. Therefore the high resolution climate indicator system (hrCIS) for South Ecuador is developed to derive climate change indicators relevant for ecosystem research. The hrCIS is generated applying the regional climate model Weather Research and Forecasting (WRF) in a dynamical downscaling approach. It covers a time period of 20 years (1995 to 2014) with a spatial and temporal resolution of 4km and 1 hour, respectively, on the inner domain. On the basis of important climate change indicators, e.g. precipitation and temperature, recent developments for the respective ecosystem are presented. Further, based on heat and energy exchanges in dependence of the different ecosystems feebacks between the atmosphere and the land coverage are discussed.

TREE GROWTH AND STABLE OXYGEN ISOTOPES AS INDICATORS OF ECOSYSTEM RESPONSE TO CLIMATE VARIABILITY IN DIFFERENT FOREST ECOSYSTEMS IN SOUTHERN ECUADOR

Achim Bräuning[1], Darwin Pucha[1,2], S. Spann[1], F. Volland[1], Volker Raffelsbauer[1], Kelly Peña[1,2], T. Peters[1]

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Variations of stable oxygen isotopes in tree-ring cellulose are a widely used proxy to reconstruct hydro-climate variability in tropical and subtropical regions. We present two $\delta^{18}O$ chronologies from different forest ecosystems in southern Ecuador spanning the past more than 100 years: a tropical mountain rainforest in 2000m altitude and a seasonally dry forest in 600m altitude. To link annual tree growth in different environments to climate forcing factors, we measured seasonal growth dynamics with high-resolution electronic dendrometers and related growth rates to local climatic variables and gridded climate data. The rainforest chronology was derived from 15 *Cedrela montana* trees growing in the Podocarpus National Park and represents the best replicated isotope tree-ring chronology from the tropics. In comparison with ring width, stable isotope variations show considerably higher correlations between individuals and thus represent a better climate proxy in this wet environment. Strong teleconnections to isotope chronologies from the Amazon lowland indicate high consistency of regional hydro-climate variations. The Cedrela $\delta^{18}O$ record is correlated with regional precipitation (January to April) and cloud cover over the Andean Cordillera Real. The dry forest chronology was derived from *Bursera graveolens* and is strongly correlated with tropical Pacific SSTs during the rainy season (January to May). Since the source of precipitation originates from the Atlantic Ocean in the rainforest and from the Pacific Ocean in the dry forest, the combination of stable oxygen chronologies from different ecosystems may indicate long-term changes in dominant tropical precipitation patterns. Hence, a combination of tree parameters using forest ecosystems along climatic and altitudinal gradients can be useful to develop monitoring systems for climate change effects on forest ecosystem functioning, especially concerning carbon uptake and water use.

RESPONSE OF THE ELEMENT BUDGETS OF A TROPICAL MONTANE FOREST TO CLIMATE CHANGE AND NITROGEN DEPOSITION

Andre Velescu[1], Sophia Leimer[1], Elias Willimann[2], Katja Trachte[3], Thorsten Peters[4], Rütger Rollenbeck[3], Jörg Bendix[3], Wolfgang Wilcke[1]

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Climate change and nitrogen deposition are currently the dominating environmental changes, threatening biodiversity and functioning of native tropical ecosystems. In the past two decades, the tropical montane forests on the Amazonia exposed slopes of the Andes of South Ecuador experienced increasing temperatures, longer dry spells, reduced air and soil humidity and increasing deposition of reactive N mainly originating from Amazonian forest fires.
Since 1998, we have been investigating at microcatchment scale the biogeochemical responses of this megadiverse tropical mountain forest ecosystem, which is considered one of the biodiversity hotspots of the Earth, to environmental changes, including climate change and nutrient deposition.
We used a Bayesian multiple regression model to distinguish between responses to climate change and nitrogen deposition. To predict future development of the study area we simulated element exports from the microcatchment under IPCC emission scenarios A1B and B1 for the decades 2050-2059 and 2090-2099 with a distributed deterministic hydrological catchment model (WaSiM).
Our results show that increasing NH_4-N export from the catchment is best explained by both increasing nitrogen deposition and climate variables, while increasing H+ fluxes with litter leachate which indicate acidification and increasing litterfall are best explained by climate variables only. Soil acidification was related to the flow regime through the organic layer, while litterfall was mainly driven by increasingly dry soil conditions. Even under scenario B1, which assumes a fast changing economy towards more sustainability, increasing exports from the study catchment with stream water are predicted for most elements.
Our results demonstrate that environmental change is likely to result in changes in ecosystem functioning of a very remote tropical mountain ecosystem with the risk of destabilization in the long run. Climate change might considerably affect future element exports from this tropical montane catchment causing off-site impacts like eutrophication of surface waters.

Merian Award Applicant

EFFECTS OF CONTINUED N AND P ADDITION ON ECUADORIAN ANDEAN FORESTS

Jürgen Homeier[1]

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Elevated N and P inputs affect virtually all components and processes of terrestrial ecosystems since the productivity of plant communities is limited by N or P, or both in the vast majority of ecosystems on the globe. Human activities will globally affect the cycles of N and P during the coming decades and tropical Andean forests are likely to respond sensitively to these changes. But the size and direction of these responses are still unclear.

The effects of continued nutrient addition on tropical montane forest ecosystems is investigated in three Andean forest types at 1000m, 2000m and 3000m within the ongoing Ecuadorian NUtrient Manipulation EXperiment (NUMEX), that started in January 2008. In this experiment moderate amounts of N (50kg ha^{-1} yr^{-1}), or P (10kg ha^{-1} yr^{-1}), or N and P are added to representative old-growth forest stands.

We are monitoring tree stem growth, fine litter production and leaf properties since the start of the experiment. In addition, tree recruitment monitoring was started in 2011.

The results of this long-term experiment show, that on the one hand responses depend on the study site but on the other hand species identity plays an important role for the observed effects.

EFFECTS OF MODERATE NUTRIENT ADDITION ON BELOW-GROUND CARBON ALLOCATION IN ANDEAN FORESTS

Jhenny Salgado[1], Jürgen Homeier[1]

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A future increase of nutrient deposition could be expected for most tropical regions, probably causing different "fertilization effects". Previous studies in tropical forest indicate that nutrients inputs could affect carbon storage and allocation, and alter the species composition and diversity of forests.

Existing studies on nutrient addition effects on tropical forest are mostly from lowland forest and had their focus on aboveground parameters.

Since tropical montane forests are important carbon stores and the belowground fraction of the stored carbon is higher compared with lowland forests, the aim of our study was to contribute to a better understanding of root dynamics under increasing nutrient availability.

For our study, we used the ongoing Ecuadorian NUtrient Manipulation EXperiment (NUMEX). In this experiment moderate amounts of N (50kg ha^{-1} yr^{-1}), or P (10kg ha^{-1} yr^{-1}), or N and P are added to representative old-growth forest stands at 1000, 2000, 3000 m a.s.l.

We evaluated the response of fine root biomass and growth of fine and coarse roots after 5-7 years of continued nutrient addition.

Merian Award Applicant

NUTRIENT-INDUCED MODIFICATION OF WOOD ANATOMICAL TRAITS OF *ALCHORNEA LOJAENSIS* REVEALED BY X-RAY MICRO TOMOGRAPHY AND QUANTITATIVE WOOD ANALYSES

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Alchornea lojaensis Secco (Euphorbiaceae) is an evergreen broadleaved tree species, which occurs in the tropical humid mountain forests in Southern Ecuador at about 2000m a.s.l.. Although the species has been described morphologically in 2008, neither its wood structure nor the functional traits of its wood anatomical parameters have been studied.

Regarding the so far unknown effects of expected higher rates of atmospheric nutrient deposition on tropical trees species in the future, it is essential to analyze the wood anatomical structures of a tree species as a plastic and adaptive trait on the cellular level.

As part of an interdisciplinary nutrient manipulation experiment (NUMEX), we carried out the first ever descriptive and quantitative wood anatomical analyses of branch wood of *A. lojaensis* fertilized with N and N/P, and a reference group as controlling factor.

For detailed analyses we applied high-resolution x-ray micro tomography like it is commonly used for medical examinations. Standard microscopic preparation techniques are used for quantitative analyses of the vessel structure of the branch wood. Investigations of more than ten different vessel parameters including vessel size, the vessel number, the vessel arrangement and the hydraulic conductivity of the vessel provide information about modifications of wood anatomical traits in response to fertilization.

The results showed that vessel diameter size and hydraulic conductivity was significantly increasing after fertilization N and the combination of N+P. The analysis of vessel grouping indices indicated clear differences among the treatments. We conclude that higher nutrient availability of N and N+P triggered higher foliage amount and water demand, leading to higher cavitation risk in larger vessels, which is counteracted by a stronger grouping of vessels with smaller risk of cavitation to ensure water supply during drier periods that are expected to occur in higher frequency in the near future.

FUNCTIONALITY OF ARBUSCULAR MYCORRHIZAL FUNGI IN THE TROPICAL MONTANE FOREST OF SOUTHERN ECUADOR

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Arbuscular mycorrhizal fungi (AMF) represent an ubiquitous group associated with more than 80% of land plants. Their predominant role as mycorrhizal symbionts in the tropics has been approved several times, though detailed data especially on their functional role in this diverse system, characterized also by special soil types, are missing. Generally, improved nutrient uptake for the plant is regarded as the main role of the symbiosis, mainly of phosphorus (P), but also nitrogen (N) and other nutrients may play an important role. Additionally, an impact of AMF on plant community composition, ecosystem productivity and soil processes has been demonstrated.

As part of a multidisciplinary research project conducted in the tropical montane forest of Southern Ecuador, we have been analyzing the ecology of AMF in this understudied ecosystem for several years. Surprising results in the response of AMF abundance to nitrogen (N) and phosphorus (P) additions (N exhibited a negative effect, whereas P increased AMF abundance) as well as interesting morphological characterizations raised our interest in the role of AMF in nutrient cycling in this ecosystem type. Therefore, consequent functional experiments have been established. First, a rotated core experiment was conducted in order to experimentally exclude AMF from parts of the soil. Additionally, the interaction with soil fauna and N availability was manipulated in this experiment. Effects of these treatments on nutrient availability, decomposition rates as well as soil microbial activity and community composition are analyzed. As a second experiment the role of AMF in plant growth and N versus P uptake was tested experimentally via pot experiments with different plant species. Following the establishment of a natural experimental setup, the comparison of plant growth as well as plant N:P ratios in AMF +/- treatments may give insights on their role in plant nutrient uptake.

LITTER MIXTURE EFFECTS ON MICROBIAL BIOMASS AND MICROARTHROPOD COLONIZATION IN A TROPICAL MONTANE RAIN FOREST IN SOUTHERN ECUADOR

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In tropical forests typically a variety of litter species enter the decomposer system and this may significantly affect the decomposition of leaf litter. Unfortunately, litter mixture effects on decomposition processes are little studied in particular in the tropics. We carried out a litterbag study to investigate litter mixture effects on microbial activity, microbial biomass and colonization of litter by microarthropods in a tropical montane rain forest in southern Ecuador.

Leaf litter from four abundant tree species with different litter traits were collected at the study site at 2000 m.a.s.l. Litterbags were filled with each individual litter species and all possible two and four leaf litter combinations. Three replicates of each treatment were established and placed on the soil surface for 6 and 12 months.

Microbial biomass and activity in the litter material was measured and mobile soil animals were extracted by heat and determined, focusing on oribatid mites, which were determined to species level. By investigating colonization of the litter by microorganisms and soil arthropods insight was gained into the mechanisms responsible for litter mixture effects. Results of litter decomposition processes and colonization by soil biota including microorganisms and arthropods will be presented.

SPATIAL PREDICTABILITY OF ALPHA- AND BETA-DIVERSITY OF FOUR TAXA ALONG AN ELEVATION GRADIENT IN A MOUNTAIN RAINFOREST ECOSYSTEM

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Information derived from various remote sensing sources provides surrogates for habitat structure and therefore information to model the occurrence respectively abundance of flagship species as well as the diversity of species assemblages across space. Such information is often of basic importance for conservation planning, particularly as limited field data are available. However, the spatial predictability of species richness or other measures of alpha-diversity is often poor. Additionally, these measures ignore information of species identity which is at least in part covered by measures of beta-diversity. Various studies have shown that the change in the composition of communities across space is closely related to spatial changes in habitat structure. Therefore, the predictability of beta-diversity by habitat characteristics derived from remote sensing information should exceed that of alpha-diversity. Here, we model alpha- respectively beta-diversity with optical texture metrics derived from remote sensing information as indicators for habitat structure using partial least-square regression. Our comparison is based on field data from four different taxa (trees, moths, ants, birds) in a mountain rainforest ecosystem in South Ecuador. The leave-one-out R^2 and root mean square error were used to assess the predictability of both diversity measures. For all four taxa, predictability of beta-diversity was higher compared to the predictability of alpha-diversity. For the tree assemblages, predictability as measured by R^2 reached even 0.9. We explain this result by the fact that measures of beta-diversity incorporate also information of the response of individual species to changes in habitat structure. Obviously this increases the predictability of such metrics on the landscape scale and thus enhances decision making in conservation planning.

MONITORING BIRD DIVERSITY ACROSS ELEVATIONAL AND LAND-USE GRADIENTS IN SOUTHERN ECUADOR

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Birds are among the most species-rich and abundant groups in the tropical Andes. They play a key role in the ecosystem as pollinators and dispersers of multiple species of plants as well as for pest control. However, the mechanisms that shape avian assemblages across elevational and disturbance gradients are poorly understood so far. In this study we aim to explore how elevational and land-use gradients as well as seasonality affect bird communities and resource availability in a tropical montane forest in the Southern Andes of Ecuador. We monitored bird diversity in 18 plots across three elevations (1000 m, 2000 m, 3000 m a.s.l.) and two habitat types (continuous near-natural forest and disturbed forest). We recorded all birds seen or heard in nine 10-minute point counts per plot. The monitoring was repeated twice in each wet and dry season and was conducted over two years. Resource availability (fruits, flowers and invertebrate biomass) was recorded at each plot. A total number of 2012 bird individuals and 181 species was recorded. Bird species richness decreased with increasing elevation and was significantly lower in natural forest sites. However, seasonality seems to be the most important predictor of bird species richness. Bird species richness was significantly lower in the wet season (127 species) compared to the dry season (157 species). This could mainly be explained by the availability of resources. We conclude that resource availability acts as strong filter to shape avian assemblages across elevational and land-use gradients as well as in different seasons.

Merian Award Applicant

MATRIX HETEROGENEITY ENHANCES BIRD MOVEMENT IN A FRAGMENTED HIGH-ANDES LANDSCAPE

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Habitat loss and fragmentation are some of the most important threats to global biodiversity. It has been shown that animal species are not only influenced by the remaining habitat patch size and its quality but also by its connectivity in the fragmented landscape. In this regard, heterogeneous matrices are known to promote connectivity between habitat fragments. However, to what extent these matrices influence species movement of different habitat guilds is little understood. We therefore studied the relationship between bird guild movements, Polylepis forest patch characteristics and surrounding páramo matrix heterogeneity in a biodiversity hotspot, the Ecuadorian high-altitude Andes. Overall, we detected 250 individuals of 16 bird species making movements between forest patches and matrix. The richness of species moving and the average number of Polylepis specialists moving increased with increasing páramo matrix heterogeneity. In the same way, community similarity in the patch and surrounding matrix was positively correlated with the heterogeneity of the páramo matrix. Our findings suggest the vital role of páramo heterogeneity in enhancing connectivity among naturally fragmented Polylepis woodland, especially for Polylepis specialist birds. We emphasize that the heterogeneity of habitats in the high-altitude Andes landscape is important for conservation at the landscape scale.

Merian Award Applicant

ANTS AS FUNCTIONAL INDICATORS IN MEGADIVERSE MOUNTAIN RAINFORESTS IN ECUADOR

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Climate change and forest degradation have an increasing impact on structural aspects of natural ecosystems across the globe. For instance, changes in species composition often affect ecological functions. Therefore, simple indicators are needed which can unveil changes in the structural and functional aspects within ecosystems. Species diversity alone covers only a small fraction of the overall diversity and functionality within ecosystems, whereas phylogenetic diversity of species is often – but not always – linked to functional diversity. Ants belong to the most abundant and species rich fauna in terrestrial ecosystems. As they perform a variety of ecological functions such as herbivory, seed dispersal and predation they are often referred to as ecosystem engineers. Furthermore, ants rely mainly on their local habitat and are particularly related to nutrient cycling and water regulation. Therefore, changes in habitats should strongly modify ant assemblages suggesting ants as process-related bio-indicators. Yet, it still needs to be tested, how the functional diversity of ant assemblages respond to climate change and forest degradation so that ants can be used as meaningful functional indicators.

Therefore, we analyzed whether ant species diversity, phylodiversity and functional diversity changed along an elevation gradient and whether they reacted to forest degradation by using a simple bait trap sampling design. Our results showed decreasing species diversity with increasing elevation but no differences between natural and degraded forests. In contrast, phylodiversity of the ant assemblage increased with elevation both in natural and degraded forests. Furthermore, preliminary results on the functional traits of the ant assemblages showed responses both to climate change and forest degradation. Therefore, ants seem to be suitable bio-indicators for functional changes within megadiverse mountain rainforests.

Merian Award Applicant

TREE WATER USE PATTERNS AT DIFFERENT TOPOGRAPHIC POSITIONS IN A SUBMONTANE TROPICAL DRY FOREST

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Tropical dry forests are rapidly transformed by anthropogenic disturbance and sensitive to climate change. As water availability to plants is low, changes in precipitation patterns are assumed to have strong influences on tree phenology and water use. Trees in dry forests have manifold drought coping strategies and site adaptations which are reflected in tree water use patterns. Our objectives are to assess those patterns at different elevational positions in a submontane dry forest of southern Ecuador. Annual rainfall at the lower slope is 600 mm yr^{-1} with an eight months dry period. At higher altitudes precipitation is slightly higher due to moisture coming from the Pacific. At three altitudes (670, 860, 1100 m a.s.l.) four tree species with different phenological characteristics were studied: *Ceiba trichistandra* (stem succulent), *Eriotheca ruizii* (root succulent), *Capparis scrabida* (facultatively leaf deciduous) and *Erythrina velutina*is (typical leaf deciduous). Sap flux densities were measured by combining Granier-type thermal dissipation probes and heat field deformation sensors. During the wet period, *Ceiba* had high values for daily water use on the lowest and driest altitude. At the same altitude *Erythrina* and *Eriotheca* had their lowest values. This pattern changed with increasing altitude. *Ceiba* reduced water consumption by about -50% at higher elevation, whereas *Eriotheca* and *Erythrina* showed differently pronounced increases (+50% and +13%, respectively). *Capparis* did not change water consumption with altitude as long as fully leaved. However, leaved periods differed among species and topographic positions. Thus, clear differences among species and topographic positions and tree water use patterns are revealed; we are working towards disentangling morphological, phenological and environmental influences.

CARBON GAIN AND DIURNAL WATER CONSUMPTION STRATEGIES OF TREES IN A NEOTROPICAL MOUNTAIN RAIN FOREST

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There is a sequence of responses of trees to environmental changes, starting with physiological responses, followed by complex functional responses such as growth and reproduction which finally can lead to structural responses in forests, i.e. a change of the species composition. Associated with these sequential steps is a difference in the time periods which are necessary to recognize and establish the effects in a reliable way.

Focusing on fast physiological responses to the climate we have monitored the daily water consumption of 11 tree species in an evergreen tropical mountain rainforest and have found a very strong correlation with the diurnal dynamics of the moisture in the air, expressed as VPD. Concomitant measurements of leaf transpiration exhibited 2 types of leaf hydraulic performance which could be associated with isohydric and anisohydric water relations of the trees. All tree species showed annually recurrent reduced water consumption in months with high amounts of precipitation, but only the anisohydric increased their water consumption in dry months significantly. The proportion of isohydric and anisohydric species in the research plot was investigated.

Anisohydric trees exhibited a significantly higher stomatal conductance and lower daily water use efficiency (WUE) of net CO_2 uptake than the isohydric species. In spite of their extended period of daily gas exchange their photosynthetic carbon gain was not higher than that of the isohydric species. This is also reflected in the extension growth of the stem.

WATER RESPONSE IN THE TROPICAL MOUNTAIN FOREST USING GROUND AND SATELLITE OBSERVATIONS

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Changes in ecosystem water regulation occur in response to climate change. This holds for the biodiversity hotspot of the tropical Andes in southern Ecuador. Subtle changes of tree water relations might be potentially observed at individual tree-, canopy- and landscape-level. While tree water relations can be observed at tree individuals (species-specific) e.g. using ground measurements of sap flow, canopy spectral properties can be used for area-wide monitoring of water induced changes in leaves and in the canopy. In the present approach, we first combine area-average measurements of evapotranspiration with leaf transpiration and sapflow measurements at species level. Then, satellite and field observations on tree crowns are used to investigate if specific types of tree species could be used as indicators of the impacts of climate change on tree water relation and thus, ecosystem water regulation. Our results using ground observations with scintillometer and porometer measurements indicate good correlation between leaf transpiration and evapotranspiration. In addition, evidences for the availability of suitable indicator species have been procured by correlation analysis of sapflow with evapotranspiration. Beyond, results using high resolution satellite retrievals of evapotranspiration under wet and dry conditions show variations at landscape and at individual crown levels in time, also indicating ET as a valuable, spatial-explicit indicator. The variations are in line with trends in weather extremes for the period of study, which in turn agree with the current predictions of climate change.

Merian Award Applicant

OPTIMIZATION OF REGENERATION OF ABANDONED PASTURE AREAS AND SUBSEQUENT SUSTAINABLE PASTURE MANAGEMENT IN THE ANDES OF SOUTH ECUADOR

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Pasture farming for meat and milk is the common form of agriculture in the humid Andes of South Ecuador. Large areas of highly diverse mountain rain forests have been cleared, mostly by “slash and burn” to create pasture land. As a consequence ofecologically inadequate pasture management such as burning for rejuvenation, bracken (*Pteridium* spp.) invadesthe pastures as a pioneer weed that dominates the weed flora over a long time.In the research area in the south-eastern Andes of Ecuador, about 40% of former pastureland has been abandoned due to infestation by bracken urging the farmers to clear more natural forest. Regeneration of the abandoned pastures could mitigate this pressure on the forestenormously. Therefore, we investigated this possibility in a long-term experiment. The strategy of the experiment comprised 3 steps: Control of bracken with several methods, replanting of the pasture grass and finally probing several protocols of potential sustainable management. The experiment was carried out ona heavily bracken-infested slope at about 2000 m a.s.l., using *Setaria sphacelata,* a C4 grass with high growth rates, as pasture grass. Following our protocol, repasturisation requires about 2.5 years until the pasture can be re-used. Sustainability depends on a balancing fertilization and grazing intensity that warrants ecological control of bracken by the grass. Ina subsequent study, we compared the suitability of *S. sphacelata* with that of thetraditionally used exotic forage grasses *Melinis minutiflora*, *Pennisetum clandestinum*, *Holcus lanatus* and of the native species, *Axonopus compressus*. In a pairwise sampling experiment topography of the area was included as an important ecological factor for pasture optimization. *S. sphacelata* exhibited optimal growth on flat or only slightly sloping areas. While the faster growth rate and competitiveness of *S. sphacelata* could also be confirmed, its nutritive value was at best equivalent but mostly lower than that of the traditional forage grass species. *S. sphacelata* outcompeted not only weeds like bracken but also other useful pastoral herbs. Optimization of pasture land therefore requires also a topographically partitioned combination of traditional and exotic grass species.

Merian Award Applicant

SPATIAL PREDICTION OF SOIL ORGANIC CARBON STOCKS BY METHODOLOGICAL SPECIFICATIONS IN MACHINE LEARNING APPROACHES

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Tropical forests are significant carbon sinks and their soils' carbon storage potential is immense. However, little is known about the soil organic carbon (SOC) stocks of tropical mountain areas whose complex soil-landscape and difficult accessibility pose a challenge to spatial analysis. The applied methodology for spatial prediction is of high importance to improve the expected poor model results in case of low predictor-response correlations. Four aspects were considered to improve model performance in predicting SOC stocks of the organic layer of a tropical mountain forest landscape: Different spatial predictor settings, predictor selection strategies, various machine learning algorithms and model tuning.

Five machine learning algorithms: random forests, artificial neural networks, multivariate adaptive regression splines, boosted regression trees and support vector machines were trained and tuned to predict SOC stocks from predictors derived from a digital elevation model and satellite image. Topographical predictors were calculated with a GIS search radius of 45 to 615 m. Finally, three predictor selection strategies were applied to the total set of 236 predictors. All machine learning algorithms - including the model tuning and predictor selection - were compared via five repetitions of a tenfold cross-validation.

The boosted regression tree algorithm resulted in the overall best model. SOC stocks ranged between 0.2 to 17.7 kg m^{-2}, displaying a huge variability with diffuse insolation and curvatures of different scale guiding the spatial pattern. Predictor selection and model tuning improved the models' predictive performance in all five machine learning algorithms. The rather low number of selected predictors favours forward compared to backward selection procedures. Choosing predictors due to their indiviual performance was vanquished by the two procedures which accounted for predictor interaction.

BIODIVERSITY RESEARCH UNDER COMPLEX CONTROL: A NEW ERA OPENS UP

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With the UN Convention on Biological Diversity (CBD), the Nagoya Protocol (NP), the European regulations (511/2014) and the national European laws on the implementation of the NP, biodiversity-related research is now under legal control. Although the main focus of this control is on „research and development" of biological material (termed genetic resources, GR) for commercial purposes, several of the issues and rules apply also to basic, non-profit oriented biodiversity and ecosystem research. Definitions of basic, applied and commercial research are still under discussion. According to the NP, simplified access to GR for non-commercial biodiversity research shall be granted by the provider countries and several countries follow this recommendation with a straightforward procedure for a permit of basic research. However, particularly in the EU, control goes beyond the provider state being in future also exercised by the country of the user, i.e. of the researcher. Since there is no obligatory uniform regulation for access to GR in the 193 member states of the CBD the researcher must exercise „due diligence" when applying for a research permit in a host country. The constituents of due diligence in applying for and performing a research project will be controlled by the authority in charge of the researcher's home country. Beyond the protection and sustainable use of GR, the CBD and in particular the NP strive for a fair sharing of benefits between the provider and the user of a GR. This is the major issue in commercial biodiversity research but also basic research projects can produce a multiplicity of benefits to be shared between the parties. In that respect the various options of capacity building and knowledge transfer shall be estimated highest. The presentation will be illustrated with experiences from a long-term research of a German group of ecosystem and biodiversity researchers in Ecuador, who have learned the most important lesson: Trust opens the doors.

SESSION 6

S6: DIVERSITY, ECOLOGY AND CONSERVATION OF MADAGASCAR'S UNIQUE NATURE

Chairs: Jasmin Mantilla Contreras & Ute Radespiel
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LINKING CONSERVATION AND SUSTAINABLE DEVELOPMENT THROUGH BUILDING LOCAL MANAGEMENT CAPACITIES IN MADAGASCAR

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Madagascar is reputed for both its high biodiversity richness and the dramatically forest cover loss increasing every year, leading to loss of this exceptional richness. The country has developed specific policy consisting into fostering local user to create an association, know as community-based organisation (COBA), into which the management of natural resources will be transferred.

In order to increase local capacity, The Aspinall Foundation Madagascar are closely working with those local community, emphasizing the reciprocal links between biodiversity and human action and wellbeing. We assist local communities in preserving their forests' biodiversity and vital resources and have started an easy management system, which is being implemented, followed and evaluated by the local community itself.

Because of its poorness and insufficient knowledge, lack of adequate management capacity is noticed as lack of scientific knowledge about the managed resources and the real needs. Our ambition is to cure those lack and insufficiency. For that we have trained local rangers and the COBA to do simple ecological monitoring. Community-based monitoring started in 2010 and was extended to plants on 2014. Monitoring plots are being used for a comprehensive floral inventory as well as for assessing forest dynamics since the beginning of 2015. All monitoring data collected will help improve management by the local community, permitting to define zones of high conservation importance and others in which natural resources can be sustainably used. The data will result in an updated simplified development and management plan.

SUSTAINABILITY CHALLENGES IN PROTECTING MAROJEJY NATIONAL PARK

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Marojejy National Park is one of the national parks in the mountainous, moist, north-eastern part of Madagascar. It is located in the SAVA region, internationally known as the origin of most of the vanilla grown in Madagascar, which is the dominating supplyer of vanilla to the world market in recent years (market share >75%). Marojejy Nationalpark and Masoala National Park in the South of the SAVA region form a major part of the UNESCO World Heritage Site *Rainforests of the Atsinananan*, that comprise much of what is left of the eastern rainforests of Madagascar. Among other conseration highlights, the Marojejy-Masoala area features particularly high micro endemism rates. German KfW funds support national park establishment and management.
One of the constant threats to Marojejy National Park is illegal logging. During the recent political crisis in Madagascar (2009-2013), it was estimated that one third of the illegally logged rosewood and palisandre (*Dalbergia spp.*) came from the national park area, and a further third from Masoala National Park. Also ebony (*Diospyros perrieri*) is illegally logged. Many of the extraction sites are close to villages in which vanilla is grown as the main livelihood straegy. While valley bottoms are often used for wet rice, vanilla is an understory crop typically grown on small plots encroaching upon the mountains and extending towards the national park.
The ecologically certified (organic, Rainforst Alliance) cropping of vanilla in the region has a certain, but limited impact on reducing illegal rainforest encroachment. The main limitation is *leakage*, i.e. a mismatch between the farming household focus of certification and the extended family/clan and landscape scales of agricultural deforestation. The repeated forest exploitation for highly valuable hardwoods is completely beyond the reach of voluntary, and/or product-based conservation measures. In collusion between the national government and organised regional forces, the government willingly opens 'windows of opportunity' during which trees can be extracted.

LAND USE AND PLANT DIVERSITY IN THE SPINY FOREST BIOME - WHO WILL SURVIVE IN A CULTURAL LANDSCAPE?

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The deciduous spiny forests of southwest Madagascar are exceptionally rich in local endemic plant species, but approximately only 3% of the original forests of this biome remain today. The largest amount persisted in the Mahafaly plateau region where the National Park Tsimanampetsotsa is located. Nevertheless, population growth combined with unsustainable land use (e.g. slash-and-burn agriculture, livestock raising, and timber harvest) lead to further deforestation outside the Park area. Here, the forests have been mostly replaced by a cultural landscape mosaic of pastures and cactus fenced crop fields. The vegetation of these anthropogenic landscape elements is composed of a mixture of introduced, purposely planted, and plant species. We investigated the value of different land use types for maintaining the original floral biodiversity of the region.

To approach this problem, we conducted vegetation surveys on 165 plots exposed to different land use in the Mahafaly region, namely on pastures, crop fields, and bosks. For reference, we compiled an artificial potential regional natural species pool by combining available published autochthonous plant species records from the Natural Park and the surrounding area. We gathered information on species traits (e.g. life form, distribution) for all species. Eventually, we analysed the relation among land use and plant species composition and the importance of species traits for their occurrence in the cultural landscape.

We found that moderately grazed pastures retained the highest proportions of autochthonous plant biodiversity while crop fields were generally poorer in species and were dominated by introduced species. Furthermore, especially tree and liana species vanish from the cultural landscape while herb and shrub species are less affected. In general, plant species with a small distributional area were more affected than widespread species, which stresses the need for effective conservation efforts for local endemics.

OPEN RANGE AND LONG LEGS - THE MORPHOLOGY OF ANTS IN TRADITIONAL LAND-USE SYSTEMS ON THE MAHAFALY PLATEAU (MADAGASCAR)

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Even within the global biodiversity hotspot Madagascar, the dry deciduous spiny forests of the south-west are emphasised as particularly diverse with an extraordinary amount of locally endemic species. However, progressing expansion of traditional land-use modifies the regional landscape and alters the natural habitats of animal species.

Among invertebrates, which constitute a major part of faunal diversity, ants are the numerically dominant insect group in most terrestrial ecosystems. The composition of ant assemblies is structured by environmental filtering and the ants competitive abilities under different environmental conditions, mediated by the species' morphological traits. Thus, the morphology of ants which can be found in a certain environment reflects the "ecological space" of traits being beneficial under the respective conditions.

Accordingly, we analysed the effects of the three dominating land-use systems (livestock raising, slash and burn agriculture, and groves) on the morphological traits patterns of ground-dwelling ant assemblages.

We selected seven traits indicating body size, foraging strategy, and movement abilities in divergently structured environments. We hypothesised that open habitats contain on average larger and longer legged ants with more dorsally positioned eyes and vice versa. Moreover, we expected that the variability of exhibited traits was linked to the structural complexity of habitats, namely that ant assemblages living in more structured environments display broader ranges of traits.

We found that different configurations of traits were associated with differing habitat types, for example, large ants found in open habitats were equipped with relatively longer legs than comparably sized ones in structurally complex habitats. The study revealed that anthropogenic modification of habitats has large but also predictable consequences for the inhabiting ant communities and diversity.

THE EFFECT OF LAND-USE CHANGES ON ANT COMMUNITIES IN MADAGASCAR

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Madagascar has an astounding level of ant diversity, much of which is found in the island's eastern rainforest biome. Much of this diversity is under threat from deforestation by a slash and burn (tavy) agricultural system. Pilot reforestation projects have been established in the last two decades to try and restore some of this forest and to help conserve biodiversity as a whole, but there has been no research to assess the success of these projects.

Pitfalls were used to sample ant communities at different stages of the tavy land use trajectory in order to assess the consequences of this "business-as-usual" land use change scenario. Following on from this, sampling of ant communities was also carried out in actively reforested areas and areas of natural forest regeneration. All the ants contained within these samples were identified to morpho-species.

Ant species diversity was measured using hill numbers (q=0, q=1, q-=2). Whilst there was a general trend for decreasing diversity with increasing degradation of the land, this was only statistically significant between the most pristine habitats (closed canopy forest) and the most degraded habitats.

Redundancy analysis showed that the three most degraded habitat types had statistically similar ant community compostions, but that these were significantly different from ant communties found in closed canopy forest. Furthermore, natural reforestation sites had a greater similiarity in ant community composition to those in closed canopy forest than the active reforestation sites did.These results will be discussed in in the context of ant conservation.

CONSERVATION IN RURAL AREAS IN DEVELOPING COUNTRIES - PARK BANDRO, A CASE STUDY OF A SMALL-SCALE CONSERVATION PROJECT AT LAKE ALAOTRA, MADAGASCAR

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A major part of the worldwide biodiversity is dedicated to developing countries in the tropics. However, nature conservation in developing countries has always been a particular challenge due to ambivalent priorities of both, the local population and the government. This is especially true for Madagascar which is one of the poorest countries in the world and at the same time has a unique biodiversity and exceptional level of endemism. With a surface area of only 85 ha, Park Bandro (PB) is an example for a small-scale community based conservation project in a rural area of Madagascar. It is confronted with conflicting stakeholder views on biodiversity conservation in a rural society dependent on subsistence agriculture. PB lies in the wetlands of Lake Alaotra in Madagascar which endure high human demands on natural resources. A massive growth of the local population during the last 50 years has had detrimental effects on the entire ecosystem and resulted in highly fragmented wetland vegetation. Established in 2004, the aim of PB is to conserve one of the last intact vegetation patches which is of particular importance for the conservation of the locally endemic and critically endangered lemur species *Hapalemur alaotrensis*.

The objective of this study is to assess the efficiency of a small-scale protected area regarding its floristic composition and physiognomy. Therefore, vegetation cover and -structure of PB were compared with a reference area (RA) outside the park. A floristic vegetation classification (TWINSPAN) discriminated clearly between PB and RA and showed, that especially physiognomically relevant plant species are associated to the PB vegetation while invasive species are common in the RA.

The results show that even a small protected area can contribute to conserve natural vegetation. However, the potential efficiency of a small protected area in an environment being subjected to a high frequency of disturbance can only be achieved for vegetation types with relatively rapid regeneration. Amidst a highly disturbed environment, last small intact vegetation patches will not offer a permanent solution, but might buy time until long-term solutions are established.

ARE WATER HYACINTH FERTILIZERS OPPORTUNITIES FOR AGRICULTURE AT LAKE ALAOTRA, MADAGASCAR?

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Madagascar is one of the most important biodiversity hotspots worldwide where intensive deforestation leads to exceptional soil erosion and leaching indicated by the red color of the rivers and the occurrence of gigantic gullies on the hillsides. This desolated landscape occurs in the highlands including the Alaotra region where Madagascar's biggest freshwater wetland complex is located. This region represents Madagascar's most important rice and fish production area and is home for several endemic species. As soil degradation is very high, agriculture in the area is only possible with fertilizers inputs (mostly expensive chemicals). As an alternative to these commonly used fertilizers we investigated the use of water hyacinth as a source of organic fertilizers. This invasive plant species is present at Lake Alaotra and causes several environmental, economic and social problems. Increasing the use of the plant could therefore be a benefit for both the environment and local livelihoods. We produced different water hyacinth fertilizers under simple conditions and compared their effectiveness with the locally used ones (NPK and cow dung) in a growth experiment with Chinese cabbage (*Brassica rapa chinensis*). The experiment consisted of eight experimental setups with 12 repetitions each: control (plain soil), water hyacinth ash, water hyacinth green manure, and three water hyacinth composts (aerobic, anaerobic and pit), cow dung and NPK (chemical fertilizer). We performed a growth analyses and determined biomass production. Besides, we determined the leaf nitrogen contents of the Chinese cabbage as well as the macronutrient contents and pH of the soil and all other fertilizers. Moreover, we investigated the heavy metal contents (Pb, Cd, Zn, Cu, Cr and Ni) of the water hyacinth to exclude any contamination. Our study showed that the soil was nutrient poorand very compact hindering therefore the soil water retention capacity and the water percolation which in turn reduce roots access to water and nutrients. The water hyacinth composts were very effective as plants treated with the compostsshowed the highest biomass production. Therefore water hyacinth compost presents a cheap and environmental friendly alternative to locally used fertilizers. On a long term, the compost could also be an option for forest restoration.

EVALUATION OF AN ENVIRONMENTAL EDUCATION COMIC DISTRIBUTED IN PRIMARY SCHOOLS AT LAKE ALAOTRA, MADAGASCAR

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Madagascar is renowned for its outstanding level of biodiversity and endemism due to its long geographical isolation. Nevertheless, Madagascar is one of the poorest countries in the world, ranking very low on the Human Development Index. It also has one of the fastest growing populations in the world and is highly prone to natural disaster risks. This combination of an extraordinary natural heritage and severe threats to it makes Madagascar one of the five most valuable biodiversity hotspots in the world. To add to its problems, the Malagasy school system is highly ineffective, offering children on average only 5.2 years of schooling combined with a primary school dropout rate nearing 60%. Despite environmental problems being of outstanding importance, environmental education is not a part of the official school curricula.

We present the results of a survey of an environmental education program applied to a cohort of 542 students in six primary schools at Lake Alaotra, Madagascar. The educational materials used were a comic book and additional materials designed specifically for local conditions in rural Madagascar. The additional materials posed practical tasks to students and were meant to stimulate teamwork and group discussion of students. There was a control and two treatment groups. A questionnaire was applied to test students' environmental knowledge at three different points in time. The survey showed a significant increase in environmental knowledge of students receiving environmental education compared to controls. This effect significantly increased with additional education materials fostering peer-to-peer learning by students compared to teacher-centred learning. Students that used those materials also had the highest scores in tests one year after environmental education ended, thus indicating the usefulness of innovative and locally meaningful materials in environmental education.

DRIVERS AND BARRIERS TO ENVIRONMENTAL EDUCATION IN THE ALAOTRA PRIMARY SCHOOLS, MADAGASCAR

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Madagascar is renowned for high poverty rates and a unique but highly threatened biodiversity. At the cross road from the Millennium Development Goals to the Sustainable Development Goals, environmental education (EE) is a key element to meeting the UN agenda. With the case study Alaotra we assess the current educational status of one of the most important agricultural regions in Madagascar. As primary schools provide the sole formal learning for a majority of the population, they play a fundamental role in the regional education.

In Madagascar, only little EE is embedded in the school curriculum. Our study identified drivers and barriers to the implementation of EE in primary schools. Over 50 semi-structured in-depth interviews were conducted with directors and teachers from 18 public primary schools. The interview guide addressed the general state of the school system and of EE in particular.

We describe a multitude of obstacles, including structural barriers such as lack of teaching material, teachers, and classrooms; educational barriers, such as generally low levels of teacher education and specific trainings, but also social barriers as the low development state coupled with little awareness and interest in environmental issues. One potential driver to the implementation of EE is the training cascade provided by the regional school authorities that could be used or imitated for specific trainings and the subsequent control of EE implementation. Additionally, previous frequent changes in methodology kept teachers flexible to adapt new teaching techniques and contents, and the school authorities are cooperative and open to external input.

In the mid-term, there would be significant transaction costs to the inclusion of EE into the regular school curriculum. With the conditions at hand, it is highly questionable whether the Alaotra region will be able to reach the Sustainable Development Goals within the suggested timeframes.

SCIENCE AND ART!

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An approach to instill biodiversity conservation to university students and primary school pupils has been conducted at the Ecole Normale Supérieure of the University of Antananarivo in partnership with a private primary school in the same city. Six illustrated books on the adventures of six young lemur species have been written in a collaborative way and used as conservation resources. One of the book has been chosen to develop the scientific and foundational knowledge of the pupils about one Madagascar ecosystem. To develop those knowledge they have learnt to be creative and innovative and finally they have decided to play and express themselves the story, which has consisted as their problem solving project. During the grounding of the play they have had to collaborate, to share ideas and to accept everyone's contribution. They have learnt to adopt new behaviors with which they are not used to in their day life Such values are some of those needed for conservation and are easily assumed by the children during the rehearsal and performance. By means of art children learn cheerfully new knowledge and behaviors. And Conservation also means behaviors.

SESSION 7

S7: HUMAN-MODIFIED TROPICAL FORESTS? IMPACTS OF FOREST DEGRADATION AND BIODIVERSITY LOSS ON TROPICAL ECOSYSTEM FUNCTIONING

Chairs: Yit Arn Teh & Rebecca J. Morris
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BIODIVERSITY, ECOSYSTEM FUNCTIONING AND POLICY ACROSS A TROPICAL FOREST MODIFICATION GRADIENT: AN OVERVIEW OF RESEARCH BY THE LOMBOK CONSORTIUM

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This talk will provide an overview of some of the work being undertaken by the multidisciplinary LOMBOK (Land-use Options for Maintaining BiOdiversity and eKosystem Functions) consortium, under the NERC Human-Modified Tropical Forests research programme. Our team works within the Stability of Altered Forest Ecosystems (SAFE) landscape in Sabah, Malaysian Borneo. Our work combines surveys of biodiversity and biogeochemistry along a gradient of forest modification (to detect patterns) with in situ manipulative experiments (to gain a mechanistic understanding of biodiversity-function linkages). We are assessing the extent to which different elements of biodiversity (e.g. species of conservation concern) co-vary spatially with measures of ecosystem function (decomposition processes and biogeochemical cycles). With vital input from forestry and agriculture stakeholders, we will model the impact of different land-use policies and environmental certification schemes on these conservation values.

THE IMPACT OF LANDUSE CHANGE FROM FOREST TO OIL PALM ON SOIL GREENHOUSE GAS AND BIOGENIC VOC FLUXES

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Monocultures of oil palm have expanded in SE Asia, and recently also in Africa and South America, frequently replacing tropical forests. This conversion is associated with a potentially large greenhouse gas burden. The physical process of landuse change, such is felling, drainage and ploughing, and subsequent fertilisation can significantly increase emissions of N_2O and soil CO_2 respiration, decrease CH_4 oxidation rates and affect volatile organic compounds (VOCs) fluxes and their speciation from soil and litter. Current understanding of soil GHG fluxes associated with landuse change from forest to oil palm is not sufficient to provide reliable estimates of their carbon footprints and sustainability or advice on GHG mitigation strategies.

To provide the necessary data we have installed a total of 60 flux chambers in logged forests, forest fragments and mature and young oil palm plantations within the SAFE landscape in SE Sabah. (Stability of Altered Forest Ecosystems; http://www.safeproject.net). Soil respiration rates, N_2O, CH_4 and VOC fluxes together with soil moisture, pH, mineral and total C and N are measured over a two year period. On the oil palm plantations we compare fluxes close to the stem, where fertiliser bags are placed, with those in between stems and also on areas where empty fruit bunches are spread. Here we will present the concept of our experimental work, data from our first year of measurements and discuss the relevance for the policy maker.

DO THE 'LITTLE' THINGS RUN THE WORLD? EXPLORING THE FUNCTIONAL IMPORTANCE OF ANTS

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Given the rapid rate of global biodiversity loss caused by habitat change and degradation, it is essential to understand the implications of species declines and local extinctions for ecosystem processes. While biodiversity as a whole is considered integral to many ecosystem processes and services, surprisingly, there has been very limited quantification of the contribution different taxa make to ecosystem services and functioning in natural systems at large-scales. In tropical and sub-tropical systems, ants (Hymenoptera: Formicidae) are the dominant terrestrial invertebrate group, making up around 75% of all individuals in tropical forests and up to 50% in more arid areas. Their functional value was highlighted by E.O. Wilson (1987) who famously declared invertebrates are the „little things that run the world". However, while it is generally accepted that ants fulfil important functions, few studies have tested these assumptions at large scales and demonstrated what happens in their absence. Here we report on findings from novel large-scale field experiments in undisturbed savanna and tropical rainforest habitat where we suppressed the abundance of ants. We report on the influence of ants on other invertebrates as well as their effect on key ecosystem processes: decomposition and herbivory. With longer-term sampling we will be able to determine the effects ant communities have on other aspects of the ecosystem (e.g. soils, nutrient cycling, the microbial community) and how their relative importance for ecosystem function varies among ecosystem types (e.g. savanna vs. forest).

PRELIMINARY STUDY OF BIOGENIC VOLATILE ORGANIC COMPOUNDS EMISSION FROM SABAH'S TERMITES DURING BALI PROJECT

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Borneo's termite colonies are shown to be a potentially significant new source of Biogenic Volatile Organic Compounds (BVOCs) to the atmosphere. Fungus cultivated by these termite species may emit dimethyl sulphide (DMS), n-hexane, 2-methylpentane, ethyl acetate and methyl chloride in significant quantities, contributing to their respective global atmospheric budgets. The study suggests that the mixing ratios of those emitted BVOCs in the microtermes sabahensis and macrotermes gilvus colony under test were significantly higher than background levels, by on average a factor of 1.0 to 2.0. Preliminary sampling was carried out at different types of mounts (new, moderately active and highly active) during 2015 *BALI* project and it was found that levels of these BVOCs were elevated during the active phases of the termite colony.

FUNCTIONAL DIVERSITY AND STABILITY OF LITTER-INVERTEBRATE COMMUNITIES FOLLOWING TROPICAL LAND-USE CHANGE

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Tropical land-use intensification is rapidly increasing in regions that harbour high levels of biodiversity, thus posing a serious threat to the stability and resilience of tropical ecosystems and the important ecosystem services that they provide. We compared functional group richness and functional dispersion in litter-invertebrate communities among four different land-use systems, ranging in intensity from primary degraded lowland forest to oil-palm agriculture in two landscapes on Sumatra, Indonesia. We then investigated the consequences for functional stability and community resilience by calculating functional redundancy and response diversity of sampled communities. From primary degraded forest to intensively managed oil-palm systems, we found a 46% decrease in species richness and a 48% reduction in density, but weaker effects on functional group richness and an increase in functional dispersion. Although we detected no significant alteration of response diversity, functional redundancy of litter-invertebrate communities decreased clearly by losing 37% of functionally redundant species due to land-use change. Our results indicate that land-use change, from tropical rainforest to oil-palm agriculture, can alter both taxonomic and functional diversity of litter-invertebrate communities, resulting in the loss of functional redundancy and thus functional stability of these ecosystems. However, we also show that land-use systems of intermediate management intensity, such as jungle-rubber agroforestry, could serve as reservoirs of functional diversity and stability in monoculture-dominated production landscapes.

EFFECT OF *RUBUS* CONTROL ON ARTHROPOD ABUNDANCE AND DIVERSITY OF *SCALESIA* FOREST SITES ON SANTA CRUZ, GALÁPAGOS

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Invasive animal and plant species pose an increasing threat to biodiversity worldwide. This is particularly true for island ecosystems, which developed in isolation. Island ecosystems are less divers leading to a lower resilience towards novel threats and overall lower capabilities to buffer negative effects. Thus, such ecosystems are more vulnerable to introduced species. A large number of different introduced species is currently threatening the endemic flora and fauna of the Galápagos Archipelago. Some alien species have been eradicated over the years, others present serious challenges for scientists and the National Park authorities. One such case is the introduced bramble *Rubus niveus*. On Santa Cruz Island this species forms thickets of up to four meters height and is widespread in farmland as well as the endemic*Scalesia*forests. High cover of *R. niveus* has led to significantly lower native plant species richness and cover, as well as to changes in the *Scalesia* forest structure. Management measures to control the *R. niveus* invasion threatening the last remnants of the *Scalesia* forest include the application of strong herbicides and mechanical control. These management measures by the National Park lead to a complete removal of the understory. The aim of the present study was to evaluate the effect of these management measures on the native fauna. To measure the impact of habitat change on arthropod diversity and abundance we conducted a field experiment in the *Scalesia* forest of Santa Cruz, where we implemented three study plots of different degree of *R. niveus* control: (1) area with recent herbicide control measures, (2) area controlled four years ago and (3) uncontrolled area heavily invaded by *R. niveus*. Preliminary results show that management measures have an effect on spider assemblages (NMDS ordination, $R = 0{,}265$. $p < 0.001$). We focused on arthropods because the diversity of this species group is unique, consisting of over 50% endemic species. The findings in this study might be helpful to National Park authorities in adapting management measures to minimize the negative impacts on the native fauna.

Merian Award Applicant

FUNGAL COMMUNITIES ALONG A TROPICAL LAND-USE GRADIENT (SUMATRA, INDONESIA)

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Root and soil fungi play an important role for ecosystem functioning and are strongly affected by deforestation and resulting land-use changes and management practices. Root-associated mycorrhizal fungi supply nutrients and water to the roots of plants and act as main pathway of carbon to soil. In contrast, pathogenic fungi cause diseases and can reduce ecosystem productivity. The influence of land-use intensification in tropical ecosystems on fungal diversity and community structure is not well understood. We hypothesized that the loss in plant species diversity resulting from the transformation of rain forests into managed plantations leads to a loss in fungal diversity and shifts in fungal community structure.

The study was conducted in the province of Jambi (Sumatra), which is one of the key areas for palm oil production in Indonesia. Sampling sites were chosen along a land-use gradient representing unmanaged rain forests, less-managed jungle-rubber agroforests and intensely managed mono culture rubber (*Hevea brasiliensis*) and oil palm (*Elaeis guineensis*) plantations. Root and soil samples were analyzed by 454 pyrosequencing to identify whole fungal communities. Fungal operational taxonomic units (OTUs) were characterized using internal transcribed spacer (ITS) regions, ITS_1 and ITS_2. Environmental properties (soil carbon (C) and nitrogen (N) concentrations) and root traits were measured (nutrient status, ectomycorrhizal (EM) and arbuscular mycorrhizal (AM) colonization).

AM fungal species richness was decreased in mono culture plantations. Soil fungal diversity was not reduced in managed systems, but the community structure of fungal guilds was shifted towards pathogenic fungi. In oil palm plantations roots had a lower nutrition and showed a degraded health. Soil C and N concentrations decreased with increasing intensification of land-use. Our results demonstrate the importance of finding management practices which improve ecological functions.

FUNGI PATHOGENS CAN INCREASE PLANT RICHNESS AND DIVERSITY IN EARLY STAGES OF TROPICAL FOREST SUCCESSION

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Understanding tropical forest dynamics and its abilities to regenerate is a valuable ecological knowledge and at the same time a tool for management. Only recently, insect and fungi pathogens exclusion experiments were conducted as an attempt to remove negative density dependence at the seedling stage. These valuable results are forcing us to consider these groups as important drivers of tree population dynamics. While the influence of insect and fungi pathogens is important for a mature forest, it can change e.g. during post disturbance succession. Due to all the above, we conducted an experiment to quantify the effect of various biotic factors on initial succession of secondary tropical forest i.e. its diversity, richness and species composition. We set up six experimental plots in approximately five years old abandoned gardens, located in a lowland tropical forest in the vicinity of Ohu village, Madang Province, Papua New Guinea. We focused on groups of organisms with potentially high impact on early successional stages: oomycete pathogens, insect herbivores and key predators (birds, bats and ants). All vegetation was removed prior to experiment and five treatments and one control plot of size 5m x 5m were randomly placed within the blocks. Treatments were: (1) fungicide application; (2) broad spectrum insecticide application; (3) and (4) increased herbivorous insect abundance at two levels; (5) predator removal. All treatments were applied repeatedly for six months. After that time we counted all plant species within each plot and estimated their coverage using Braun-Blanquet scale. Compared with a control, only fungicide treated plots had smaller number of species (14 vs. 19 average species; $P = 0.0275$) and they were about 13% less diverse (2.34 vs. 2.70 average Shannon Diversity Index; $P = 0.0152$). RDA ordination showed no significant differences in community composition between all used treatments.

VARIATIONS IN BRYOPHYTE COVER IN RELATION TO FOREST STRUCTURE AND MICROCLIMATE IN TROPICAL CLOUD FORESTS OF ANDEAN AMAZONIA

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Epiphytes are common in tropical cloud forests, playing possibly an important role in forest stand ecohydrology. They can intercept cloud water and release it slowly through evaporation, having thus importance in air humidity maintenance within the forest stand. Bryophytes are one of the most abundant epiphytic plant groups in tropical cloud forests. Degraded forest stands have been observed to harbor less bryophytes than natural forests. In this study, we explore the relationships between forest structure, bryophyte cover and microclimate in tropical cloud forests of Alto Mayo river basin in Northern Peru in order to define which forest structural features are the most strongly related to bryophyte cover and how microclimate varies between forests of different structure and/or different degree of degradation and different bryophyte cover. This information has important practical implications on the management and conservation of tropical cloud forests, which are the most diverse but also currently the most threatened ecosystems globally due to expanding agriculture and other land use practices in these areas. We estimated bryophyte cover systematically from the bases of tree trunks and visually in the forest stand level, and measured tree height, basal area and canopy openness in 36 plots (400 m^2) located between 1000 and 1300 m. We also measured microclimate in half of the plots during 6 months. Preliminary results indicate that bryophytes cover decreases with decreasing mean tree height and basal area and with increasing canopy openness. This indicates the importance of old-growth and closed canopy forests for bryophytes and thus also for canopy water cycle and air humidity maintenance within the forest stand. We also found a strong correlation between visually estimated stand level bryophyte cover and systematically estimated bryophyte cover near forest floor, but visual estimation gave lower estimates, especially when the bryophyte cover was low. This indicates that forest structural changes affect bryophytes more strongly in canopy level than near forest floor, which can be a result of a direct coupling of canopy to atmosphere and exposure of bryophytes in canopy to higher temperatures and drying.

DISTRIBUTION AND ABUNDANCE OF SEEDLINGS, SAPLINGS AND TREES: CASE STUDY OF URBAN FOREST IN MALANG CITY, INDONESIA

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Urban forests make contributions to the environment of the surrounding areas in Indonesia's cities, such as Jalan Jakarta Forest in Malang city, which is located alongside Jakarta streets and important to regulate the street microclimate. It contributes by regulating air and water quality, cooling down the air temperature, protecting from the ultraviolet radiation, maintenance of biodiversity, pollution reduction, and human health in Indonesia. Due to its important roles, Jalan Jakarta forest structure should be maintained for its sustainability. This study assessed the distribution and abundance of seedlings, saplings, and trees in Jalan Jakarta Urban Forest, Malang city, Indonesia by using Point Centered-Quarter Method (PCQM). By assessing tree developmental stages, the future urban forest could be predicted. 19 points were distributed evenly with range at 10 m interval in the 7843.46 m^2 forest. Trees, seedlings, and saplings DBHs and point-tree distances were recorded and thus relative importance value (RIV) could be calculated. The result revealed that there are 17 tree species (12 families), 11 sapling species (10 families), and 11 seedling species (9 families). The highest RIV value species were *Gmelina* sp. (Lamiaceae) for tree, and *Swietenia macrophllya* (Meliaceae) for sapling and seedling (18.75%, 54.74%, and 37.83% respectively). Some three species with high RIV were not found in the sapling and seedling stages, such as *Erythrina christa-galli* (Fabaceae) (11.98%) and *Paraserianthes falcataria* (Fabaceae) (10.01%). Based on the data, it is predicted that the the species richness may be decreased and Swietenia macrophylla may be dominating the forest structure. For maintaining biodiversity, planting seedling should be done.

Merian Award Applicant

HUMAN-INDUCED MODIFICATIONS OF THE FRUGIVORE COMMUNITY TRANSLATE INTO REDUCED SEED REMOVAL AT THE COMMUNITY LEVEL IN A NEOTROPICAL RAINFOREST

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Tropical rainforests worldwide are under increasing pressure from human activities, which are altering key ecosystem processes such as plant-animal interactions. However, while the direct impact of anthropogenic disturbance on communities such as game species has been well studied, the consequences of such defaunation on mutualistic interactions like seed dispersal remains chiefly understood at the plant species level. We asked whether communities of endozoochorous tree species had altered seed removal in forests affected by hunting and logging and if this could be related to modifications of the frugivore community. We focused on four families of animal-dispersed trees (Sapotaceae, Myristicaceae, Burseraceae and Fabaceae) at two forest sites in French Guiana: Nouragues (protected) and Montagne de Kaw (hunted and partly logged). We assessed the abundance of the seed dispersers and predators of our focal families by conducting daytime distance sampling along line transects. Several key dispersers such as large-bodied primates were greatly reduced in abundance at Kaw, where the specialist frugivore *Ateles paniscus* is probably extinct. In parallel, we estimated seed removal rates from fruit and seed counts conducted in one square meter quadrats placed under fruiting trees. Seed removal rates dropped from 77 % at Nouragues to 47 % at Kaw, confirming that the loss of frugivores induced by human disturbance impacts seed removal at the community level. Weaker declines in seed removal for Burseraceae and Myristicaceae suggest that some compensation may occur for these bird- and mammal-dispersed families, probably because of the high abundance of toucans at the disturbed site.

SESSION 8

S8: BIOGEOCHEMISTRY AND BIODIVERSITY OF TROPICAL FOREST ECOSYSTEMS IN A CHANGING CLIMATE: RELATING OBSERVATIONS TO MODELLING

Chairs: Anja Ramig & Kirsten Thonicke
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TROPICAL FOREST RESPONSE TO ELEVATED CO_2: MODEL-EXPERIMENT INTEGRATION AT THE AMAZONFACE SITE

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The terrestrial biosphere's response to current and future elevated atmospheric carbon dioxide (eCO_2) is a large source of uncertainty in future projections of the C cycle, climate and ecosystem functioning. In particular, the sensitivity of tropical rainforest ecosystems to elevated CO_2 is largely unknown even though the importance of tropical forests for biodiversity, carbon storage and regional and global climate feedbacks is unambiguously recognized. The AmazonFACE (Free-Air Carbon Enrichment) project will be the first ecosystem scale eCO_2 experiment undertaken in the tropics, as well as the first to be undertaken in a mature forest. AmazonFACE provides the opportunity to integrate ecosystem modeling with experimental observations right from the beginning of the experiment, harboring a two-way exchange, i.e. models provide hypotheses to be tested, and observations deliver the crucial data to test and improve ecosystem models. We present preliminary exploration of observed and expected process responses to eCO_2 at the AmazonFACE site from the dynamic global vegetation model LPJ-GUESS, highlighting opportunities and pitfalls for model integration of tropical FACE experiments. The preliminary analysis provides baseline hypotheses, which are to be further developed with a follow-up multiple model inter-comparison. The analysis builds on the recently undertaken FACE-MDS (Model-Data Synthesis) project, which was applied to two temperate FACE experiments and exceeds the traditional focus on comparing modeled end-target output. The approach has proven successful in identifying well (and less well) represented processes in models, which are separated for six clusters also here; (1) Carbon fluxes, (2) Carbon pools, (3) Energy balance, (4) Hydrology, (5) Nutrient cycling, and (6) Population dynamics. Simulation performance of observed C fluxes and biometry at the AmazonFACE site (a.o. from the K 34 eddy flux tower) will highlight process-based model deficiencies, and aid the separation of uncertainties arising from general ecosystem responses and those responses related to eCO_2.

SENSITIVITY OF AMAZONIA TO CLIMATE CHANGE: THE MAIN UNCERTAINTIES ARE EFFECTS OF DROUGHT, ELEVATED TEMPERATURE AND ELEVATED CO_2

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Amazonia is under threat of the combined effects of unsustainable regional development and climate change. As summarised in the IPCC reports of 2007 and 2014, studies in the past ten years indicate that these pressures can lead to deforestation, regional and global disturbance of temperatures and the water cycle, as well as causing loss of carbon stocks and biodiversity. In turn, these transitions can result in forest loss, droughts, low river levels, floods, loss of hydropower energy and plenty of other ecosystem services. Here, we address three major biophysical uncertainties related to the impact of climate change on Amazonia: the effects of drought, elevated temperature and elevated CO_2.

Several novel elements and insights for better understanding and modelling these uncertainties have recently been developed. This includes new data on the response of tropical forests to drought and temperature change, and approaches to modelthe impact of nutrient limitations and turnover. Also, major experiments are being set up to address one of the largest uncertainties of all: the impact of CO_2 rise.

In this paper we will discuss examples of each of these, using, among others, results from rainfall exclusion and heating experiments, development and analysis of two contrasting dynamic global vegetation models (INLAND and LPJ). We will develop a number of hypotheses from these studies that may guide further work to strengthen the insights into the furture of the Amazon.

THE EFFECT OF SOIL MOISTURE ON SEEDLING DEMOGRAPHY IN PANAMA

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While light is regarded to be the main abiotic niche for shaping tree communities in moist tropical forests and soil water gradients are expected to be small, there are manifold signs that droughts strongly affect tree communities in the tropics. Barro Colorado Island (BCI) in Panama provides long-term data on tree communities through its permanent 50-ha forest plot, and is therefore ideal for studying the effect of resource availability and climate on tropical forest dynamics. Whereas the light niche has been quantified for the majority of the tree species in the plot, the role of soil moisture is largely unknown. I have measured soil water potential in the dry season at 200 seedling plot locations in the plot, and I quantify the effect of water availability on the demography of seedlings of ~230 species. I compare the effect of water versus light availability to disentangle the relative importance of these niches for explaining the high diversity of tropical forests. Our results allow for improved predictions of the effect of climate change and possible changes in the frequency and intensity of droughts on tropical forest composition and dynamics.

Merian Award Applicant

THE AMAZON RAINFOREST: BIOMASS STABILITY, TIPPING POINTS AND EARLY WARNING SIGNALS

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The response of Amazon rainforests response to climate change determines to a large extent the carbon climate feedback at sub-millennium timescales. We explored how realistic a complete loss of the forest is given the pressures it is currently experiencing from both human induced deforestation and climate and if we can forewarn such an event.

We used a 0-D soil-vegetation-atmosphere model, based on the CASA model for vegetation, and including feedback from surface to atmosphere to assess he stability of the Amazon rainforest biomass to its parameterization. The simulations indicate a resilience of the woody biomass, rather than the presence of possible tipping point behaviour, but the sensitivity of the equilibrium biomass to moisture supply is very high once the latter becomes limiting.Parameters determining the soil water budget are very important for the vegetation development, but a considerable decline in the long-term water balance would be necessary to trigger a dieback of the forest. We obtained a fairly robust relationship between the start of the dieback and the decline of the soil moisture below a threshold defined by the occurrence of long-term drought. Consequently, correct parameterization of drought- thresholds is crucial. Other fire-related parameters determine to a lesser extent the time of onset of decline, but rather the rate of the decline once it has begun. Especially important is the choice of the mortality rate, once fire becomes important. Details concerning dependence of fire on litter mass and on lightning seasonality have little influence on the results. Temperature rise is itself disadvantageous for the stability of the forest, as it promotes soil moisture stress and inflammability of litter, apart from causing NPP decline (but the NPP may acclimate to temperature increase). Rise of CO_2 concentration may stimulate NPP, and more economic water use by the foliage, but elsewhere it may lessen the precipitation of recycled water. The results indicate that for the prediction of forest dieback, the prediction and monitoring of soil moisture would be of the greatest importance. It would also be important to improve understanding the relation between soil moisture and tree mortality and litter inflammability.

The definition of early warning signals that may provide advance warning of such a decline presents a big challenge. We further show that interaction of biomass with soil moisture generates additional complexity to the possibility of deriving early warning signals. We show that early warning signs that are typical of classic climate tipping points may not accompany such a decline.

PLEISTOCENE ECOLOGICAL DYNAMICS IN THE NORTHERN ANDES

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The evolution of mountain forest in the northern Andes is now documented in deep continental pollen records Funza1 (~1700-27 ka), Funza2 (2250-27 ka), Fúquene9C (284-27 ka), and LaCocha (14-0 ka). All sedimentary archives accumulated between 2550-2780 m elevation and only post-2010 age models have been used. Determinants of long-term ecosystem assembly include plate tectonics (*Alnus, Quercus*), ecological drift (*Borreria*) and intrinsic taxon interactions (*Polylepis, Weinmannia, Morella, Alchornea*). Extrinsic climate control has driven (a) changes in altitudinal vegetation distributions and upper forest line (UFL) positions have shifted between 2000 and 3400 m, (b) spatial biome patterns: current páramo surface is 4% of last glacial maximum (LGM) surface, and (c) dramatic changes in population connectivity and potential gene flow. The Pleistocene is a showcase of successive different forest types connected by taxonomic legacies. Glacial time accounts for up to 80% of the Quaternary but UFL positions below the elevation of the archiving sedimentary basins reflect only c. 25% of Pleistocene time. Therefore, at 2550 m elevation glacial-interglacial couplets show strongest evidence on the evolution of upper montane forest (now between 2300-3200 m) and páramo (now between 3200-4600 m) biomes. Current (pre-anthropogenic) forest composition is the ultimate taxon assembly and analogs have not existed before. However, conservative ecological niche ranges allow inferences of past environmental conditions in the absence of pollen-vegetation calibration sets. A re-visit of the large data sets by numerical data analysis sheds new light on Pleistocene ecological and biodiversity dynamics, including functional patterns (downcore biomisation), compositional turnover, and rates of change.

THE EFFECT OF CHANGING CLIMATE CONDITIONS REVEALED BY STABLE ISOTOPES IN TREE RINGS IN SUB-SAHARAN AFRICA

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Many countries in Africa lack adequate long term climate information, and the impacts of atmospheric CO_2 concentrations, higher temperatures or prolonged drought events is poorly understood. Tree rings and stable isotopes in tree rings are important proxies for paleoclimate and eco-physiological studies because they contain continuous historical records of inter-annual and intra-annual time resolutions, which range over hundreds of years. This study uses tree ring width, stable carbon and oxygen isotopes in tree rings to understand the drivers and impacts of climate change in sub-Saharan Africa, their ability to reconstruct past regional climate variability and climatic trends, and the effect of climate variations on ecosystems. Our approach considers large scale climate gradients and different temporal scales (inter-annual and intra-annual variations) and combines multi- parameter measurements (carbon and oxygen isotopes, whole wood and cellulose measurements). We collected samples from East and West Africa that are widely distributed in sub-Saharan Africa. Both carbon and oxygen stable isotopes showed strong climatic signals and proved a very valuable indicator to evaluate long-term tree responses to climate variations in dry tropical forests. We also observe species dependent responses which is important to be considered by process-based modelers.

SESSION 9

S9: LAND USE CHANGE AND LAND MANAGEMENT: REGIONAL CONFLICTS AND SUSTAINABLE DEVELOPMENT OF TROPICAL ECOSYSTEMS

Chairs: Gerhard Gerold & Stefanie Steinebach
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TRANSNATIONALIZED LAND CONFLICTS IN THE CONTEXT OF REDD+, INSIGHTS FROM JAMBI, INDONESIA

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Conservation areas in the global south have expanded significantly during the last decades. In Jambi the recent expansion of commercial oil palm plantations and the simultaneous expansion of protected areas has been disruptive in social and environmental terms.

Based on qualitative interviews with governmental agencies, NGOs, peasants and local public authorities this paper aims to investigate power struggles over access and control of Indonesia's state forest in the REDD+ pilot province of Jambi. Conservation initiatives in Jambi have to cope with ongoing, in part violent land conflicts between implementing agencies and peasant communities with regard to access and control of forest and agricultural land. More specifically the paper focuses on land occupations and the formation of settlements within two conservation projects. First the paper unravels the structural conditions permitting the formation of the settlements and seeks to identify the involved actors. Second the paper investigates the multi-scalar strategies different peasant groups employ for defending the settlements and their agricultural land against forest authorities and conservation companies.

The findings show that the formation of the settlements has been facilitated by multi-scalar actor coalitions involving customary leaders and village and district governments. Power shifts after the fall of Suharto permitted them to openly challenge the Ministry of Forestry and to start attempts to reestablish former ethnic territories. Peasants and customary leaders consider the occupation of state forest as a legitimate response to the politics of dispossession starting with Dutch colonization. Recently REDD+ has added another conflict layer. REDD+ projects as transnational conservation projects are financed by public and private donors for mitigating climate change. They link local struggles over land and land-use to northern greenhouse gas emitters and consequently to questions of global climate justice.

HOW TO ACHIEVE EFFECTIVE PARTICIPATION OF COMMUNITIES IN THE MONITORING OF REDD+ PROJECTS: A CASE STUDY ON THE DEMOCRATIC REPUBLIC OF CONGO (DRC)

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While the 'Reducing emissions from deforestation and forest degradation in developing countries' (REDD+) mechanism is still being finalized under the UN Framework Convention on Climate Change (UNFCCC), individual countries have started to implement national REDD+ programs and local-scale REDD+ pilot projects. The participation of local communities and indigenous peoples in the implementation of REDD+ activities is one of the safeguards to be addressed by REDD+ countries. Since REDD+ is a result-based mechanism, it is also required that REDD+ countries establish a robust and transparent national monitoring system in order to measure, report, and verify (MRV) efforts in reducing emissions at the national and sub-national level. Remote sensing is the most frequently used method for that purpose. As it has been acknowledged that a number of gaps result when collecting field data based only on this method, local-level community-based monitoring (CBM) has been proposed as a way of providing additional data to the national MRV system, especially with regard to non-carbon benefits. In fact, case studies conducted at the project level in some REDD+ countries showed many potential benefits from CBM, such as increased cost efficiency, community ownership, and data quality. In the Congo Basin region, the second largest forest ecosystem in the world after the Amazon, most of the REDD+ projects implemented take place in the DRC, which is our case study. Yet little information exists about CBM of REDD+ projects in this region. This research aims to build knowledge about the current and potential role of local community and indigenous peoples in monitoring REDD+ projects, in order to develop a baseline of indicators for the implementation of a CBM of REDD+ projects in DRC. It is based on a literature review and the Delphi technique, a method that facilitates reaching a consensus among a group of experts in a given area of research. The Delphi technique will be implemented through three rounds of questionnaires; key experts were selected from among the scientists, government agencies, private sector employees, and national and international NGO representatives who are involved in REDD+ and CBM. This study is expected to contribute to the development of CBM indicators for REDD+ projects in DRC and to develop recommendations for their use in the national MRV system.

ON LAND USE AND SUSTAINABLE LIVELIHOOD: ANALYZING THE DRIVERS OF DEGRADATION OF GRAZED ECOSYSTEMS IN THE LAKE CHAD BASIN

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Grazed ecosystems are important sources of livelihood for millions of herdsmen and their cattle globally. Over the years, these grazed lands have become one of the most degraded land use type of the world. As a consequence, pastoralists and their cattle have taken to seasonal migration resulting into friction and sometimes violent conflicts with local farmers. In the last few years, conflicts between herdsmen and local communities have intensified because of combination of other factors which include competition for vital resources such as water or pasturelands; worsening security, ethnic politics and climate change. In Nigeria, several recent studies have debated the social tension between farmers and herdsmen from the perspective of environmental conflcits. Hence, with a case from south fringe of Lake Chad, this paper offers an analysis on a direct consequence of land use change to livelihood sustainability. The presentation will also consider the potential impacts of strained group relations mostly between the traditional local farmers and migratory herders over land encroachment and utilization of pastures against payment to traditional authorities. As a solution, the presentation will offer the prospects of participatory natural resources management to enhance social interactions and improve sustainability.

ANALYSIS OF FOREST COMMUNITIES' ECONOMIC ACTIVITIES BASED ON A SUSTAINABLE DEVELOPMENT CONCEPT

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Tropical forests represent natural capital storing carbon in their biomass, supporting biodiversity, acting as sources for timber and Non Timber Forest Products, and being the habitat for forest communities. Despite their importance and national and international efforts to protect them, deforestation of tropical forests continues.

I propose a concept for empowering forest communities in tropical forest conservation. This concept is based on field research results of economic activities in Brazilian, Indian and Thai forest communities. I aim to answer how to achieve sustainable development of economic activities for forest communities' inhabitants including improvement of their living standard and conservation of tropical forests.

Formalizing qualitative causal relations of sustainable development allows concluding that sustainable development in forest communities cannot be achieved without external support. In particular this support includes (1) legal rights for forest management, (2) targeted investments and initial capital for the organization of economic activities with social responsibility, and (3) organizational, technical, and methodical support.

ARE GRASSLANDS CARBON NEGATIVE?

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Land uses both sustainable and converted are crucial area of research to explore the opportunities and adversity for global climate change mitigation. The role of customary managed *Imperata* grassland which is among the oldest forms of rural land use in Barak valley, North East India was studied to understand whether thesegrasslands are carbon (C) source or sink. We estimated (i) organic carbon accumulation rate (OCA) in soil (ii) C input from aboveground biomass (CIAB) (iii) C input from belowground biomass (CIBB) and (iv) Soil CO_2 efflux/soil respiration (Rs) on monthly interval from September 2013 to October 2014 following standard methods. Monthly soil C budget (OCA+CIAB+CIBB-Rs) showed that *Imperata* grasslands act as atmospheric CO_2 sink and also as source in different intervals of time. Soil system had its highest capacity to sink in September when it removed 122.4 gram CO_2/m^2 followed by 93 gram CO_2/ m^2 in November and 63.1 gram CO_2/m^2 in October. However it was characterized as carbon source in January, February and from May to July during study. During the carbon source months, it added 254 gram CO_2/m^2 per year to the atmosphere whereas during carbon sink months, it removed 382 gram CO_2/m^2 per year. Hence *Imperata* grasslands have its negative feedback to the global climate change and present study indicated the demands for future research to enhance its carbon sink capacity.

INDICATORS FOR CARBON CYCLING IN ORGANIC AND CONVENTIONALLY MANAGED CACAO PRODUCTION SYSTEMS IN ALTO BENI, BOLIVIA

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Regional adapted agroforestry (AF) systems are an adequate compromise against carbon loss by fire clearing deforestation and inadequate soil management. Cacao (*Theobroma cacao*) as a shade tolerant plant growth in AF systems with various trees, shrubs and herbaceous plant species. With higher aboveground and belowground biomass AF systems provide the opportunity to increase and sequester organic carbon in tropical agroecosystems in comparison to monoculture. The potential of carbon sequestration of cacao AF systems depend on soil and climate conditions as well as management, structure, and the age of the plantation.

The Research Institute of Organic Agriculture (FiBL) and local partners established a long term field trial for cacao production in Bolivia in 2008. The trial is divided into a system (agroforestry vs. full sun) and a management (organic vs. conventional) comparison. The objective of the study is to quantify (1) above- and belowground biomass, (2) carbon, nitrogen, and phosphorous in microbial biomass as indicators of soil fertility and (3) litter decomposition, which may be affected by litter chemistry or microclimate.

Total aboveground biomass was highest in AF systems due to the presence of shade trees. Biomass of cacao was highest in in full sun. Conventionally managed systems show a trend of a faster growth. Microbial biomass C and N contents were mainly affected in the uppermost layers with lowest values in the conventional full sun system. In vicinity to legume trees, however, microbial C and especially N contents were increased down into the B-horizon. Litter decomposition was similar after one year related to the management. While the litter residuals in the AF systems were higher. Cacao litter decomposed slower than legume-tree litter.

Overall, results indicate a faster C-sequestration in biomass in conventional systems, which however, may level out with maturity of the systems. Microbial indices showed that negative effects of full sun monoculture can be reduced by either organic management or by switching to agroforestry. Nutrient recycling from cacao leaves was similar in all systems, but introduction of legume trees provide easily degradable leaves.

EXPLAINING SPATIAL PATTERN OF THE ABUNDANCE OF AFRICAN BUSH MANGO TREES IN WEST AFRICA

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Bitter and sweet African bush mango trees (ABMTs) are the top priority agroforestry species in West and Central Africa. Their diversity is exposed to increasing erosion and the spatial pattern of their abundance is largely unknown. Here we investigated data that might explain the distribution of their abundance in the Dahomey Gap, the broad savannah eco-region, separating the Upper and Lower Guinean forest blocks. Occurrences of ABMTs were used in GIS to calculate density values in 25 km grid cells. These density data were regionalized with the position in the middle of grid cells and were considered as stationary. Variogram and kriging techniques were applied to the density data to calculate the spatial structure and predict values over the entire Dahomey Gap. Characteristics of conservation systems where ABMTs occur were used with socioeconomic data in a logistic regression, to explain the observed spatial pattern. Results indicated geographically limited and low densities for wild bitter ABMTs in the Volta region. Such a distribution pattern is not suitable for geostatistical analysis. In contrast, sweet ABMTs occur in forest gardens, home gardens, and cultivation fields with higher densities (up to more than 41 trees/ha). Isotropic variograms were calculated, indicating an equal fluctuation trend in all directions with the existence of small patches of uniform density levels in a radius of 25 km. The conservation is thus due to small scale farmers converting poor soils into ABMTs orchards. Farmland status, ethnic group and type of ABMTs determine this structure of the density, which is not correlated with any aspect of ethnobotanical knowledge in the region. Sweet ABMTs are used to mitigate climate change because of their high ecological adaptability and are shaping agrosystems through intensive cultivation to improve global productivity on poor soils. This is expanding their distribution range, while that of the bitter ones is reducing. Unfortunately, the traditional mass selection process is narrowing the diversity, while no gene bank is established in West Africa.

SESSION 10

S10: PAST, PRESENT AND FUTURE OF TROPICAL (WETLAND) ECOSYSTEMS

Chairs: Hermann Behling & Katherine Roucoux
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WHAT CAN BE LEARNED FROM THE PAST? AN INTRODUCTION TO THE SESSION "PAST, PRESENT AND FUTURE OF TROPICAL (WETLAND) ECOSYSTEMS"

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Palaeo-ecology is the study of past ecosystems which cannot be directly measured and as such it involves a wide range of approaches and disciplines spanning different temporal resolutions, from decadal-centennial to millennial and even geological time scales. Using (multi-) proxies to unravel changes and responses of ecosystems to disturbance and climate variability in the long-term, this body of research have provided strong evidences to test modern ecological hypotheses. Examples include testing of the relict status of refugial populations, quantifying fire regimes and the links to ecosystem dynamics, testing for resilience and sensitivity of ecosystems against human and climatic induced changes.

While most of the palaeo-ecological science have been focusing on temperate ecosystems, a growing number of researchers are now turning their attention on the rapidly changing tropics.

This contribution is meant to be an introduction to the session, during which papers presenting palaeo- and neo-ecological studies in the tropics will be presented. An overview of the different topics will be given, with particular emphasis on the current challenges and future perspectives of obtaining an integrative view of tropical ecosystem dynamics.

The final aim is to provide a guide and stimulate discussion amongst all presenters and participants to the session.

ECOLOGICAL BASELINES FOR THE HIGH ANDES

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That an ecologist knows what is the "natural" state in an ecosystem is often assumed, but is seldom verified. Ecological baselines, the state of nature before human alteration of landscapes, are especially poorly known when pre-historic landuse was both extensive and long-lasting. In the high Andes, successive societies such as the Tiwanaku, Wari, Chanka, Inca, and Europeans, impacted the region to such an extent that the modern landscape has been characterized as "manufactured" and natural baselines simply unknown. Similarly, landscapes that are apparently mature and undisturbed, which ecologists could hold to be natural, may also have been previously altered; forming a "shifted" baseline. The paleoecological investigation of three Andean lakes shows divergent ecological histories and allows us to assess the relevance of the concept of natural and shifted baselines on millennial scales.

Although human-induced landscape transformation in the Central Andes is undeniable, the degree of landscape transformation cannot be assumed to be spatially homogeneous. Paleoecological reconstruction derived from Lakes Miski, Huamanmarca and Pacucha show that Pre-Columbian landscapes were a mosaic of "near pristine" and disturbed patches. Trajectories of past environmental change in the studied sites suggest that the early Holocene (c. 10 ka) could be used as "natural" ecological baseline for restoring long-term human disturbed Andean ecosystems. The trajectories of vegetation change from Lakes Miski and Huamanmarca further show that ecological baselines cannot be expected to reach stability as assemblages vary, constantly influenced by climate, biotic and stochastic processes.

ARAUCARIA FOREST, HUMAN LAND USE, AND CLIMATE CHANGE LINKAGES IN SOUTHERN BRAZIL DURING THE LATE HOLOCENE

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The Araucaria Moist Forest of southern Brazil is a unique ecological mosaic, dominated by the 'Paraná pine' (*Araucaria angustifolia*), an iconic 'living fossil', dating back to the Mesozoic era. This forest comprises part of the Atlantic Forest, a global biodiversity hotspot with exceptionally high levels of endemism. Unfortunately, after centuries of deforestation, *Araucaria angustifolia* is now critically endangered, restricted to only 3% of its original distribution. Even though this species is protected by Brazilian law, the rise in temperatures and changes in precipitation predicted under future climate change represent an additional challenge to the conservation of this endangered species.

However, in contrast to the negative impact of humans since colonial times, there is indication that pre-Columbian societies in the region may actually have favoured the expansion of this species. Palaeoecological and archaeological evidence show the appearance of the Jê indigenous culture's settlements coinciding with both climatic change (increasing precipitation) and the abrupt expansion of Araucaria moist forest approximately 1000 years ago. Here, we use an interdisciplinary approach to better understand the inter-relationship between climate change and human land use in driving this late Holocene expansion of Araucaria forest.

We present palaeoecological data from peat bog cores within archaeological excavations at Campo Belo do Sul, Brazil. We use fossil pollen and charcoal data to reconstruct vegetation history, land use and past agricultural practices. The results of our analyses will improve understanding of the relationship between the Jê culture and the surrounding vegetation over at least the last c. 2,000 years. This information will allow us to differentiate between the natural drivers and early anthropogenic land use that impacted the development of the Araucaria moist forest. Finding the role that indigenous populations may have had in shaping the structure of current forests gives us crucial information which can inform conservation policy.

HOLOCENE VEGETATION DYNAMICS OF SUB-MONTANE RAINFORESTS FOLLOWING VOLCANIC DEPOSITION IN THE KERINCI SEBLAT NATIONAL PARK, SUMATRA (INDONESIA)

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The Kerinci Seblat National Park located on the island of Sumatra is the second largest national park in Indonesia with an area of 13,791 km^2. The park includes a large part of the Barisan mountain range which form the western spine of Sumatra Island and includes the highest peak in Sumatra, Mount Kerinci (3,805 m), one of more than five active volcanoes in the national park. Ash produced by eruptions occurs in screes on the tops of volcanoes, such as Mt. Kerinci, which have been active in the recent past. They are barren, pervious, sterile and unstable, moving downhill, particularly during heavy rains. The vegetation changes from the valleys to the peak of the mountains, as the physical environment changes, are well studied. However, nothing is known about the impact of volcanic deposition on the lower montane tropical ecosystems.

We present the multi-proxy palynological results of a 491 cm sediment core recovered in 2013 from the margin of the small marshy lake, Danau Njalau (2.275073°S, 101.556131°E, 1041 m a.s.l.). The site is surrounded by natural montane rainforests and little disturbance by human activities is found in the area. Pollen and spore analyses were used to reconstruct the vegetation dynamics with particular attention to the diversity, rate of change and vegetational compositional change.

Preliminary results indicate a slow succession of the vegetation which took 900 years to recover to primary forest after volcanic deposition in the soil ended. A secondary phase from 2200 to 850 cal yr BP might suggest sensitivity of these ecosystems to climate variability linked to ENSO. Little human-landscape interactions were attested in the area despite to close proximity to known megalith sites.

The high resolution palaeoenvironmental record of Danau Njalau provides important information on mountain rainforest vegetation response to volcanic activities in the biodiversity hot spot tropical rainforests of the Kerinci Seblat National Park.

Merian Award Applicant

TRACING 25,000 YEARS OF VEGETATION DYNAMICS IN THE SAVANNA OF SOUTH-EASTERN KENYA: THE LAKE CHALLA POLLEN RECORD

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Late Quaternary sediments recovered from Lake Challa, a steep-sided crater lake situated at 840 m a.s.l immediately southeast of Mt. Kilimanjaro, present a uniquely continuous record of vegetation dynamics in the lowland savannahs of eastern equatorial Africa since the Last Glacial Maximum (LGM).
Today, the Challa crater basin is surrounded by a landscape of mostly open bush and grass savannah with scattered woodland trees and shrubs, and strips of riverine forests along seasonally dry streams. The inner crater slopes are covered by a narrow strip of evergreen riverine forest around the lakeshore, a dry *Euphorbia* forest on steep middle slopes, and open grassland with local patches of dry savannah woodland along and just outside the rim.
Pollen taxa representing savannah vegetation were abundant throughout the past 25,000 years, revealing long-term dynamics of the region's grass-dominated ecosystem. During the LGM and the early deglaciation period, until about 17 kyr BP, the landscape was characterized by mixed Poaceae and Cyperaceae grassland with abundant Asteraceae and *Euphorbia*. After 17 kyr BP this changes to a Poaceae-dominated savannah with less Cyperaceae and Asteraceae. Taxa of the *Ericaceae*-belt are most abundantly recorded during the LGM, suggesting that these vegetation types shifted down slope during the cold and dry LGM climate conditions, which prevailed at higher altitudes. Montane forest taxa have been present since the LGM, but especially the montane forest trees *Olea*, *Podocarpus*, *Juniperus* and *Syzygium* were most prominent after the LGM between 21 and 17 kyr BP. These results indicate not only that today's montane forest taxa persisted in the East African mountain ranges during glacial time, but also that during the locally dry early deglaciation period grass pollen influx from (and thus possibly, ground cover in) lowland savannah was reduced.
Around 16 kyr BP, pollen taxa characteristic of dry savannah forest start expanding, consistent with the enhanced precipitation and warming conditions indicated by independent climate proxies. This expansion continues steadily until the mid-Holocene. The Late Holocene is characterized by the further evolution of the dry savannah forest community around Lake Challa to becoming dominated by *Euphorbia* and *Acalypha* with a diverse understory. The gradual decrease in pollen from montane forest taxa throughout the Holocene likely represents the retreat of montane forest to higher elevations and their replacement by more drought-tolerant taxa at lower elevations.

MID-HOLOCENE SHIFT FROM DRY TO WETTER CONDITIONS IN NORTHWESTERN AMAZONIA, INFERRED FROM POLLEN AND CHARCOAL ANALYSIS, A REGIONAL OVERVIEW

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Changes in vegetation assemblages in savanna regions are suitable for long term studies of vegetation and climate dynamics. In the tropical savannas of South America, long term palaeoecological studies point to a shift in vegetation from dry to wetter conditions during the late Holocene. Most of them are characterized by a decrease on the representation of savanna elements like Poaceae and Cyperaceae and the increase on forest vegetation besides the expansion of the palm *Mauritia flexuosa*.

Serra do Tepequém is a plateau (1000 m.a.s.l) located at the Brazilian Guyana and its vegetation is mostly characterized by a mosaic of Amazon rainforest and grassy savanna. In Roraima State, palaeoecological records show wetter conditions for the late Holocene with dominance of *Mauritia flexuosa* and gallery forests, but there is no clear signal when those humid conditions in the region started. Our results are the first approach that detect the change from dry to wetter conditions in that area since mid-Holocene (6500 cal yr BP) and can be integrated into a regional overview. Dryer conditions were found from 7500 cal yr BP with high peaks of microcharcoal particles, low values of organic matter content and huge percentages of grassland vegetation. Expansion of *Mauritia flexuosa* started since 6500 cal yr BP at Serra do Tepequém with a reduction on the savanna elements as well as an increase on the organic matter accumulation, reflecting a humid phase. Similar results have been reported in the Colombian savannas, starting ca. 6000 yr BP and 3600 yr BP with the increase of gallery forest, palms and the contraction of savanna vegetation

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LONG-TERM DYNAMICS OF AMAZONIAN RAINFOREST AND WETLAND ECOSYSTEMS AND THE ROLE OF CLIMATE, SEA-LEVEL, FIRE AND HUMAN IMPACT

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The Amazon rainforest is the largest rainforest ecosystem on Earth, representing nearly 50 % of the Earth‘s tropical rainforest area. Consequently it plays a significant role in global climate, hydrological cycle, carbon cycle and biodiversity. The increasing number of pollen and charcoal records from different regions in Amazonia shed more light into past vegetation and climate changes as well as human impacts during the late Quaternary. In respect to the issue of global change the question is raised how stable the Amazon rainforest ecosystems are and how far they react on disturbance by climate, sea-level, fire and human impact. Palaeoecological studies based on pollen analysis in different ecosystems in the central and eastern part of Amazonia and neighbouring regions provide inside on long-term vegetation dynamics and the response to environmental change.

LEARN FROM PALEO-CLIMATES: SEMI-PERMEABILITY OF ISTHMUS OF KRA FOR MAMMAL MOVEMENTS DURING PLEISTOCENE

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The high biodiversity of Southeast Asia is generally considered as a result of its diverse geological history with changing sea levels exposing and flooding large parts of the Sunda Shelf. Although this region has attracted wide scientific interest, the question how the Isthmus of Kra shaped current biodiversity patterns is still controversially discussed. So far the Isthmus of Kra has been seen as the major geographical barrier between the Sunda Shelf and Indochina. We hypothesized that not the Isthmus of Kra itself hindered animals movement between Indochina and the Sunda Shelf, but rather that the cooler and drier climates during the last glacial maximum (LGM) impeded the movement of species from the evergreen forests in the Sunda Shelf northwards, whereas the movement of Indochinese species into the Sunda Shelf was facilitated by the LGM climates. We tested this hypothesis using species distribution models for more than 70 Southeast Asian mammal species, of either Sundaic or Indochinese origin. The hindcast projections of species distribution models to LGM and mid-Holocene were used to infer the species suitable habitat ranges north and south of the Isthmus of Kra. To compare the costs associated with movements from one landmass to the other we used a least cost path analysis. We found that for species of Indochinese origin the proportion of predicted suitable habitat south of the Isthmus of Kra was higher during the LGM compared to current and Mid-Holocene climates, whereas almost no area was predicted as suitable north of the Isthmus of Kra for the Sundaic species. Similarly, the movement costs from Borneo or Sumatra to Indochina were significantly higher compared to the costs for the southward movement of Indochinese species. In contrast to the general assumption of an Isthmus of Kra geographical barrier our analysis showed that rather ecological factors facilitated the diversification of the Sundaic and Indochinese fauna.

LONG-TERM DEVELOPMENT OF WESTERN AMAZONIAN PEATLANDS: PATTERNS AND PROCESSES

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Extensive peatlands occur in western Amazonia, but their developmental history, vegetational characteristics, and carbon storage dynamics remain essentially unknown. Recently our group published a re-evaluation of the area and carbon stocks of peatlands in the Pastaza-Marañón basin, lowland Peru (Draper et al. 2014, Env. Res. Lett. 124017). Here we present some of our other recent findings on the present ecology, palaeoecology, geochemistry, and hydrology of these peatlands. Our ecological survey data include the first quantitative description of 'dwarf pole forest' occurring on ombrotrophic peat. Using pollen analysis, we documented the developmental history of one palm swamp, Quistococha, which has accumulated up to 4 m of peat since 2200 cal BP in an abandoned channel of the Amazon River. In outline, initial sedge fen and/or floating mat vegetation gave way to seasonally-flooded mixed woodland after 1900 cal BP; palms became more abundant after 1000 cal BP but vegetation similar to the present-day palm swamp forest has only been in place since 400 cal BP. However, in detail the vegetation succession was complex, with reversals, repetitions, and abrupt transitions. Comparison with other peatland sites in the region suggests that different trajectories of development can also occur. Changing flooding regimes probably drove some of the complexity, suggesting that the peatland was sensitive to external (possibly climatic) environmental variations. This sensitivity may be explained by hydraulic conductivity measurements which indicate that the woody peats at this and other sites in the region are very free-draining, and hence likely prone to desiccation during droughts. Geochemical analyses alongside the pollen data demonstrate that variations in peat properties relevant to carbon storage, including lignin content (linked to peat recalcitrance) and base cation abundances, depend partly on the initial botanical composition of the peat and partly on subsequent alteration. Palaeoecology, as a component of multidisciplinary research projects, is critical to our understanding of the past and future dynamics of these important carbon stores.

THE MOST CARBON-DENSE ECOSYSTEMS IN AMAZONIA: THE LONG-TERM DEVELOPMENT OF A DOMED PERUVIAN PEATLAND

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Field surveys and remote sensing have shown that the peatland pole forests of the Pastaza-Marañón Foreland Basin (PMFB) are the most carbon-dense ecosystems known in Amazonia. Here we report a palaeoecological reconstruction of the development of one of these peatlands, San Jorge, located 35 km south of Iquitos, north-east Peru. Our data show that the overall pattern of vegetation change is not straightforward: the record does not reflect a process of simple, gradual terrestrialization, but a series of reversals and of wetting and drying trends. The pole forest at San Jorge formed c. AD 1800, synchronous with evidence for climatic drying recorded elsewhere in Peru. Given this young age it is possible that (a) this pole forest, and others like it, may not yet be at ecological equilibrium, which is relevant to explaining their present-day ecology; and (b) thick accumulations of peat are not restricted to pole forests (but can also be present under *Mauritia*-dominated palm swamps), which is relevant to carbon mapping. An age model based on radiocarbon and 210Pb dating provides the first evidence from a PMFB peatland that peat accumulation has been discontinuous, with evidence for a hiatus around 1300–400 cal BP, and an ecological change from open lake to palm swamp, which may have been driven by climatic change. Additional palaeoecological records are required to further improve our understanding of the sensitivity of Amazonian peatlands to past and future climate change.

UNDERSTANDING FLORISTIC PATTERNS IN TIME AND SPACE IN WEST AMAZONIAN PEATLANDS

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The peatland ecosystems of the Pastaza Marañon foreland basin in Northern Peru harbour some the least diverse and most spatially variable tree communities found in Amazonia. Explaining these striking patterns of diversity has proved difficult when only present day processes are considered. Here we present palaeoecological data in order to understand the role of historical processes in determining current patterns of composition and diversity in Amazonian peatland communities using an innovative multidisciplinary approach. Combining pollen data from eight peat cores and floristic data from eight forest census plots distributed across two sites, we show that the most species-poor ecosystems are a relatively recent feature on the landscape. This finding suggests that ecosystem age may be a key determinant of their low diversity. Both autogenic (internal biotic) processes and allogenic (external environmental) factors can be significant determinants of floristic change through time. These results demonstrate the importance of often-ignored historical processes in the assembly of tropical forest communities.

RECONSTRUCTING 7000 YEARS ENVIRONMENTAL CHANGE IN SERRA SUL DOS CARA'S, USING PALYNOLOGY, SOIL CHEMISTRY AND REMOTE SENSING: A NEW APPROACH

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Former palaeoecological studies from savanna on the plateau of Serra Sul dos Carajás revealed a long process of forest expansion that started at ca. 6500 cal a BP, and reached its maximal expansion at ca. 2500 cal a BP. However the new palynological record from the rainforest on the slopes around the plateau shows that a well-established rainforest has been existed since 6700 cal a PB. Therefore we conclude that through a period of ca. 4000 years the forest border has slowly shifted toward the savanna. To test the hypothesis that the Fe and Al rich infertile shallow lateritic soil on the plateau has been the reason for the slow forest expansion, soil development was studied by a new method based on the projection of the modern remote sensing information of the plateau's ferruginous surface into the past using the chemical analysis of the sediment core. Results show that the area of ferruginous soil might be larger at ca. 6650 cal a BP than today which prevent forest expansion on top of the plateau. The prevailed wetter climate that is attributed to the southward shift of ITCZ might accelerate soil formation and triggered forest expansion since 6700 cal a BP.

Merian Award Applicant

DEGLACIAL AND HOLOCENE ENVIRONMENTAL AND PEAT-CARBON ACCUMULATION DYNAMICS OF A PEATLAND IN THE COASTAL AREA OF CENTRAL SUMATRA, INDONESIA

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A 3.5 m-long core from a coastal peatland in Jambi Province, Indonesia provided the history of the oldest peatland in the coastal area of Sumatra that has been reported so far. A multi-proxy study reveals that the accumulation of the peat deposit started around 13,400 cal yr BP in a floodplain lake, part of a riverine forest ecosystem. The pollen data suggests that vegetation of the peatland changed over time from riverine forest to peat swamp forest promoted by lateral migration of the river system. Result from charcoal analysis shows that the rate of peat accumulation was not affected by the intensification of ENSO in the late Holocene. Early anthropogenic activities in the area are detected by an opening up of the vegetation correlated to the Malayu Empire period from the 9th to the 14th century. Land use transformation under the colonial state was also observed in the record reflected by the increase in fire magnitude and fern spores. The value of the peatland is underlined by the continuous peat accumulation and high carbon accumulation in the last two millennia, following the change in organic matter inputs.

Merian Award Applicant

IMPACT OF HUMAN ARRIVAL ON THE OCEANIC ISLANDS OF MAURITIUS AND RODRIGUES

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Human arrival on tropical islands has led to large-scale habitat destruction and extinctions of local flora and fauna. Understanding the process of how humans have so thoroughly transformed island ecosystems soon after first colonization has obvious relevance to current conservation and restoration strategies. The Indian Ocean islands of Mauritius and Rodrigues were first colonized in the 17th century and have a well-documented history of human impact. High-resolution paleoecological reconstructions from these islands provide a unique opportunity to compare ecosystem processes and dynamics before and after colonization.

Multi-proxy reconstructions of coastal wetland sediment records in Mauritius show that the islands were frequently impacted by climatic extremes. A rich fossil site in the Mare aux Songes contains bones of over 100,000 individual vertebrates, including the extinct dodo (*Raphus cucullatus*) and extinct giant tortoises (*Cylindraspis spp.*), evidencing a local population collapse after an extreme drought 4200 years ago. Nevertheless, the persistence of insular vertebrates until human colonization demonstrates their resilience to rapid climate change.

Fossil pollen document a significant loss of plant diversity after colonization. In particular, palm species that provided valuable sources of food and timber for early settlers disappeared rapidly from the islands' forests. The abundant fossil records and well-documented history of Mauritius and Rodrigues shows that first colonization had more rapid and severe consequences for insular biota than currently anticipated.

HUMAN IMPACT AND CLIMATE RECONSTRUCTIONS FROM SOUTH AMERICAN POLLEN RECORDS DURING THE LAST 2000 YEARS

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Fossil pollen records are excellent indicators of human impact through time. Evidence for human land use in pollen records is useful for distinguishing natural from anthropogenically driven vegetation change. Here we discuss the variability and implications of human indicators in South American pollen records from the last two millennia. This period is also an important baseline for current climate as conditions were very similar to the present. We relied on records, where the degree of human impact on the vegetation is at a minimum or absent, and applied a qualitative approach to reconstruct climate in terms of temperature and hydrological balance. Interpretations for selected regions were made based upon the integration of different sources of information, including pollen records, climate models, plant-environmental interactions, archaeology, and additional proxy data. We conclude that pollen records allow assessing changes in the large-scale atmospheric circulation, butare also sensitive to local-scale variability. Long-distance synchronicity (differences and similarities) in vegetation changes are detected and interpreted as anindication of regional precipitation and temperature variability, though these patterns are more complex in mountainous regions. This study is part of the PAGES workgroup *Long-term multi-proxy climate REconstructions and Dynamics in South America* (LOTRED-SA). This collaborative long-term initiative offers the ideal framework for the integration of the various paleoclimatic sub-disciplines. Here we stress the high potential of pollen records as a valuable contribution to our understanding of tropical ecosystems in the context of the last two millennia.

PHYTOLITH SIGNATURES ALONG A GRADIENT OF ANCIENT HUMAN DISTURBANCE IN WESTERN AMAZONIA

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The ecological status of prehistoric Amazonian forests remains widely debated. The concept of ancient Amazonia as a pristine wilderness is largely discredited, but the alternative hypothesis of extensive anthropogenic landscape remains untested in many regions. We assessed the degree of ancient human impacts across western Amazonia based on archaeological and paleoecological data using methodologies that would allow inter-regional comparisons. We also aimed to establish baselines for estimating the legacies of ancient disturbances on modern vegetation. We analyzed charcoal and phytolith assemblages from soil samples from an archaeological site, sites in close proximity to archaeological sites, sites from riverine and interfluvial forests, and a biological research station believed to contain some of the least disturbed forests within Amazonia. We then quantitatively compared phytolith assemblages within and between the surveyed regions. Palm enrichment was evident at the archaeological site, and the biological station survey contained little to no evidence of ancient human activity. The other sites exhibited a gradient of ancient disturbance across the landscape. The phytolith assemblages showed statistically significant between-region variations that indicated our metrics were sufficiently sensitive to detecting ancient disturbance. Our data highlight the spatial heterogeneity of ancient human disturbances in Amazonian forests. The quantification of these disturbances provides empirical data and a more concrete link between the composition of the modern forest and ancient disturbance regimes. Accounting for ancient disturbances will allow a deeper understanding of the landscape heterogeneity observed in the modern forests.

LINKING ALTITUDINAL EFFECTS OF CURRENT BIOTA WITH MODELED SCENARIOS AND PALEO-RECORDS OF FRESHWATER OSTRACODES FROM THE NEOTROPICS

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The Neotropical region is recognized as a hotspot for freshwater species diversity and is highly sensitive to environmental changes with severe consequences for biota. Currently, two main approaches have been developed to evaluate future effects of global climate change. The first relies on species distribution modeling, which can be established using different computational algorithms and input data. The second is based on fossil assemblages from analogous past periods. Freshwater ostracodes (bivalve microcrustaeans) can be used for both approaches because they combine high diversity of extant species and excellent fossil records in sediments. Therefore, the objective of this work is to evaluate the congruence and reliability of both approaches in aquatic ecosystems. We collected data from 20 water ecosystems across an elevation gradient of 100–3400 m a.s.l. ranging from southern Mexico to central Guatemala. Environmental factors controlling species diversity and distribution, such as temperature, elevation and precipitation, were used to construct models of species distribution using the maximum entropy algorithm and Maxent software. We used global climate data from the WorldClim database, corresponding to the Last Glacial Maximum (cooler and drier) and the Last Interglacial (warmer and wetter) periods to evaluate the hypothetic responses of the biota to such contrasting periods. Analyses of paleorecords from Lake Petén Itzá were carried out for the same periods. Results indicate poor congruence between modeled species distribution and paleorecords during the LGM, because although models describe tropical species displacement, the fossil record consists of a mixture of temperate and tropical taxa. During the Last Interglacial both approaches were congruent for lowland regions, and the fossil record attests a high abundance of species. Models also suggest a retraction of temperate species to higher elevations (> 3000 m a.s.l.) as expected by a temperature increase. This study highlights the importance to validate results from computational modeling with paleorecords in order to gain more reliable insights of future climatic changes.

HISTORY OF GEOGRAPHICAL PARTHENOGENESIS OF NEOTROPICAL OSTRACODA USING FOSSIL AND MOLECULAR DATA - A CONSEQUENCE OF CLIMATE FLUCTUATIONS?

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Geographical parthenogenesis (GP) is a phenomenon describing the geographically distinct distribution of sexual and asexual populations of a single species. This phenomenon is recognized as a consequence of the historic interaction of the taxa and their changing environment. Climatic variations such as the Pleistocene glacial/interglacial cycles are currently recognized as one of the most important triggers of GP in the world. The GP is, however, rare in the Neotropics currently only recognized in *Paspalum* grass species. Here, we evaluate potential cases of GP of Neotropical freshwater ostracode taxa (bivalve microcrustaceans) and investigate the responsible historical context using molecular and fossil data. Results are based on extensive sampling campaigns in the northern Neotropics and records from continental species distribution, highlighting that *Chlamydotheca unispinosa* is a geographical parthenogen with sexual populations (n=4) restricted to the northern-central Yucatán peninsula. *Cytheridella ilosvayi* shows a potential intermediate case of GP, with sexual (n=15) and asexual populations (n=38) still largely distributed in the continent. Patterns of divergence and phylogeny inferred from COI gen of both species, illustrate high cryptic diversity within sexual and asexual populations (p-distance >10%), as commonly observed for European geographical parthenogens (Horne & Martens 1999). Divergence times suggest that *C. ilosvayi* populations, and most probably *C. unsipinosa* as well, colonized northern Yucatán Peninsula caves 0.94 myr ago, allowing sexual populations to find relatively stable environments. A ~300 ka BP paleo-record from Lake Peten Itzá, Guatemala, shows that cooling stages (MIS6, LGM, HS 1) caused the displacement of tropical ostracode taxa in the region, however, subsequent warmer episodes allowed species recolonization, which is well-known to favor asexuals (Kearney, 2005). The survival of sexuality exclusively on the Yucatán Peninsula may have been due to species adaptation to semi-subterranean environments that provide long term climatic stability. This study illustrates that climate variations in the Neotropics have important influence on the configuration of aquatic species and how biota responds to these changes.

SESSION 11

S11: BIODIVERSITY, BIOTIC INTERACTIONS AND ECOSYSTEM PROCESSES ALONG ELEVATIONAL GRADIENTS

Chairs: Katerina Sam & Marcell K. Peters
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PLANT-INSECT FOOD WEBS ALONG ALTITUDINAL AND LATITUDINAL GRADIENTS IN FOREST ECOSYSTEMS

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Latitudinal and altitudinal gradients generate strong trends in biodiversity on all trophic levels, from plants through herbivores to predators and parasitoids. Here we explore the consequences of changing vegetation along environmental gradients for the structure of plant-insect food webs, using data on plants, leaf-mining larvae and ants from New Guinea rainforests as a test case. In particular, what are the null expectations for the diversity and host specificity of insects on the forest vegetation changing from tropical lowlands to either tropical mountains or temperate lowlands, and how well do real food webs conform with these expectations? To what extent are latitudinal and altitudinal gradients in insect communities driven by vegetation?

THURSDAY 09:15

MOTHS AND MOUNTAINS: THE ROLE OF ALTITUDE AND DEFENSIVE CHEMISTRY IN STRUCTURING INSECT HERBIVORE COMMUNITIES ON FICUS IN PAPUA NEW GUINEA

Simon Segar[1,2], Martin Volf[1,2], Brus Isua[3], Emol Brus[3], Legi Sam[5], Jan Zima[1,2], Petr Simek[1], Martin Moos[1], Juha-Pekka Salminen[7], George Weiblen[6], Vojtech Novotny[1,2]

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Herbivore host specificity is considered to function at the genus level in tropical forest communities: as such large species rich genera provide a considerable resource for insect herbivores and are known to support high levels of biodiversity. Whilst our knowledge of such genera and their associated insect communities in lowland rainforests has been advanced considerably in recent years much less is known about the patterns of species turnover, host specificity and species interactions along elevational gradients. We present data from our ongoing studies of *Ficus* along a continuously forested elevational gradient spanning from 200m to 2,700m a.s.l. situated in Papua New Guinean central range. As part of a larger study collecting detailed food web data for caterpillars, beetles and galling insects we obtained population genetic, community phylogenetic, trait (nitrogen and carbon content, trichome density and specific leaf area) and plant chemistry data (pentacyclic triterpenes, polyphenols and alkaloids). We studied three species of *Ficus* in detail along the gradient, each of which showed some degree of morphological variation with altitude (*F. hahliana,* 200-2,700m; *F. hombroniana*, 200-2,200m and *F. arfakensis*, 200-1,700m). For each species we report distinctive low land and highland populations with the strongest barriers to geneflow between 1,200-1,700m. Furthermore, we find consistent trends among species regarding investment in compounds with known defensive roles and find that this elevational variation with regards to trait composition has a cascading influence on insect community composition and insect phylogenetic diversity. We suggest that the structure of caterpillar communities associated with montane *Ficus* is driven by plant traits, genotypic variation and environmental factors which may modify insect plant interactions across elevations.

BETA-DIVERSITY AND HOST-SPECIFICITY OF LEPIDOPTERA FEEDING ON FICUS (MORACEAE) ALONG A COMPLETE ELEVATIONAL GRADIENT IN PAPUA NEW GUINEA

Legi Sam[1,2,4], Brus Issua[3], Salape Tulai[3], Joachim Yalang[3], Bradley Gewa[3], Nigel Stork[1,2], Roger Kitching[1,2], Vojtech Novotny[4,5]

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We still lack basic understanding of species richness patterns and the dynamics of plant–insect interactions along elevational gradients. Building this information is useful for managing species diversity in a human modified world projected to become warmer. Studies show that the significant turnover of *Ficus*–feeding caterpillar assemblages between tropical lowlands and highlands remains independent of altitudinal changes in the composition of the vegetation. We present findings from New Guinea, one of the few tropical areas with undisturbed rainforests along complete altitudinal gradients from seacoast to the alpine zone. We used caterpillars feeding on *Ficus* trees as a model system. Within 5ha of forest per elevational study site, we collected all externally feeding caterpillars by hand from 1500 m^2 of foliage area. The study sites start at 200 m *a.s.l.* and end at 2700 m *a.s.l.* separated by 500 altitudinal metres. We present results of changes in host–plant, caterpillar, and host–plant–caterpillar interactions with elevation in response to changing environment.

ELEVATIONAL PATTERNS IN PREDATION, HERBIVORE PERFORMANCE AND HERBIVORY IN HOSTILE AND ENEMY FREE SPACE

Katerina Sam[1,3], Bonny Koane[2], Jimmy Moses[2,3], Peter K. Amick[2], Vojtech Novotny[1,3]

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It is well recognized that predators can enhance plant growth by reducing herbivore abundance. Yet the strength of such trophic cascades has been found to be quite variable both within and between communities.We hypothesised that birds, bats and ants are important predators of arthropod. However, their relative importance will differ along a forest elevational gradient (200 - 3700 m). We also expected that various predators will affect prey in different ways, based on their size and life history. We conducted exclosure experiments at eight elevational sites (500 m elevational increment) along the elevational gradient of Mt. Wilhelm in Papua New Guinea. We excluded ants, birds, bats separately and in combinations from tree saplings (*Ficus* sp., 100 per site) and completed experiment with work on control saplings. We protected saplings by nets (against birds and bats), by nets opened daily in the morning and in the afternoon (separate birds and bats) and by tangle foot (against ants). We surveyed insect communities and herbivorous damage every three months. Further, we completed our experiments with surveys of focal predators. Herbivorous damage and arthropod abundances decreased with increasing elevations, and exclusion of vertebrates and birds had significant effect on herbivorous damage as well as on arthropod abundances, and their body size. Bats did not seem to influence insect communities significantly, and ants influences insect communities only at lowest elevations. Species richness of insectivorous birds and bats decreased with increasing elevation, while their abundances peaked at mid-elevations. Ant species richness as well as abundance decreased steeply with increasing elevation. We conclude that herbivore pressure and herbivore abundances are higher towards lowlands. Stable arthropod populations are remained low by natural enemies of various importance along gradients. Disruption on communities of natural enemies has the potential to allow arthropods to reach high levels, resulting in extensive herbivorous damage.

A TROPICAL ELEVATIONAL GRADIENT IN ANTS: DIVERSITY PATTERNS, FOOD PREFERENCES AND SCAVENGING ACTIVITIES ON MT WILHELM, PAPUA NEW GUINEA

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The adverse effect of the predicted climate change on our natural ecosystems has resulted in concerted efforts to document and examine both faunal and floral responses. A widely feasible approach is to study the responses of particular taxa on elevational gradients, which are analogous to latitudinal gradients in some aspects (viz. temperature) but not others (viz. seasonality). Since species responses vary greatly between tropical mountains and among different taxa, the underlying mechanisms driving these variations are currently poorly understood. We used Mt Wilhelm elevational gradient to study trends in diversity, food preferences and scavenging activities in ant communities. In particular, our study aims to investigate the changes in ant richness-elevational trends, variations in community composition, species-specific nutrient preference and movement of food pellets in tropical forest ecosystems by ants. Five complementary sampling methods comprising pitfall traps, complete search, tuna baiting, nutrient preference and bait removal experiments were used. Our total estimated number of ant species represented a quarter of all described New Guinea ants. Species accumulation curves combining all methods did not reach an asymptote. Ant richness was higher at 200 m - 700 m a.s.l., then decreased linearly with altitude. The rate of species turnover was higher at lower elevations, then declined steeply towards higher elevations. Additionally, most ant species at low elevations had narrow altitudinal ranges than those at higher altitudes. There were no significant inter-specific differences in preferences for baits containing carbohydrate, protein, salt and lipid. Rate of pellets removed was positively correlated with richness and abundance. Spatial variations in ant communities in natural ecosystems along the elevational gradient appear to be determined by temperature, habitat specialization, changing vegetation structure, dispersal limitation and resource availability.

NETWORK SIMPLIFICATION AND THE BREAKDOWN OF AN ANT-PLANT PROTECTIVE MUTUALISM WITH ELEVATION

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Ant – plant protective mutualisms are widespread and common in the tropics. While the costs and benefits for the partners involved in these interactions have been reasonably well quantified, it is not known how the balance of these factors is impacted by changing elevation. Understanding these shifts is important, as this is expected to shed light on responses of species interaction networks to climate change. We investigated how the mutualistic interaction network between ants and their host plants changes along a primary forest elevational gradient from 700 to 1600m above sea level in Papua New Guinea. We described the network structure of 23 species of terrestrial ant-plant and 10 ant species. We then described in detail the interaction between the understorey tree *Myristica subalulata* and resident *Anonychomyrma* ants, quantifying how ant protection of the host plant changes with elevation by experimental exposure of model herbivores and assessing herbivory damage. We found that in the lowlands multiple ant and plant species are involved in the mutualistic network, with little specialisation. At higher altitudes, ant plants are less abundant and the interaction network becomes simpler, and the highest elevations have only a low occurrence of one species of ant-plant and ant. At higher elevations, ants are less abundant on the leaves of their host plants and take longer to find a model herbivore. This is accompanied by increased levels of herbivory on plants at higher elevations. We speculate that this potential break-down of the mutualism at high elevation is driven by reduced ant activity due to lower temperatures, thus reducing the benefits for plants of ant inhabitation. This could have wider effects on the current and future distribution and abundance of ant-plants in New Guinea and other tropical montane habitats.

Merian Award Applicant

THE EFFECT OF FOREST SUCCESSION ON ARBOREAL ANT COMMUNITIES IN A TROPICAL MOUNTAIN FOREST IN NEW GUINEA

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Ants in tropical forests are an ecologically important group, but very little is known about tree dwelling ants from tropical mountain areas. We censused the ants from trees in 3 stages of highland forest along succession gradient in New Guinea (primary forest older secondary forest and young secondary). A total of 1,232 trees were examined, from which we collected 716 nests of 24 species of ants.

The total diversity of species in the area was greater in primary forest, but did not grow linearly with forest age (young forest was richer, but insignificantly, than the middle-aged). The number of species per tree grew, as expected, linearly with forest age. Also, the relationship of alpha diversity with the diameter of tree trunks changed with succession. Interestingly, the similarity of ant species between individual trees proved to be surprisingly higher in middle-aged forest compare to the other two stages

Species composition of arboreal ants changed even less during succession since the same dominant species were present in all phases of the forest. Ant nesting habitats also were mainly unaffected, changing only a little with succession.

The much smaller influence of succession in highland forest compared to lowland forest may be a result of an increasing number of generalists adapted to cold temperature in the mountains and of the similar composition of nesting microhabitats in all the forest stages. The only significant effects were thus on species diversities, driven primarily by the forest structure (density and size of trees, crown connection).

In terms of nature conservation, arboreal ants seem to be not good indicators of forest quality in highland forests compared to lowland forests where they are known to react greatly to forest disturbances. Future comparisons of our results with other ecologically important animals (e.g. butterflies, birds) are needed to effectively protect the endangered forest biota of tropical mountain forests.

INTEGRATING INTRASPECIFIC VARIATION IN COMMUNITY ECOLOGY UNIFIES CONTRASTING THEORIES ON BODY SIZE SHIFTS ALONG CLIMATIC GRADIENTS

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Traditionally, intra- and interspecific trait shifts along environmental gradients have been investigated in isolation.However, a surge of theoretical approaches and studies with plants demonstrated that the explicit integration of trait variation among and within species can be essential for identifying the mechanisms that shape traits and related ecosystem functions along environmental gradients.Here we show for the first time, that two classical but contrasting theories on body size shifts along climatic gradients (Bergmann's rule *versus* energy-driven community assembly rules), can be merged when considering intraspecific variation in community ecology. We studied community-wide body size variation of wild bees at Mount Kilimanjaro and found that along a 3680 m elevational gradient bee individuals became on average larger within species, while large species were increasingly absent from high-elevational communities. With this, we empirically prove that the parallel consideration of intra- and interspecific trait shifts can sharpen our understanding about the drivers of morphological variations in animals, substantiating theoretical debates on the significance of intraspecific variation in community ecology.

AVIAN DIVERSITY ALONG ELEVATIONAL GRADIENT OF MOUNT CAMEROON, WEST-CENTRAL AFRICA

David Hořák[1], Ondřej Sedláček[1], Michal Ferenc Ferenc[1], Eric Djomo Nana[1,4], Tomáš Albrecht[2,3], Pavel Munclinger[2], Petr Synek[2], Jiří Doležal[5,6], Martin Dančák[6,7], Jan Altman[5], Miroslav Svoboda[8], Luboš Majeský[9]

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Mount Cameroon is the highest peak of West-Central Africa and a unique representative of wet coastal tropical mountains. Its slopes offer a 2000 elevational meters high gradient of well preserved tropical forests, which is rich in birds including many range restricted species. An excellent ecological model mountain is thus of great conservational importance, too. A project dealing with altitudinal diversity patterns on Mount Cameroon was established in 2011. Using point counts, mist netting and random walks we collected information about species richness, densities, predation risk and parasitic load for 6 avian assemblages across different elevations. Our investigations corroborated decreasing species richness with increasing elevation, however, we found no effect of elevation on total abundances of local assemblages. This is likely due to the fact that members of montane species poor assemblages have high population densities. Functional, phylogenetic and taxonomic diversity patterns are compared to reveal mechanisms behind species distribution along the gradient. In order to estimate selection forces on avian life histories, we employed artificial nests of different types to asses nest predation rate. In contrast to our predictions, we found a decreasing survival rate of shrub nests towards higher altitudes, which is likely linked to changes in forest vegetation structure. Surprisingly, avian malaria prevalence was highest at montane elevations and we observed lowest diversity of parasite lineages at the montane forest/savannah border and at mid-elevations, at which the most pronounced diversity exchange was found.

SEASONALITY IN SINGING ACTIVITY OF RAINFOREST BIRD COMMUNITIES ALONG ELEVATIONAL GRADIENT OF MOUNT CAMEROON, WEST AFRICA

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Breeding cycles of birds are generally much less seasonal in the tropics. However, recent studies suggest that bird communities show distinct seasonal peaks in number of breeding species and individuals. Moreover, new findings on singing behaviour of tropical birds suggest that males sing very little outside of the breeding season and increase the singing rate during the nesting period. However, there is an essential lack of tropical studies examining year-round singing activity at community level. In this study, we examined seasonal variation in singing activity of bird communities along elevational gradient of Mt. Cameroon (lowland forest – 350m, mid-elevation forest – 1100m, montane forest – 2300m), using the newly developed year-round automatic sound recording devices. The number of species detected per day decreased with elevation. Bird communities at all elevations vocalized year-round but the number of species singing was significantly influenced by rainfall seasonality. The highest number of species (both per day and per 5-min samples) sang at the beginning of the dry season, followed by gradual decrease of singing with increasing rainfall. We detected the lowest species richness during the peak of rains and steep increase of activity with drop of the rainfall. Temporal species turnover was highest during the transition period between dry and rainy season and relatively low during heavy rains and the driest months. The seasonality in number of vocalizing species was most pronounced in lowland, where the total annual amount of rainfall is highest. We found intermediate level of seasonality in mid-elevation forest and almost no seasonality in montane forest. However, the singing rate of particular species was negatively related to the monthly precipitation in all elevations.

TROPICAL BIRDS CAN SMELL TREES CALLING FOR HELP ALONG AN ELEVATIONAL GRADIENT: AN EXPERIMENT WITH CHEMICALLY AND MANUALLY INDUCED HERBIVORY

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Smell and olfactory in birds are extensively studied from the second half of the 20th century. Only recently, experiments showed that birds are using olfactory more than we ever expected. It was for example confirmed that insectivorous birds can smell volatile compounds which are released by leaves damaged by herbivorous insect. Recent studies were however conducted only on a simple study system "Great Tit – Birch – Autumnal Moth". Our aim was to investigate the ability of tropical insectivorous birds to use herbivore-induced plant volatiles (HIPV) to aid search for prey. We conducted the research at several sites in lowlands and along elevational gradient of Mt. Wilhelm in Papua New Guinea. In first experiment, we induced HIPV mechanically on several plant species along elevational gradient. In second experiment, we induced HIPV by Jasmonic Acid on *Ficus phaeosyce* in lowlands, and *Ficus hahliana.* Attractivity oftreated (mechanically or chemically) and untreated/control saplings to predators of herbivorous insect was studied with aid of plasticine caterpillars. Exposition of green plasticine caterpillars allowed us to compare predation attacks by individual groups of predators on various saplings and at different elevations. Along elevational gradient, the predation rate decreased with altitude from 10% day^{-1} at 200m a.s.l. to 1.8% day^{-1} at 3700m a.s.l. Ants were relatively more important predators in the lowlands, while birds became dominant predators above 1700m a.s.l. Caterpillars exposed on trees with herbivorous damage were attacked significantly more than caterpillars exposed on trees without damage. The herbivory attracted both ants and birds, but its effect was stronger for ants. Similarly, caterpillars exposed on saplings treated with jasmonic acid attracted significantly more predators, and this response lasted for about 48 hours. In lowlands, saplings treated with jasmonic acid were more attractive to all predators than saplings with mechanically damaged leaves. The attractivity of individual plant species differed significantly both for control and experimental treatments. The predation pressure from various predators correlated closely with abundance of potential predators but not with their species richness.

TRANSFORMATION OF ELEVATIONAL DIVERSITY GRADIENTS BY HUMAN IMPACT

Marcell K. Peters[1], Tim Appelhans[3], Christina Behler[4], Alice Claßen[1], Stefan W. Ferger[5], Maria Helbig-Bonitz[4], Claudia Hemp[1], William J. Kindeketa[1,6], Ephraim Mwangomo[3,7], Christine Ngereza[8,9], Juliane Röder[8], Connal D. Eardley[11,12], Ralph S. Peters[13], Axel Ssymank[15], Victor Kakengi[16], Zhang Jie[1], Katrin Böhning-Gaese[5,17], Roland Brandl[8], Thomas Nauss[3], Marco Tschapka[4], Markus Fischer[5,19], Andreas Hemp[2], Ingolf Steffan-Dewenter[1]

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Tropical mountains are hotspots of diversity and endemism. While human appropriation of tropical mountain ecosystems is increasing in all parts of the tropics, its impacts on elevational biodiversity remains poorly understood. We quantified species richness and structure of animal communities in all major natural and anthropogenic habitats along a 3.7 km elevational gradient on Mt. Kilimanjaro, Tanzania. We found that a differential impact of human land use in lowland savannah versus humid montane ecosystems transforms the elevational distribution of animal diversity from a linear decline in natural habitats to a hump-shaped pattern in anthropogenic habitats. Mean annual temperature was the predominant driver of animal diversity in natural habitats. However, under increasing human land use animal diversity appeared to be co-limited by primary productivity. Our study underscores the extraordinary diversity and fragility of tropical savannah ecosystems and suggests that the increasing human footprint in mountain ecosystems may hamper our ability to detect the mechanism structuring the distribution of biological diversity on Earth.

EFFECTS OF LAND-USE AND CLIMATE ON SEED-DISPERSAL NETWORKS ON MT. KILIMANJARO, TANZANIA

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Land-use and climate change pose threats to biodiversity worldwide and especially in tropical ecosystems. Many studies show the effects of these drivers of global change on species richness, but less studies investigated the effects of global change on ecosystem functions by animals. For instance it is poorly understood, how land-use and climate can influence mutualistic interaction networks between plants and their animal seed dispersers.

To our knowledge, the present study is the first to simultaneously investigate how land-use and climate affect seed-dispersal networks of fleshy-fruited plants and birds in a tropical environment. We recorded seed-dispersal networks in 10 different habitat types (ranging from pristine to highly disturbed habitats) and at 4 elevational belts (800 – 3000 m a.s.l.) on Mt. Kilimanjaro, Tanzania.

Our preliminary results show that seed-dispersal networks were more specialized at the extremes of both the land-use and climatic gradient. Specialization of the networks decreased with increasing plant diversity, suggesting that high network specialization was primarily a response of seed dispersers to low resource diversity. The high specialization in habitats with high human impact and harsh climates suggests a low tolerance of avian seed-dispersal to species loss in these environments.

Merian Award Applicant

DUNG BEETLE ASSEMBLAGES AND THEIR CONTRIBUTION TO DECOMPOSITION ALONG ELEVATIONAL AND LAND USE GRADIENTS ON MT. KILIMANJARO

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Macroinvertebrates like dung beetles provide important ecosystem functions such as nutrient cycling, bioturbation, secondary seed dispersal and the suppression of disease vectors. We studied the contribution of dung beetles to decomposition along a tropical elevational gradient and tested the hypothesis that human land use impacts dung beetles assemblages with negative consequences for decomposition. We analyzed dung beetle assemblages and their contribution to decomposition in natural and disturbed habitats from 870 to 4550 m a.s.l. on Mt. Kilimanjaro, northern Tanzania. To quantify dung beetle assemblages we used baited pitfall trapping. The contribution of dung beetles and other macroinvertebrates to decomposition was measured using three-level exclosure experiments at all sites. Here, we will present first data of this study.

DECOMPOSITION OF LEAF AND ROOT LITTER IN TROPICAL MONTANE RAIN FORESTS ALONG AN ALTITUDINAL GRADIENT IN SOUTHERN ECUADOR

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The effect of altitude, litter origin and litter type on decomposition rates and microorganisms in a tropical montane rain forest in southern Ecuador was investigated. Leaf litter from the three most abundant tree species and roots of different diameters were collected from three sites along an altitudinal gradient (1000, 2000, 3000 m). Litter and roots were placed in litterbags in the field at the three altitudes, and after 6, 12, 24, 36 and 48 months the remaining amount and percentage of C and N, microbial biomass, basal respiration, metabolic oxygen quotient (qO_2) and ergosterol content were determined.

Altitude was the main factor influencing most of the investigated parameters, while the origin and quality of litter material were of minor importance. At 2000 and 3000 m the amount of C declined over the first 12 months, before reaching a limit value of ~50% of initial, while at 1000 m the decline continued. This suggests that after 12 months lignified litter components accumulated at higher altitudes. In contrast, at lower altitude favourable conditions for litter decomposition prevent the accumulation of soil organic matter. Site specific conditions also strongly affected microbial parameters. At higher altitude fluctuations in microbial biomass after 24 months indicate a shift in the microbial community, while at 1000 m microbial biomass remained rather constant. High microbial biomass despite slowed down C loss in the later phase of decomposition, suggests nutrient supply for microbial community through roots and mycorrhiza derived resources, highlighting the importance of side specific trophic interactions for the decomposition process.

Merian Award Applicant

INDIRECT EFFECTS OF CLIMATE CHANGE ON SOIL CARBON CYCLING IN THE PERUVIAN AMAZON-ANDES

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The Andes are predicted to warm by 3–5 °C this century. This rapid warming is expected to change plant species distributions and thus the amount and complexity of plant inputs to the soil. This may, in turn, accelerate soil organic matter mineralization through "positive priming effects", altering the quantity of soil-derived CO_2 released to the atmosphere. However, the mechanisms determining the magnitude of changes in soil carbon (C) cycling in response to climate change are poorly understood. Here we used soils from a 3200 m elevation gradient of contiguous tropical forest in the Peruvian Amazon-Andes, to probe the indirect effects of climate warming on soil C cycling. We determined how soil microbial communities and abiotic properties differed with elevation. We then tested how these differences affected soil respiration responses to C inputs using 13C substrates. We found no consistent patterns in priming effects with elevation. Instead substrate quality was shown to be the dominant control on priming effects. Our results show that the relative abundance of microbial functional groups is an important predictor of soil respiration responses to changing C inputs along this elevation gradient and that this can be attributed to functionally distinct microbial groups. Our findings suggest that the microbial pathways by which plant inputs and soil organic matter are mineralized are determined primarily by the quality of plant inputs and the functional diversity of microbial taxa, rather than the abiotic properties of the soil. These results are consistent with our other research from this gradient showing that the temperature sensitivity of decomposition is regulated by the chemical composition of plant inputs and both the physical and chemical composition of pre-existing soil organic matter. Changes in the complexity of plant inputs to soil will, therefore, be important regulators of C dynamics in tropical forest soils under future climate change.

CHANGES IN THE FINE ROOT SYSTEM OF NEO- AND PALEOTROPICAL FORESTS ALONG ELEVATIONAL GRADIENTS – RESULTS FROM A META-ANALYSIS AND CASE STUDIES

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Fine roots represent not only the organs of trees for nutrient and water uptake, but are acknowledged as well for they importance in the carbon cycle of forests. Changes in the environmental conditions with increasing elevation in tropical mountains have been shown to strongly affect aboveground tree growth. However, there is only a limited number of studies that investigated elevational effects on the fine root system of tropical forests. In this contribution, results of a comprehensive meta analysis from available literature data on elevational changes in fine root abundance and dynamics of tropical forests as well as results from case studies of elevational transect studies at neo- and paleotropical mountains are presented. The results clearly show strong effects of the decreasing temperature regime and associated changes in the environmental growth conditions with elevation on the fine root system of these forests. It is concluded that there is a marked shift in the trees' carbon allocation towards the fine root system with elevation suggesting an increasing importance of the tree fine roots in the carbon cycle of tropical forests at higher altitudes.

EPIPHYTE TRAIT SPACE COMPARED TO TERRESTRIAL VASCULAR PLANTS AT MT KILIMANJARO, TANZANIA

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Epiphytes are a prominent feature of tropical habitats. Although occurring even in temperate regions (mosses) and arid environments (some highly adapted Bromeliaceae), they reach their highest diversity and abundance in wet evergreen forests. As epiphytes have no access to soil nutrients and water, and often experience higher solar radiation than terrestrial plants, differences in plant functional traits between epiphytes and terrestrial plants are likely. Here, we present data from Mt Kilimanjaro, Tanzania. We sampled terrestrial plants as well as epiphytes from the twelve dominant vegetation types along elevation and a land use gradients along the mountain. Both elevation, i.e. temperature, and different land uses were strong filters shaping epiphyte assemblages. We compare single traits as well as trait space, i.e. the multidimensional volume spanned by the individual traits, and discuss the relationship of trait expressions and environmental conditions as well as their implications in the light of climate change and conservation.

GLOBAL EVOLUTION OF ELEVATIONAL GRADIENTS OF FERN SPECIES RICHNESS

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A promising way to understand global patterns of plant diversity is to incorporate phylogenetic data to add an evolutionary perspective to ecological research. Advances in resolving phylogenetic relationships have triggered recent progress in community ecology. Disentangling the evolutionary processes generating elevational diversity patterns is therefore at the forefront of macroecological and macroevolutionary research. Aside from intrinsic key innovations and species interactions, the differences in the abiotic environment can influence diversification rates of ferns along elevational and latitudinal gradients. For a global dataset of one of the oldest groups of vascular plants, ferns, we can show that diversification rates increase with elevation but show no pattern with latitude, which is probably due to elevation-dependent environmental factors such as topographic isolation and heterogeneity. Based on these diversification rate patterns, we modelled that after the last major extinction event at the K-T boundary, their maximum species richness was found in tropical lowlands. Since then, the diversity peak has gradually migrated upwards on the mountain slopes and the elevational diversity pattern became hump-shaped, which is the prevailing pattern today.

SPECIES RICHNESS AND DISTRIBUTION OF HERBACEOUS ANGIOSPERMS ALONG GRADIENTS OF ELEVATION AND HUMAN DISTURBANCE IN CENTRAL VERACRUZ, MEXICO

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In tropical forests terrestrial herbs are an important element of the flora; however, there is a lack of research focused on them. The aim of this study was to analyze the patterns of species richness and distribution of herbaceous angiosperms in central Veracruz, Mexico, where we established an elevational transect (40 - 3540 m) in eight locations with ca. 500 m elevational distance on the Cofre de Perote. We recorded the occurrence of terrestrial herbs within 136 plots of 20 m x 20 m. Within each location the habitats old-growth, riparian, degraded and secondary forest stands were located (n = 5). We analyzed species richness and floristic composition and compared different locations and habitats using generalized additive and generalized linear mixed models. We recorded 252 plant species (30 endemic to Mexico and three threatened). Alpha diversity (mean species per plot) was highest at 2500 m and 3000 m elevation. Species richness in secondary and degraded habitats was insignificantly higher (p = 0.23 and 0.11 respectively). Using Sørensen dissimilarity as a measure for beta-diversity showed that compositional heterogeneity was highest between 1550 and 2500 when old growth forest was degraded or converted to secondary forest. Transition of degraded to secondary habitats did not show an elevational pattern. Highest gamma diversity (total number of species) was found at 2500 and 3000 m (50-58 species) and intermediate gamma diversity at 500, 1500 and 2000m (30-40 species). The location at 2500 m will be the most sensitive to human pressure, because the high gamma diversity is comprised by high alpha and beta diversity. This means that each change in forest is more likely to change a unique floristic composition. At 3000 m, on the other hand high gamma diversity is explained mainly by high alpha diversity. Therefore, heterogeneity is lower and loss of a specific area is more likely compensated by occurrence of similar assemblage at other areas of the same location.

RELATIONSHIPS BETWEEN ELEVATION AND THE BIOGEOGRAPHY OF TREE SPECIES IN MALESIA - INSIGHTS FROM PLOT-BASED INVENTORIES

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Malesia, also called the Indo-Australian Archipelago, harbors the largest number of tree species of any tropical region worldwide. Its immense geological and biological complexity, including sharp biogeographic boundaries, has been well known since the monumental work of Alfred Russel Wallace. In recent years, biogeographic relationships of several tree taxa have been elucidated using molecular and phylogeographic methods. These studies showed that most taxa were present either in Asia or in Australia before c. 20 Mya. Then, as Wallacea, the central part of Malesia, formed, migration between the two major land masses became possible and the 'Malesian floristic interchange' began. During that interchange, the Asian taxa presumably have been much more successful than their Australian counterparts, dominating most of the Malesian ecosystems today. While relationships are clear for single genera and families, we know little about how tree species of the two groups contribute to the composition of different vegetation types and whether their relative dominance changes along the elevational gradient.

Here, we used data from our own plot-based tree inventories along an elevational gradient in Sulawesi and supplemented these with published results from other plots in the Malesian subregions of Sumatra, Borneo, Java, the Philippines and the Moluccas. Applying results from phylogenetic studies as well as distribution and fossil data, we assigned each species occurring in the inventory plots to one of two ancestral areas: Asia or Australia. The results show that patterns change clearly along the elevational gradient, both in number of species and number of individuals. Based on these results we discuss different possible migration pathways during the Malesian floristic interchange.

Merian Award Applicant

CONSERVATION VALUE OF DISTURBED AND SECONDARY FORESTS FOR FERNS AND LYCOPHYTES ALONG A SUBTROPICAL ELEVATIONAL GRADIENT

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Tropical forests are being degraded at an alarming rate, so that disturbed forests and secondary forest are often considered to represent important refuges for forest dependent biota. However, little is known about the conservation value of such non natural habitats in subtropical forests, and especially for ferns and lycophytes (for brevity called ferns). We studied the richness and composition of fern assemblages in 120 study plots at eight elevations at 20-3500 m in central Veracruz, Mexico, in three forest types: natural forest (NF), disturbed forest (DF) subjected to timber extraction and grazing, and secondary forest (SF) regrowing after total clearance 15-20 years ago. In addition, we measured microclimatic conditions in the three forest types at five elevations over a year. Fern richness peaked in humid montane forests at mid elevations and was low in the dryer habitats at the extremes of the gradient. Humid montane forests were most sensitive to disturbance, showing increases in mean temperatures by about 1°C and reduction in relative air humidity by about 20% in DF and SF compared to NF. This went along with a reduction of fern species richness by 5-60% and marked changes in species composition. In contrast, drought-deciduous forests at low elevation and coniferous forests at high elevation already had low humidity and high light intensity in NF and were less affected by human use: Their microclimatic conditions and fern assemblages did not change markedly in DF and SF. We conclude that the conservation of much of the humidity-dependent biota (ferns and presumably also groups such as bryophytes and amphibians) in humid montane forests depends on the protection of natural fragments without human disturbance. In contrast, the naturally open forests at the extremes of the gradient can be subjected to some exploitation while conserving much of their biota as long as a general forest structure is maintained.

SESSION 12

S12: FREE TOPICS

CARBON SEQUESTRATION IN PINE PLANTATIONS ON PÁRAMO SITES

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Within the framework of Clean Development Mechanism (CDM) and several related projects, Pine plantations have been established on Páramo sites during the last decades on large areas in Ecuador. However, negative impacts on e.g. biodivesity, hydrology regulation or soil characteristics have been claimed and the performance of Pine plantations regarding carbon sequestration is not clear. Even worse some studies suggest that pine plantations could be depleting soil carbon. To find out the carbon sequestration performance of pine plantations on Páramo will give insights for the sustainable management of this ecosystem. We quantify carbon stock in aboveground and belowground biomass and soil organic carbon in Pine plantations and control (sites) in Southern Ecuador. Five randomly distributed sample plots have been stablished within Pine plantations on 9 different sites at 3 elevations levels (3300m - 3500m - 3700m; 45 plots in total); the mean age of the plantations was 16.6, 17.3, 15.6 respectively. Aboveground and belowground biomasses were measured for pine plantations and for the control sites. Results showed that Carbon Stocks in aboveground biomass are decreasing with higher elevations. Especially at 3700m the stocks are considerably low in comparison to the stocks at 3300m. The same tendency was detected regarding belowground biomass and SOC. SOC stocks contribute considerably to total carbon stocks in Pine plantations on Páramo sites and the contribution of biomass is relatively low. Drecreasing stocks on higher elevations are expected; however, the differences in stocks are quite strong on a relatively small elevation gradient. A comparison with the Carbon Stocks of natural Páramo vegetation will be conducted in order to asses the effects of Pine plantations, which are also supposed to have negative impacts on SOC stocks via ectomycorrhizal fungi.

FIRE FREQUENCY AND PLANT DIVERSITY IN TROPICAL DRY DECIDUOUS FOREST: A CASE STUDY OF KUMBHALGARH WILDLIFE SANCTUARY, INDIA

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Tropical dry deciduous forests of India are subjected to a wide range of anthropogenic pressure of which wildfires are the most important one. Despite having a significant role in altering various ecosystems, there is no comprehensive data on the different dimensions of fire in India. We assessed the impact of different fire frequency on plant community's structure and composition of a tropical dry deciduous forest in Kumbhalgarh Wildlife Sanctuary, Rajasthan, India.
Using a combination of remote sensing and GIS techniques, three fire frequencies [no fire (0 fires in 12 years), low fire (1-3 fires) and high fire (4-7 fires)] were extracted from 13 years Landsat data (1999-2011). A total of 455 vegetation plots were laid representing different fire frequencies on homogeneous site conditions of slope and aspect. Data regarding the number of plant species and species cover of all the life forms was collected. MRPP (Multiple Response Permutation Procedure) shows that the diversity of trees, grasses and herbs were positively correlated to high fire frequency especially at north aspect but no significant difference was found for the shrub layer on both aspects. The average tree dbh (diameter at breast height) did not differ significantly between the two fire frequencies but smaller dbh classes were found to be less in frequent burnt areas and at southern aspects. Frequently burned spots showed a significant lower plant cover in the middle layer as compared to no fire areas ($p < 0.001$). Frequent fires trigger the number of seedlings while those species are not represented in the middle and canopy layer in both the aspects. We conclude that the frequent burning in addition to specific site conditions increases the diversity and richness of the plant species while simplifying the structure of the vegetation. The development of plant diversity over longer time periods under the absence of fire is not known but is seen as essential for fire management.

PHYSIOGRAPHIC CONTROL OF SPATIAL TREE DIVERSITY IN HIGH-ELEVATION, ORIENTAL BEECH (*FAGUS ORIENTALIS*)-DOMINATED FORESTS IN NORTHERN IRAN

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Hyrcania is a highly productive forest along the southern coast of the Caspian Sea (northern Iran). The forests are mostly uneven-aged, oriental beech (*Fagus orientalis*)-dominated hardwood mixtures.These forests often include the presence of *Carpinus betulus*, *Alnus subcurdate*, *Acer velutinum*, and several other tree species and shrubs. These forests are mostly broadleaved, but *Taxus bacata* and *Cupressus* spp. do appear on some specialized sites. These forests are home to about 80 different tree species and 50 shrub species.Hyrcanian forests have multiple ecological functions, such as provide for (i) the production of wood fiber and lumber, (ii) the protection of watersheds, including their water and soils, and (iii) the conservation of biodiversity.
The topic of biodiversity has become a primary focal point in deliberations of sustainability worldwide, as a result of the rampant decline and degradation of natural environments initiated by urbanization, unrestrained resource extraction, and wanton disregard for nature. Furthermore, global climate change broadens our need to incorporate significant amounts of knowledge on biodiversity and functionality in developing contemporary forest management plans, which is not always easy to achieve. In this chapter, we develop a computational framework that relates measures of tree diversity (based on actual field surveys) to modelled physical (abiotic) variables. Here, we calculate tree diversity using the Shannon-Weiner index; an index commonly used to characterize species diversity in plant communities by accounting for both species abundance and evenness.

SELF-AMPLIFIED AMAZON FOREST LOSS WITH DRY-SEASON INTENSIFICATION

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Vegetation-atmosphere interactions are of key importance to sustain precipitation and forest resilience across the Amazon basin. Interacting effects of land-use change and rainfall variability may trigger local critical transitions from tropical forest to grass-dominated ecosystems. As dry-season evapotranspiration rates for forest are higher than for savanna or treeless vegetation, forest loss could weaken large-scale continental moisture recycling that currently amounts to 25-50% of total Amazonian rainfall. While regionally-driven feedbacks between forest loss and rainfall reduction may threaten the ecological integrity of the Amazon forest, the severity and extent of this threat is yet unknown in relation to projected prolonged dry seasons and rising deforestation rates in the future. To tackle this uncertainty we used empirical estimates of moisture recycling and local forest resilience to model the coupled Amazon vegetation-rainfall system as a heterogeneous and interconnected dynamic complex network. We found an exponential increase of self-amplified Amazon forest loss with dry-season intensification. While it is expected that this process affects up to 10% of the current forest, particularly in central and western Amazonia, a complete Amazon dieback cannot be ruled out. Our results suggest that self-amplified forest loss is diminished by the variability in the forest's sensitivity to altered rainfall regime, highlighting the importance of plant diversity and landscape heterogeneity for the stability of the forest. Considering the strong internal connectivity of the Amazon forest in establishing conservation management strategies is essential to maintain the forest ecosystem integrity. Our results pave the way for accounting for the non-linear and complex vegetation-atmosphere interactions in estimating impacts of global environmental changes in the Amazon basin and beyond.

Merian Award Applicant

BRIDGING THE GAP - BIODIVERSITY CONSERVATION IN THE FRAMEWORKS OF RESEARCH AND DEVELOPMENT COOPERATION

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Biodiversity research is chronically underfinanced, research grants are difficult to obtain and normally small. But nevertheless and often unknown, there are impressive amounts invested into biodiversity conservation. The Convention on Biological Diversity (CBD) obliges the states that ratified the convention to invest certain amounts in conservation measures within the respective countries, but also, worldwide. In this framework Germany invested on a bilateral basis in the countries of the Congo basin (mainly Cameroon, Central African Republic and Democratic Republic of Congo (DRC)) via the Federal Ministry of Economic Cooperation and Development (BMZ) in 2010 around 100 Million Euro for sustainable natural resource management, including 27 Million Euro only for Biodiversity conservation in DRC! This money is channelled via GIZ and KFW, the technical and financial German cooperation agencies. Implementation is normally managed by consulting firms like *GFA Consulting Group GmbH*. The expenditures follow bilateral contracts, political lines, to support the national institutions for example in a joint national park management approach or building up and reinforcing the national institutions for conservation and nature protection. Normally, within these projects there are funds available for biodiversity inventories and monitoring, but these interventions are normally executed via international NGOs, not researchers.

The talk will present the finance mechanisms in the development cooperation context and show possible options of synergisms and possible shared interests between researchers and consulting companies like *GFA Consulting Group GmbH*.

LINKING ECOLOGICAL RESEARCH WITH CONSERVATION: A CASE STUDY ON THE ENDANGERED CROCODILE LIZARD IN VIETNAM

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We report a case study on an ecologically specialized and highly endangered living fossil, which was described as a new family, genus and species from isolated sites in South China and recently discovered in North Vietnam by our team. The Crocodile Lizard *Shinisaurus crocodilurus*, Ahl 1930, represents an ancient but prominent anguid lizard clade, Crocodile Lizards are semi-aquatic habitat specialists, which are adapted to clean and remote streams along mountain ridges within undisturbed evergreen broadleaf lowland forest. The critical taxonomic position, long evolutionary history as well as specific life-history traits and high sensitivity to environmental conditions make the Crocodile Lizard particularly important for understanding the evolution and ecology of lizards. Due to several anthropogenic pressures the species is now at the brink of extinction. While the Chinese population was estimated to comprise only 950 individuals we estimated an effective population size of only less than 100 individuals in Vietnam. Furthermore, our population monitoring revealed a dramatic decrease in mature individuals during the last recent years. We further predicted the overall suitable habitats of *S. crocodilurus* to be rare, fragmented, and poorly covered with protected areas. Targeted field surveys in predicted suitable habitats confirmed the reliability of such theoretical models. At present, climate change is recognized as one of the major forces biasing species distribution and it is assumed to imperil numerous tropical lizard species, due to their narrow temperature tolerances. Crocodile lizards are regarded as dependent on annual moderate cool temperatures and thus likely being affected by climatic change and habitat alteration. We predicted an almost 95% loss of suitable habitats for *S. crocodilurus* from 2020 to 2080 throughout its distributional range, due to climate change. Based on this finding we conducted comprehensive research on microhabitat requirements, niche segregation and thermobiology as well as an impact of threats evaluation of the Crocodile Lizard in Vietnam, providing essential baseline data for species conservation and the protection of remaining natural habitats. Besides in-situ research we further initiated subsequent conservation activities which will be roughly introduced.

Merian Award Applicant

GALAPAGOS GIANT TORTOISES AND FARMERS: COEXISTENCE OR CONFLICT?

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Human population growth and the consequent land use that occurs around protected areas set the scene for human-wildlife interactions. Outside protected boundaries wildlife is forced into human extensions into what once was their habitat, using human space for both shelter and food. As a reaction humans can take actions to protect their lives and livelihood against the trespassing wildlife. If not properly managed, this can lead to a human-wildlife conflict. The Galapagos National Park entirely surrounds human settlements in the inhabited islands of the archipelago. In Santa Cruz Island the migratory routes of giant tortoises cross the National Park border and enter in the rural area. Through a set of semi- structured interviews, questionnaires and ecological assessments we have investigated the interaction between giant tortoises and the farmers of Santa Cruz Island. Although negative perception towards giant tortoises was not predominant in the sample population, reporting damages and having agriculture were the drivers that led farmers to take action against giant tortoise incursions. The most common action to protect the crops was the use of fences. Fences are predicted to increase with the intended agricultural development of the rural sector. As a consequence tortoise migratory routes and their undisputable role as ecological keystone species could be further disrupted causing a cascading effect that could jeopardize their ecosystem function in the Island. We suggest that an agricultural implementation in the island should take into account both tortoises migratory routes and farmers perspective to avoid a negative impact of wildlife on the goals of humans and a negative impact of these on wildlife needs.

Merian Award Applicant

EFFECTS OF SEASONALITY ON THE RESPONSES OF NEOTROPICAL BATS TO LOCAL- AND LANDSCAPE-SCALE ATTRIBUTES IN A FRAGMENTED LANDSCAPE

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Changes in plant production can cause oscillations in resource availability, affecting the presence and abundance of species. When seasonality is associated with fragmentation, it can exacerbate the impacts of the latter. We evaluated how different bat species respond to seasonality in a fragmented landscape in the Central Amazon characterized by different-sized fragments of primary forest surrounded by a matrix comprised of secondary forest in different successional stages. Based on two years of capture data, we assessed how general patterns of bat species abundance changed between the wet and dry seasons in forest fragments, secondary forest sites, and continuous forest controls. Measurements of local and landscape characteristics were used to examine the relative effects of local vegetation structure and metrics of landscape composition and configuration in shaping bat abundance patterns. Relationships between species abundances and local vegetation structure and landscape characteristics were both season-specific and scale-dependent. The way that species responded to these metrics varied between frugivorous and animalivorous species.In the dry season, frugivores responded more to compositional metrics whereas during the wet season local and configurational metrics were more important. Animalivorous species showed similar patterns in both seasons, responding to the same group of metrics in the wet and dry season. This suggests that for animalivores, seasonality and consequently the variability in resource availability may not play such an important role as it does for frugivores. Differences in responses occurred probably due the differences in the chronology of flowering and fruiting events between primary forests and the secondary forest matrix, which affected the foraging behavior and the way that bats use the habitat. Management actions should promote secondary forest regrowth and consequently minimize fragment and matrix contrast in order to maintain and improve habitat quality for bats, although measures should prioritize primary forest conservation to preserve both frugivores and animalivores. Finally, seasonality should be considered in management actions to guarantee that bats have the necessary resources during non-breeding and breeding seasons.

NECTARIVOROUS BAT *ANOURA GEOFFROYI* AS POLLINATOR OF THE EPIPHYTIC BROMELIAD *TILLANDSIA MACROPETALA* IN CENTRAL VERACRUZ, MEXICO

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Tillandsia macropetala Wawra is an epiphytic bromeliad of the severely threatened tropical humid montane forest ecosystem in central Veracruz, Mexico. This species has floral characteristics that are typically associated with nocturnal pollinators, particularly bats; however, its anthesis begins at dusk and lasts until the following day, which allows also for the visits of diurnal animals. However, since the longest period the flower remains open occurs during the night, the most efficient pollinators would be the nocturnal visitors. To test this hypothesis, observations and recordings were made of both diurnal and nocturnal visits, along with exclusion pollination treatments for nocturnal and diurnal visitors, as well as mist net trapping of the visitors to check these for pollen. Furthermore, the nectar production pattern was determined. We found that the nectarivorous bat *Anoura geoffroyi* Gray was the only observed pollinator of the bromeliad, since hummingbirds do not pollinate the flower while visiting. Although *T. macropetala* is self-compatible, its floral morphology makes self-pollination difficult, and thus it only produces fruits following visits by bats. Nectar production and concentration also correspond to the expected patterns for a bat-pollinated bromeliad. This is the first report of chiropterophily within the species-rich genus *Tillandsia*. Even if some aspects of the floral biology, such as floral longevity of over 12 hours, enable visits of diurnal animals, this bromeliad displays a pollination system that is specialized towards nocturnal visitors.

SESSION 12-O10 - FREE TOPICS

THE HELPING TRIAGE: SELECTIVE AID DEPENDING ON INJURY SEVERITY IN *MEGAPONERA ANALIS*

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The ant *Megaponera analis* is a specialized termite predator, solely raiding termites of the subfamily Macrotermitinae at their foraging sites. The evolutionary arms race between termites and ants led to various defensive mechanisms in termites, e.g. a caste specialised in fighting predators. As *M. analis* incurs high injury/mortality risks when preying on termites, some risk mitigating adaptations evolved, including a helping behaviour focused on injured nestmates. Ant injuries at the hunting ground include the loss of an extremity or a termite clinging to the ant. The injured ants are registered by their nestmates and after a short investigation they are picked up and carried back to the nest. Within the safe confounds of the nest the ant is able to recover from its injury and is aided by nestmates in the removal of clinging termites. In this study we show that the ants are able to differentiate between the severity of the injury, leaving heavily injured ants behind, i.e. individuals that would not be able to become a productive member of the colony again. Behavioural experiments led us to the conclusion that the mechanism leading to this differentiation is caused by the injured ant itself. Heavily injured ants show very restless behaviour, making it impossible for the helping ant to pick up the injured individual, while light injured individuals assume a pupae-like position once antennated, making transportation easier. Further, the behaviour of an injured ant varies depending on the proximity of nestmates. If there are nestmates nearby the injured ant barely moves forward, while when alone an increase in the return speed by 300% is observed. This helping behaviour focused on injured individuals is already unique in social insects. The additional specialization, leading to the differentiation of injured states, further illustrates the high evolutionary pressures on *M. analis* to reduce its foraging costs.

Merian Award Applicant

SESSION 12-O11 - FREE TOPICS

BROAD-SCALE SPATIAL PATTERNS IN FERN GENUS COMPOSITION ACROSS THE AMAZON BASIN

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There is considerable interest in the degree to which plant community composition in the Amazon basin is influenced by current environmental conditions, relative to other factors, such as dispersal limitation, or historical drivers. Answering these questions is challenging, as obtaining a good level of sampling coverage requires decades of field inventory effort and taxonomic identification of plant specimens. Collaborative efforts between research groups are needed to overcome these obstacles. Here, we combine data from field inventories of fern species occurrences obtained separately during two long-term field survey efforts with different geographical scopes, one sampling mostly western Amazonia and the other, mostly central Amazonia. In total, these represent c. 600 transects, each with associated soil data. This enables broad scale analysis across the Amazon basin of how soils, climate (or surrogates thereof) vs. spatial separation contribute to patterns of taxonomic turnover in this common understorey plant group. We analyse patterns of turnover at the genus level across the entire dataset, and show that within the western and eastern sub-regions, generic and species-level turnover patterns are well correlated. The two most pronounced spatial patterns in the dataset are a roughly westerly to easterly gradient in turnover (linked to underlying patterns in species richness) and clear associations of particular fern genera with richer vs. poorer soils in both the west and east. Earlier work at smaller extents suggests that turnover patterns identified in ferns are likely to correlate with those in other plant taxa as well, including with trees.

SESSION 12-O12 - FREE TOPICS

CAN FERNS AND LYCOPHYTES TELL US SOMETHING ABOUT THE HABITAT USE OF MONKEYS?

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Studies in Western Amazonia have found that the distributions of many groups of plants are highly correlated with soil properties, and that ferns and lycophytes are good indicators of this kind of general patterns. It has also been suggested that such habitat differences may affect the occurrences of animals. This study aims to produce a habitat map based on fern and lycophyte data in order to help interpret the results of long-term primate studies that have been carried out in the Quebrada Blanco Biological Station (EBQB) in North-Eastern Peru. Data on the habitat use of monkeys (mainly *Saguinus mystax* and *Saguinus nigrifrons*) have been collected along a permanent trail system during a number of studies on their behaviour and ecology. Now we have systematically registered the abundances of all ferns and lycophytes along 11 transects established adjacent to the trails used for monkey surveys. The most common fern species in the study area are indicators of relatively poor soils, but indicators of more productive soils are present in two areas. Preliminary results for a single survey year show that monkey ranges are smaller in the areas inferred to have richer soils. Further analyses will be carried out to test if this result holds for all ten years of monkey survey data.

SESSION 12-O13 - FREE TOPICS

POLLINATORS OF *MICROMELUM MINUTUM* IN VIETNAM

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Micromelum minutum, locally known as *'mắc mật'*, is amultipurpose fruit tree species of high economic importance, native to the limestone forests of Vietnam; is considered the most remote genus in the citroid subfamily Aurantioideae (Rutaceae) (Swingle). The genus contains 9 (- 10) species which all are small trees or shrubs. *Micromelum minutum* Forster differs from the other *Micromelum* species in having a wider distribution. In this study, the flower visitors to *Micromelum minutum* were investigated in northern Vietnam. Visitors are identified to lowest possible taxonomic level and their abundances are estimated during the first month of flowering. The pollen load of visitors is analyzed in order to evaluate their importance as pollen vectors and their flower constancy.
Flower visitors to *Micromelum minutum* were caught and identified. The pollen load of each insect was investigated. Information on visitor abundance, behaviour, body structure and pollen load were used to propose a flowering strategy of *M. minutum*. The flowers were visited by a diverse assemblage of insects. Butterflies (Lepidoptera) constituted half of all flower visitors, both in abundance and number of species. The most abundant flower visitor was the cabbage butterfly *Appias albina*. Hymenoptera was well represented by two species of bees and seven wasp species, and Diptera were abundant flower visitors most pronounced in one species of *Episyrphus*. Almost half of all butterflies above a certain size carried Micromelum pollen on their proboscis. The highest amount of pollen was found on *Bombus melanurus*, which was only caught once. Many individuals of the most abundant visitors carried *Micromelum* pollen, and are on the basis of this and their behaviour thought to pollinate. Based on the findings, *M. minutum* is thought to be highly generalized in its pollination ecology. This is a basic step to study further on how ecological and evolutionary interactions between plants, insects and microbes play out in a spatial setting.

SESSION 13

S13: MANAGING OIL PALM LANDSCAPES FOR BIODIVERSITY AND PRODUCTION: LESSONS FROM SE ASIA

Chairs: Edgar Turner & Teja Tscharntke
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WHAT DO WE KNOW ABOUT THE IMPACT OF OIL PALM PLANTATIONS ON THE ENVIRONMENT?

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What do we know about the impact of oil palm plantations on the environment? This study involves a fully comprehensive systematic review of the impact of palm plantations on the environment. It includes a synthesis of research to date; categorising studies into general topics, highlighting research strengths and gaps, and illuminating spatial biases where research effort has been concentrated. In addition, this talk will present the findings of a meta-analysis including all currently available research of the biodiversity shift occurring when forest is converted to oil palm. This meta-analysis quantitatively synthesises over 50 studies elucidating the average impact on biodiversity of forest to palm oil conversion. We also take into consideration the effect that the ecoregion and palm oil age have on biodiversity, while exploring the land use change impact on particular taxa. The result of this work will inform in what areas further research is necessary to mitigate the environmental impact of oil palm in the tropical landscape. The meta-analysis also gives a deeper insight into palm oils effect on biodiversity and more specifically which taxa are the most vulnerable to forest conversion to palm oil. Finally, we highlight the paucity of research into the effect of biodiversity loss and species composition change on ecosystem function.

TRANSPIRATION CHANGES BY TRANSFORMING TROPICAL RAINFOREST TO RUBBER AND OIL PALM PLANTATIONS

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Rainforest transformation to monocultures alters ecosystem water cycles with respect to the magnitude of fluxes, and their spatial and temporal heterogeneity. For the 'Maritime Continent' of Indonesia, a current deforestation hotspot, eco-hydrological consequences of rainforest transformation to the prevalent production systems rubber and oil palm remain unknown. In this study, we assessed plot-level transpiration rates in forests, jungle rubber, and rubber and oil palm monoculture plantations. Each land use type was studied with eight replicate plots in the lowlands of Jambi, Sumatra. Transpiration rates were derived from sap-flux measurements with thermal dissipation probes and stand inventories. The results suggest that the stand transpiration on sunny days was highest in forest (1.8 mm day^{-1}), intermediate in 'jungle rubber' (1.6 mm day^{-1}) agroforests and oil palm (1.4 mm day^{-1}) plantations and much lower in rubber (1.0 mm day^{-1}) plantations, with considerable spatial variation in particular among forest and oil palm stands. The day-to-day variability of transpiration was much lower in the oil palm compared to the forest, which points to a buffered response of oil palm transpiration to environmental drivers. Oil palms reached maximum transpiration rates at only 50% of maximum VPD and 85% of maximum radiation levels. While the dicot trees showed a much closer response to micrometeorological drivers, in particular to radiation. Pronounced eco-hydrological differences between dicot trees and oil palm point to increased susceptibility of oil palm dominated landscapes for periodical water scarcity and thus to potentially severe and neglected hydrological consequences of the continuing transformation of tropical rainforests.

NUTRIENT LEACHING AND NUTRIENT RETENTION EFFICIENCY FROM LOWLAND FOREST CONVERTED TO OIL PALM AND RUBBER PLANTATIONS IN SUMATRA, INDONESIA

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In the last two decades, Sumatra, Indonesia has experienced rapid conversion of rainforests to oil palm and rubber plantations. Such widespread land-use change necessitates assessment of its environmental impacts. We examined the impact of forest conversion to oil palm and rubber plantations on nutrient leaching and nutrient retention efficiency in the soil. Our study was conducted in two landscapes (loam and clay Acrisol soils) within Jambi Province. Within each landscape, we investigated four land uses: lowland forest, jungle rubber (rubber interspersed in secondary forest), rubber and oil palm. Each land-use was represented by four replicate sites in each landscape, totaling to 32 sites. We measured leaching losses using suction cup lysimeters installed at 1.5-m depth in the soil, with bi-weekly to monthly sampling from February to December 2013. Differences in leaching fluxes and retention efficiencies were strongest in forest sites, where leaching losses of dissolved nitrogen (N) and base cations (BC) were higher and retention efficiencies of N and BC were lower in the loam than clay Acrisol ($p \leq 0.05$); similar differences in N and BC retention efficiencies between landscapes were observed in jungle rubber. N and BC retention efficiencies across landscapes correlated with effective cation exchange capacity. Among land uses in loam Acrisol, oil palm had higher NH_4+, NO_3-, dissolved organic C (DOC) and total S leaching fluxes than rubber and higher Na and Ca leaching fluxes and lower N and BC retention efficiencies than all the other land uses ($p \leq 0.05$). In clay Acrisol, oil palm showed higher DOC and Ca leaching losses than forest and higher Na and Mg leaching losses than all the other land uses ($p \leq 0.05$). In oil palm, increased nutrient leaching losses and decreased N and BC retention efficiencies were attributed to fertilization and liming. These call for improved soil management practices to minimize leaching losses and their effect on ground water quality.

IMPACTS OF LOGGING AND OIL PALM ON FRESHWATER MACROINVERTEBRATES AND THEIR POTENTIAL AS BIOINDICATORS TO ASSESS HEALTH OF SE ASIAN STREAMS

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Freshwaters perform important ecosystem functions, provide essential services for people, and valuable habitat for lots of species, but they are heavily threatened. In Southeast Asia, freshwater systems are increasingly suffering impacts from rainforest logging and oil palm plantations. Disturbance and conversion of habitat surrounding waterways can cause changes in flow, increased inputs of sediment, reduced shading and higher water temperatures, and changing inputs of organic matter, whilst oil palm agriculture specifically can cause elevated nutrient levels from fertiliser runoff.
Tropical streams support a diverse but poorly known assemblage, and macroinvertebrates (including insects, crustaceans and molluscs) in particular dominate in terms of numbers and functional importance. We consider how land use and consequent changes in stream conditions affect macroinvertebrate abundance, richness and community composition. We studied sixteen streams in pristine forest, logged forest of varying quality, oil palm plantations with riparian buffer strips and oil palm with no buffers, at the Stability of Altered Forest Ecosystems (SAFE) Project, in Sabah, Malaysia. Forest quality was assessed using satellite images and on the ground measurements, whilst stream conditions were measured along transects. Macroinvertebrates were caught using a Surber sampler and nets along the same transects, and were identified by microscopy.
Macroinvertebrate taxa varied in their responses to habitat disturbance, with some taxa showing significant changes in abundance and richness with changes in forest quality and stream conditions, but others remaining diverse across the land use gradient. This indicates that there is variation in tolerance to habitat disturbance and that consequently community assemblage and the functions they perform are likely to be altered. In addition, this variability in response offers an opportunity for developing indicator taxa to help assess stream ecosystem health; an important conservation monitoring tool that is currently lacking for Southeast Asian freshwaters.

Merian Award Applicant

MAPPING ECOSYSTEM FUNCTIONS IN HUMAN-MODIFIED TROPICAL LANDSCAPES

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In many parts of South-East Asia, and in particular in Malaysian Borneo, conversion to oil palm plantations remains the main driver of loss in tropical humid forest cover. Detecting and mapping impacts of forest loss and degradation on forest processes is a primary conservation concern, as these impacts feed through to changes in biodiversity and ecosystem functions.

We show that high-spatial resolution satellite sensor data can be used to map impacts of selective logging on aboveground live tree biomass (AGB), canopy leaf area index (LAI) and fractional vegetation cover (FCover). LAI and FCover are Essential Climate Variables and regulate many of the ecosystem services and processes we are interested in. We measured these forest attributes in 193 permanent vegetation plots that we set up in rainforest and oil palm plantations across the degradation landscape of the Stability of Altered Forest Ecosystems project (http://www.safeproject.net/), located in Malaysian Borneo.

Satellite-derived spectral and texture information explained up to 62 % of variation in forest structure using beta-logistic regression models allowing us to map these attributes across the landscape. These maps revealed a pronounced decline in aboveground live tree biomass with increasing disturbance, impacts which are also visible in the field data. Yet, while field data suggest a rapid recovery in canopy structure to pre-disturbance levels a decade after logging, our maps indicate that both LAI and FCover are still significantly reduced in logged compared to primary forest stands.

Our maps can be interpreted for changes in habitat quality and ecosystem processes. They can also be linked to biodiversity estimates at species and community level, a currently measured on the ground.

THE BIODIVERSITY AND ECOSYSTEM FUNCTION IN TROPICAL AGRICULTURE PROJECT: INVESTIGATING OPTIONS FOR SUSTAINABLE OIL PALM

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The Biodiversity and Ecosystem Function in Tropical Agriculture (BEFTA) Project investigates management options for enhancing biodiversity within oil palm landscapes, together with the important ecosystem functions that this biodiversity can support. Taking an experimental approach, the project has manipulated the understory complexity in large, replicated plots in established oil palm plantations in Riau, Indonesia, to directly test the effects of within-plantation habitat complexity on a wide range of different taxa and processes, including oil palm yield.

Now in its third year, the project is beginning to reveal clear effects of differing levels of understory complexity on a range of different taxa, including a marked reduction in some important predatory groups, such as predatory bugs and frogs, when understory vegetation is removed. Small-scale exclusion experiments within the BEFTA Project have also demonstrated the importance of different components of the oil palm community on processes including pest control, seed removal and decomposition.

The results of this work have clear implications for management options to support more sustainable palm oil production, which will be discussed. The development and outcomes of this programme clearly demonstrate that collaboration between industry and research organisations can (a) provide effective and realistic projects and (b) lead to the development of best management practice guidelines.

THE IMPACT OF FOREST CONVERSION ON ALIEN SPECIES INVASION AND THE PHYLOGENETIC STRUCTURE OF UNDERSTORY PLANT COMMUNITIES IN SUMATRA (INDONESIA)

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The conversion of forest into oil palm plantations and other agricultural areas has severe impacts on tropical plant diversity. Alien species are supposed to exacerbate the effects of land use change by replacing native species and leading to homogenization of floras. However, the effects of forest conversion and alien species invasion on the phylogenetic diversity and structure of tropical plant communities are largely unknown. We investigated how forest conversion into agricultural areas affects phylogenetic diversity and structure.

In the context of the CRC990-EFForTS project, we studied a total of 32 core plots in four land-use systems (tropical lowland rainforest, jungle rubber, rubber plantations and oil palm plantations) and in two landscapes (Harapan, Bukit Duabelas). A total of 151,728 individuals of 1,533 species and 135 plant families were used for the analysis. We combined taxonomic (species richness, Simpson's index) and phylogenetic metrics (phylogenetic diversity and net relatedness index; NRI).

Our results showed that forest conversion into agricultural areas leads to a pronounced loss in taxonomic diversity and phylogenetic diversity. Conversely, in the most intensively managed systems the phylogenetic distance among the understory communities was higher. Furthermore, the NRI in oil palm plantations indicated more overdispersed phylogenetic structure.

The presence of alien plant species significantly influenced the phylogenetic structure of understorey plant communities. When alien plant species were excluded, the number of plots with an overdispersed phylogenetic structure increased.

In conclusion, forest conversion into agriculture areas negatively affects understorey plant diversity both at taxonomic and phylogenetic level. Forest conversion generates overdispersed phylogenetic structures along an intensification gradient. The invasion of alien plant species plays a strong role in changing the phylogenetic structure of the plant communities.

EFFECTS OF UNDERSTORY VEGETATION AND SOIL MANAGEMENT PRACTICES ON SOIL BIODIVERSITY AND ECOSYSTEM FUNCTIONS IN OIL PALM PLANTATIONS

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The conversion of forest to oil palm plantation has negative consequences for biodiversity and ecosystem functions. However, oil palm plantations represent relatively complex agricultural habitats, with 25-30 year replanting cycles. This allows management practices to be used to restore and maintain biological processes to support soil physical and chemical fertility throughout the crop cycle. Here we look at the effect of understory vegetation, as part of the BEFTA Project, and soil management practices associated with the application of Empty Fruit Bunch (EFB) residue on soil biodiversity and ecosystem functions, in mature oil palm plantations in Riau, Indonesia.

As part of the Biodiversity and Ecosystem Function in Tropical Agriculture (BEFTA) Project the understory vegetation was manipulated in large, replicated plots resulting in reduced, normal and enhanced vegetation treatments. Here we examined ground dwelling arthropods using pitfall traps and soil biological activity through litter decomposition and bait lamina sticks. In a neighbouring site we examined the impact four soil management zones: areas under (1) EFB application, (2) chemical fertilization, (3) pruned palm fronds, and (4) harvesting paths. Using the bait lamina method we assessed whether soil-feeding activity was associated with changes in soil chemical and physical properties.

Our results show that these differences in management have district effects on the soil biological activity and that practices such as EFB application and maintenance of understory vegetation can play an important role in enhancing soil ecosystem functioning in oil palm plantations.

WASPS AS BIOCONTROL AGENTS IN OIL PALM - A POTENTIAL WAY OF INCREASING BIODIVERSITY IN OIL PALM

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The oil palm industry is rapidly expanding in SE Asia, and growing in other tropical regions. Oil palm is the most productive oil crop worldwide, meaning that higher yield can be achieved per hectare in this system, potentially reducing the pressure to deforest areas of remaining natural habitat.

Like many other intensive monocultures, oil palm plantations are low in diversity and experience heavy pest outbreaks affecting yield, with palm-defoliating Lepidoptera as one of the main pests in mature oil palm plantations. Previous studies show that 10-13% defoliation of the palm crown cause crop losses of 33-40%, thus it is desirable to keep the number of larvae under a damage threshold. Integrated pest management systems have long been used in oil palm plantations to decrease the use of pesticides. These systems rely on natural enemies of the Lepidoptera larvae, such as wasps, to regulate the number of larvae. A key factor for adult wasps is the presence of nectar resources in order to prolong their fecundity and longevity.

From November 2012 to January 2013, we investigated the number of larvae per leaf, level of herbivory damage to palm fronds, Hymenoptera abundance and species richness in 20 locations with nectar-rich plants and 20 control sites with only understory plants.

These studies indicate that nectar-rich plants increase the abundance of wasp species as well as decrease the level of herbivory damage to the fronds. They furthermore indicate that the beneficial wasps have a negative effect on defoliating Lepidoptera and that nectar-rich plants positively affect the general insect abundance.

FERTILIZER-INDUCED SOIL N_2O AND NO FLUXES FROM SMALLHOLDER OIL PALM PLANTATIONS FOLLOWING DEFORESTATION IN SUMATRA, INDONESIA

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Expansion of oil palm plantations, due to increasing global demand, causes rapid deforestation in Sumatra, Indonesia. Although forest conversion and the application of nitrogencontaining fertilizers in agricultural land uses is known to influence soil nitrous oxide (N_2O) and nitric oxide (NO) fluxes, measurements from fertilized oil palm plantations are scare in this region. Our study aimed to determine changes in soilatmosphere fluxes of N_2O and NO with forest conversion to oil palm plantations. InJambi Province (Sumatra, Indonesia), we selected two landscapes on heavilyweathered soils that differed mainly in texture (i.e. loam and clay Acrisol soils). Within each landscape, we investigated reference land uses (lowland forest and secondary forest interspersed with rubber, termed as *jungle rubber*), and oil palm plantations (9-16 years old). We measured soil N_2O and NO fluxes monthly from December 2012 to December 2013. In the oil palm plantations, we also conducted more frequent measurements during 8 weeks following fertilization. In both landscapes, the monthly measured soil N_2O and NO fluxes were not significantly different between oil palm plantations and the reference land-use systems. However, the intensively-measured soil N_2O and NO fluxes during 8 weeks following fertilizer application increased fluxes up to a thousand fold for N_2O and over three hundred fold for NO within small fertilized areas around oil palm trees, resulting in N-oxide (N_2O + NO) emissions of 0.20.7 % $year^{-1}$ of the applied N fertilizer. If we multiply this N fertilizer-induced emission with 0.4 Mha, the increase in areal coverage of oil palm in Jambi from 1996 to 2011, this suggests soil N-oxide emissions of about 56-131 Mg N $year^{-1}$ for typical smallholder fertilization practices.

TREE-STEM EMISSIONS OF N_2O INCREASE WITH FERTILIZER APPLICATION IN LOWLAND TROPICAL OIL PALM PLANTATIONS

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Tropical soils are an important source of nitrous oxide (N_2O) globally, and their source strength can be altered by land-use changes. Studies quantifying N_2O fluxes in tropical regions have shown discrepancies between top-down estimates and bottom-up estimates, suggesting that in addition to gas diffusion directly from the soil to the atmosphere, additional conduits of N_2O from the soil may exist. We investigated whether tree stems from an oil palm plantation in Jambi Province (Sumatra, Indonesia) contributed to the emission of N_2O to the atmosphere, and whether fluxes were affected by application of N fertilizer. We used oven-bag chambers placed around tree stems to quantify N_2O fluxes in situ. Initial results showed that oil palm stems emitted N_2O and that the strength of the N_2O emissions increased markedly after application of N fertilizer to the soil (increasing from 0.8- to 32.8-µg N_2O-N m^{-2} stem surface area h^{-1}). Presently, we are continuing to investigate how these tree-stem N_2O fluxes compare to those from the soil surface and - using 15N tracing - whether N fertilizer added to the soil is indeed the source of N_2O emitted from oil palm stems.

BIODIVERSITY ENRICHMENT IN OIL PALM PLANTATIONS - A LARGE-SCALE, LONG-TERM EXPERIMENT

Holger Kreft[1], Ulrich Brose[2], Damayanti Buchori[3], Yann Clough[4], Martin Ehbrecht[1], Anne Gérard[1], Hendrayanto[3], Dirk Hölscher[1], Bambang Irawan[5], Yeni Mulyani[3], Prijanto Pamungkas[1], Leti Sundawati[3], Miriam Teuscher[1], Meike Wollni[1]

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The magnitude and velocity of the recent oil-palm expansion in South-East Asia and elsewhere challenge any attempt to alleviate the negative impacts of intensively managed plantations on biodiversity and ecosystem functioning. While current conservation strategies focus mostly on conserving forests of high-conservation value either inside of protected areas or as set-asides of large oil palm estates, these opportunities no longer exist in large swaths of South Asia, because forests has already disappeared. This calls for new strategies to restore biodiversity and ecosystem functionality, while considering the livelihood needs of local people. To date, there is very little empirical data and basic knowledge that would be urgently needed to develop sustainability standards and design sustainably managed oil palm landscapes. Here, we report on a recently established interdisciplinary long-term tree planting experiment in an oil palm plantation in Jambi province (Sumatra, Indonesia), one of the hotspots of the oil palm expansion. The experiment addresses three main research questions: 1) Are gap enrichment plantings a suitable measure for biodiversity enrichment in oil palm plantations? 2) Do tree islands act as nuclei for colonization of flora and fauna? 3) What are the socio-economic and ecological trade-offs? In late 2013, we established 56 experimental plots where we systematically varied plot size (5 x 5 m to 40 x 40 m), tree species composition and diversity (ranging from 0 to 6 species). All planted tree species are native to the region, of multiple uses for local people as sources of fruits, latex, and timber and have different ecological traits. We study a suite of variables related to tree growth, ecological services and disservice of tree islands on oil palm, plant-animal interaction, seed rain, plant and animal succession, spatial landscape context, and oil palm yields. Accompanying household surveys are conducted to evaluate the uses of native trees by smallholders and their willingness to adopt tree planting.

THE ROLE OF ANTS, BIRDS AND BATS FOR ECOSYSTEM FUNCTIONS IN OIL PALM PLANTATIONS

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Oil Palm is one of the most rapidly expanding crops in the world, particularly in Malaysia and Indonesia. However, although it is well established that the conversion from rainforest to oil palm has severe impacts on biodiversity, the impacts on ecosystem services following conversion have received less attention. We established a full factorial experiment, excluding ant and flying vertebrates (birds and bats) in six oil palm sites in the lowland of Jambi Province, Sumatra. Manipulation of ant, bird and bat access allows testing the impact of these groups on plants, above- and belowground animal communities, related ecosystem processes and crop yield. We periodically quantified ecosystem processes such as herbivory, predation, decomposition and pollination. Farmers also provided accurate yield measurements throughout the experiment and intensive invertebrate surveys were conducted after 1 year of exclusion. Although we found treatment effects on arthropod predator abundance and all ecosystem functions (decomposition, herbivory and predation), surprisingly, our pervasive treatments did not impact yield significantly, which was rather driven by environmental co-variates. We hypothesize that in our study region, where oil palm has been introduced only one crop cycle ago, oil palm is largely unaffected by arthropods and their associated functions like herbivory and predation.

RETAINING BIODIVERSITY IN INTENSIVE FARMLAND: EPIPHYTE REMOVAL IN OIL PALM PLANTATIONS DOES NOT AFFECT YIELD

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The expansion of agriculture into tropical forest frontiers is one of the primary drivers of the global extinction crisis, resulting in calls to intensify tropical agriculture to reduce demand for more forest land and thus spare land for nature. Intensification is likely to reduce habitat complexity, with profound consequences for biodiversity within agricultural landscapes. Understanding which features of habitat complexity are essential for maintaining biodiversity and associated ecosystem services within agricultural landscapes without compromising productivity is therefore key to limiting the environmental damage associated with producing food intensively. Here we focus on oil palm, a rapidly expanding crop in the tropics and subject to frequent calls for increased intensification. One promoted strategy is to remove epiphytes that cover the trunks of oil palms and we ask whether this treatment affects either biodiversity or yield. We experimentally tested this by removing epiphytes from four-hectare plots and seeing if the biodiversity and production of fruit bunches two months and one year later differed from equivalent control plots where epiphytes were left uncut. We found a species-rich and taxonomically diverse epiphyte community of 58 species from 31 families. Epiphyte removal did not affect the production of fresh fruit bunches, or the species richness and community composition of birds and ants, though the impact on other components of biodiversity remains unknown. We conclude that as they do not adversely affect palm oil production, the diverse epiphyte flora should be left uncut. Our results underscore the importance of experimentally determining the effects of habitat complexity on yield before introducing intensive methods with no discernible benefits.

HOW CAN WE MAXIMISE BIODIVERSITY AND ECOSYSTEM SERVICES IN OIL PALM LANDSCAPES? PROVIDING THE EVIDENCE BASE TO AID BETTER POLICY-MAKING

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The Socially and Environmentally Sustainable Oil palm research (SEnSOR) programme aims to test and improve sustainability standards in oil palm agriculture through policy-relevant scientific research. The industry is currently grappling with how to maximise biodiversity and ecosystem services in the landscape while balancing the demand for increasing palm oil production. To aid more effective policy on this issue, we synthesised new and published data on biodiversity and ecosystem services in oil palm growing regions of Malaysia and Indonesia. Our aim was to determine how well fragmented forest supports biodiversity and ecosystem services in comparison to continuous forest, and whether the land-uses that are important for biodiversity are the same land-uses that are important for carbon storage: a vital ecosystem service for reducing climate change impacts. We present the results of this study and provide recommendations for suitable forest patch size and priority areas for biodiversity and carbon conservation.

THE CONSERVATION SCOPE OF SUSTAINABILITY TOOLS AND INITIATIVES IN THE OIL-PALM INDUSTRY: SCALES, SYNERGIES AND GAPS

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Oil-palm agriculture has been at the center of conservation efforts in the tropics, because of the large-scale deforestation associated to the rapid expansion of this crop. Public pressure has precipitated the creation of various sustainability initiatives aiming to minimize social and environmental impacts of current and future expansion of the oil-palm industry. These initiatives include certification standards (e.g. RSPO, ISPO), zero-deforestation commitments from important industry actors, deforestation moratoriums, and methodological frameworks to aid the identification and avoid conversion of areas of social and environmental importance (e.g. HCV, HCS, HCS+). Although many of these initiatives have had the support from the main stakeholders in the sector, there is a tacit agreement that their success has been limited and many question their effectiveness and credibility.

We conducted a policy analysis on how these different initiatives address the various mechanisms that can result in biodiversity changes in palm-oil producing regions. We identified policy synergies and gaps that may enhance or undermine the effectiveness of these initiatives. We found that habitat loss is the mechanism of biodiversity loss better addressed by the combined implementation of these initiatives, however, their impact is limited to the plantation and thus ineffective at broader scales. Other mechanisms such as fragmentation and migration, which operate at wider spatial and temporal scales that go beyond the plantation and its poductive cycle, can also result in species declines in palm-oil producing landscapes and regions. We argue that current sustainability initiatives in the oil-palm industry fail to address these issues, which compromises their effectiveness for conservation.

Merian Award Applicant

SESSION 14

S14: TROPICAL FOREST LANDSCAPES: FROM ECOLOGY TO SUSTAINABLE MANAGEMENT

Chair: Sven Günter
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BIODIVERSITY CONSERVATION AS FACILITATOR OF DEVELOPMENT IN WEST AFRICA: DEFORESTATION, AGRICULTURE AND SUSTAINABLE DEVELOPMENT IN CÔTE D'IVOIRE

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Côte d'Ivoire is a West African country that is characterized by an outstandingly high biodiversity, which is heavily threatened due to its socio-economic development since independence. The importance of this biodiversity is indicated, on one hand, by the fact that most of the protected areas of the country belong to the global priority zone for the conservation of biodiversity in West Africa (the Upper Guinea biodiversity hot spot); and on the other hand, by the presence of two important UNESCO Biosphere reserves and World Heritage Sites in the country (Taï NP with the last continuous primary moist rain forest in West Africa, and Comoé-NP as largest savannah NP in the region). However, from 1958 to the present, the country lost nearly 90% of its original forest cover (at a rate of 7.6% per year), as well as many species due to exploitative land use practices and conversion of large proportions of natural habitats into cropland triggered by its unprecedented economic growth. A time series record of rainfall from 1958 to now days, shows a north east-south west gradient of aridity highly correlated to deforestation and increased in agricultural areas. We can also notice a decrease in agricultural productivity. Aware of this impacts and long-term socio-economic consequences of such a development, the country has recently committed itself to a sustainable development policy for an emerging economy by 2020. What are the foundations of this new development policy? How can a landscape approach to biodiversity conservation contribute to achieve this goal? What is the contribution of scientific research on biodiversity and climate change in order to enhance sustainable development and a green economy by 2020? These are the questions addressed in this presentation, which represents the vision of the Research Unit on Ecology and Biodiversity of the Research Pole in Environment and Sustainable Development of the University Nangui Abrogoua in Côte d'Ivoire

FRIDAY 09:15

TOOL OR DISASTER - LOGICS AND TRADE-OFFS BEHIND WILDFIRES IN THE OKAVANGO BASIN

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The tropical dry forests and woodlands of south-central Africa are among the world's most frequently burnt ecosystems. It is frequently stated that fire is important for the conservation of African savannahs and that woodland ecosystems are adapted to it. However, for large parts of the region the naturalness of current fire regimes is questionable. There is a lack of analyses bringing together ignition events, resulting fire seasonality and dynamics, and rationales behind man-made fires in south-central Africa. We thus aim to disentangle fire patterns of the forest-savannah mosaic in the Okavango Basin.

We used a 15 year compilation of the MODIS products Active Fire and Burned Area to analysed fire dynamics in different parts of the basin. For each vegetation type we look at seasonal patterns of fires and relate them to land management and vegetation.

Forest and grassland fires in the area are anticyclical to thunderstorms. Thus, fires are rather man made than natural disasters. From north to south, the main fire season shifts from early dry season to late dry season. Along the same gradient the mean size and the radiative power of fires increase. A closer look at fire dynamics reveals a more complex picture, e.g. widespread early season fires in grasslands of the Angolan Plateau while forest fires in the same area peak late in the season.

Our observations indicate that fire is used as a targeted tool to achieve specific purposes, varying according to season and land use system. Sometimes large fires are intended; sometimes local fires get wild, when risky timing promises benefits and affected resources are seen as unlimited.

Understanding the trade-offs of fire application in a given socio-ecological context offers new perspectives to reduce ecological drawbacks. Tree regeneration in the suhumid tropics passes through a bottleneck of 4 to 6 years. During this period the saplings are vulnerable to fire. Therefore, short fire return periods prolong grass rich juvenile stand phases almost ad infinitum. This ‚fire trap' constitutes a tipping point at landscape level between savannahs and forests. Management can tackle the tipping point both ways, e.g. to turn around further degradation of dry tropical forests or to prevent woody encroachment of savannahs.

CONSERVATION PRIORITIES FOR BORNEO'S DIVERSE CARNIVORE COMMUNITY

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Borneo harbours more endemic carnivores than any island except Madagascar and almost half of the Bornean carnivore species have been classified by the IUCN Red List of Threatened Species as threatened. We compiled an occurrence dataset of more than 4000 records, followed by a hierarchical modeling approach to estimate the potential distributions of all cats and small carnivores (20 species) on Borneo based on environmental data and the suitability of current land cover. We find that highest predicted carnivore species richness corresponds to interior lowland, upland and lower montane forest, whereas areas with lowest predicted species diversity are coastal lowlands in the Indonesian provinces, areas which have largely been converted to oil palm plantations. Many of our proposed carnivore conservation landscapes are centred around the tri-national Heart of Borneo initiative though additional areas are required to cater for lowland and wetland species. Using a community perspective, we propose 13 areas of conservation importance for carnivores focusing on large landscapes with an emphasis on connectivity between subunits. A large proportion of these conservation areas are under production and therefore, further efforts on more sustainable management practices are needed. We identify the most important research priorities for Bornean carnivores to be studies on species resilience to altered and fragmented landscapes, studies in undersurveyed regions and the effects of hunting. The most pressing conservation interventions include more targeted conservation research on the most threatened Bornean carnivores, the Bornean Ferret Badger and Hose's Civet, two highland endemics, and the wetland specialists, the Flat-headed Cat and Otter Civet. Though more resources are needed for conservation and research activities, this joint effort of scientists, conservationists and governmental authorities raises hope that more targeted conservation efforts for Bornean carnivores can follow in the upcoming years.

BIRDS, BATS AND WILDLIFE-FRIENDLY FARMING LANDSCAPES IN THE TROPICS - GLOBAL PATTERNS AND REMAINING CHALLENGES

Bea Maas[1,2], Daniel S. Karp[3], Sara Bumrungsri[4], Kevin Darras[2], David Gonthier[5], Joe C.-C. Huang[6], Catherine A. Lindell[7], Josiah J. Maine[8], Laia Mestre[9], Nicole L. Michel[10], Emily B. Morrison[7], Ivette Perfecto[5], Stacy M. Philpott[11], Çagan H. Şekercioğlu[12], Roberta M. Silva[13], Peter J. Taylor[14], Teja Tscharntke[2], Sunshine A. Van Bael[15], Christopher J. Whelan[16], Kimberly Williams-Guillén[5,17]

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[13]Programa de Pós-Graduação em Ecologia e Conservação da Biodiversidade, Universidade Estadual de Santa Cruz, Bahia, BR
[14]School of Life Sciences, University of KwaZulu-Natal, Durban, ZA
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Understanding ecosystem services and their potential impact on human well-being and wildlife-friendly landscape management has become a research focus in ecology - especially because rapid agricultural expansion and intensification is threatening biodiversity and many of Earth's critical life-support systems. Birds and bats have received great attention in this regard because they provide valuable economic benefits to farmers, particularly in the tropics. But only in recent years, the effects of birds and bats on arthropod suppression, multitrophic interactions and crop yield have been evaluated experimentally and in relation to local and landscape factors, to understand their relative importance.

We analyzed the existing body of studies on bird and bat services in forests, cacao, coffee, and mixed fruit orchards across the tropics revealing global patterns of bird and bat predation services – with implications for improved agricultural management. We have reviewed the distribution patterns of insectivorous birds and bats, their local and landscape drivers, and their effects on trophic cascades in tropical ecosystems.

The results of our review showed that for birds, but not bats, community composition and relative importance of functional groups changes conspicuously from forests to agroforests, with reduced representation of insectivores in the latter. The relative importance of birds *versus* bats in regulating pest abundances varies with season, geography and management.

Using examples from individual studies and different tropical regions existing approaches from ecological research and applied landscape management will be discussed together with remaining key questions and challenges on the way to improved wildlife-friendly management.

IMPROVING AND APPLYING OCCUPANCY MODELS TO ASSESS THE BIODIVERSITY CO-BENEFITS OF FOREST CERTIFICATION

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Southeast Asian biodiversity is threatened by the loss and degradation of tropical rainforests. Financial incentives to manage forests sustainably (e.g. certification or carbon storage payments) are assumed to have biodiversity co-benefits. This claim remains little studied for rainforest mammals, which are particularly threatened, but challenging to survey.Occupancy models are a valuable tool for assessing species responses to environmentalchanges, as they estimate occurrence probabilities while accounting for imperfect detection. We useda camera-trapping dataset from three commercial forest reserves with different management histories in Sabah, Malaysian Borneo to 1) assess the potential of high-resolution satellite imagery for generating useful habitat covariates using single-species occupancy models and to 2) quantify biodiversity co-benefits of forest certification with community occupancy models.

Both spatial scale and spatial resolution affected the usefulness of land cover data for explaining occupancy patterns of six small to medium sized species/species groups. Particularly for small, patchily distributed habitat features, high-resolution land cover data had considerably more model support than lower-resolution data. They provide more flexibility in defining appropriate spatial scales and can be used as a surrogate for certain in-situ measures, reducing field effort in difficult environments.

Community occupancy models showed that species richness was higher and threatened species occupied larger areas in the FSC-certified reserve. While the certified reserve held the highest aboveground biomass (AGB), within reserves, mammal richness did not coincide consistently with high AGB, particularly along reserve borders. Combining camera-trapping with community occupancy models provides a powerful, flexible and standardized tool to assess biodiversity co-benefits and can be used to designate areas of high conservation value within the reserves.

ROADLESS SPACE AND LOGGING IN INTACT FOREST LANDSCAPES OF THE CONGO BASIN

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Forest degradation in tropical regions, e.g. through agricultural colonization and unregulated hunting, is often associated with roads built for selective logging. Forest areas that are not accessible by roads are valuable because they provide habitat that is not immediately impacted by major human activities. The protection of such Intact Forest Landscapes (IFL) is high on the biodiversity conservation agenda, leading to calls for better planning and management of road networks especially in forest concessions certified by the Forest Stewardship Council (FSC). A frequently advocated conservation objective is to maximise the retention of "roadless space", a concept that is based on distance to the nearest road from any point. We used the Empty-Space Function - a general statistical tool based on stochastic geometry and random sets theory - to calculate roadless space in a part of the Congo Basin that has recently seen rapid expansion of road networks for selective logging. We compared the temporal development of roadless space in certified and uncertified logging concessions inside and outside areas declared as being IFL in the year 2000. We showed that over the past 15 years roadless space inside IFL has decreased rapidly. Concessions that are now certified by FSC showed a slower rate of decrease before certification but after that their roadless space decreased to a level comparable to non-FSC concessions. Only national parks remained road-free. Interestingly, the established concessions outside IFL showed a slight increase in roadless space due to forest recovery on closed roads. We recommend that forest management should make the preservation of large connected forest areas a top priority by effectively monitoring - and limiting - the occupation of space by roads that are accessible at the same time.

Merian Award Applicant

FOREST MANAGEMENT CERTIFICATION: MANAGEMENT OF INTACT FOREST LANDSCAPES; HCV AND OTHER NEW APPROACHES & RESEARCH NEEDS

Marion Karmann[1], Pasi Miettinen[1]

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The world's remaining Intact Forest Landscapes (IFL) are a global treasure that must be protected and carefully managed.To be lasting, solutions for conflicting interests in forests must be developed through engagement with all relevant actors and within a scope that includes land use rights, social and economic development and ecosystem functions. Forest Stewardship Council (FSC) standards for forest management are a result of such engagement process and include requirements for the protection of environmental values and services from any negative impacts, and also for managing critically important forest areas, known as High Conservation Value Forests (HCVFs). IFLs are one of the categories of the HCVF concept. Under the lead of Greenpeace, the FSC membership confirmed at their General Assembly 2014, that FSC shall direct the development of indicators aiming to protect the vast majorities of IFLs, taking into account scale, intensity and risk of forest management as well as respecting the activities and rights of traditional forest communities. FSC also tests the management and certification of forest ecosystem services (ForCES) and discusses approaches for landscape certification.

The paper provides a summary of current work on the IFL and other new concepts, and will present the biodiversity impact indicators of FSC's Monitoring and Evaluation program. Based on a literature review, case studies, and analysis of certification reports from different tropical countries, the paper demonstrates that certification requirements have reduced negative impacts of conventional forestry on biodiversity. But there remains a critical need to understand more about the effects and long-term outcomes of certification on the ground and for standards to improve in the areas where they could be performing better. The authors invite independent researchers to engage in related topics.

SOCIAL NETWORK ANALYSIS OF THE GOVERNANCE FRAMEWORK IN ECUADOR AS A BASIS FOR SUSTAINABLE MANAGEMENT OF FOREST GENETIC RESOURCES

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Ecuador, a tropical megadiverse country with a dynamic developing economy, concentrates on the conservation of poorly documented native tree species on one side and on the other side aims at increasing its wood production based on few domesticated exotic taxa. National inventories report more than 3,200 tree species; at least 750 of them are harvested from natural forests each year. The existing national plan for productive reforestation of 120,000 hectares until 2022 promotes only 19 tree species, most of them are allochthonous species, and for the indigenous tree species the forest reproductive material is of non-autochthonous origin. Until 2017, another 500,000 hectares are planned for restoration purposes, mainly with autochthonous species from unknown origin. Success of both rather contrasting programmes strongly depends on the provision and efficient management of suitable forest genetic resources. This requires a clear definition of roles of institutions involved and their ability to cooperate in order to balance the multiple demands for ecosystem services.

We described the current political and legal framework, financial mechanisms and the institutional set-up with relation to the status of forest genetic resources in the country. We analysed the implications of these governance aspects on the future diversity of natural forests, planted forests and forest plantations. Stakeholders at national level were identified by the snowball method, and clustered according to their legal competences, factual roles and documented interests. With a social network analysis based on an online survey, in depth interviews and stakeholder workshops, we quantified the architecture of forest governance among the key players in reforestation and restoration in Ecuador. We tested whether those clusters show segregation into conservation and production purposes, whether such configuration is reflected in the political, legal and institutional set-up and how this is linked to the aims of different user groups. Our results reveal institutional barriers, contribute to the development of strategies for sustainable management of forest reproductive material, and offer recommendations for improved governance in the forest genetic resources sector.

Merian Award Applicant

PUTTING THE PIECES TOGETHER: LANDSCAPE FORESTRY IN THE TROPICS

Sven Günter[1], Richard Fischer[1], Margret Köthke[1], Jobst-Michael Schröder[1]

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This presentation concludes the session on “tropical forest landscapes-from ecology to sustainable management”. Tropical forests have to fulfill multiple demands from multiple stakeholders on multiple spatial scales. Despite of notable discrepancy in methods and results, current figures from FAO and Global Forest Watch indicate that deforestation is still alarmingly high and affecting mainly poor countries of the tropics. Increasing population pressure as predicted for the next decades will even increase conflicting aims on land use affecting related local people´s livelihoods and global communities´ demand for ecosystem services. Therefore it appears essential to apply approaches for the integration of different spatial scales in order to analyze deforestation drivers and the consequences for forest related ecosystem services and benefits. Recommendations for an effective allocation of appropriate policy instruments depend on a thorough analysis combining disciplines and scales. Based on the presentations of this session we summarize the most urgent challenges for landscape approaches in science and practice. Using the example of a new project “LaForeT-Landscape Forestry in the Tropics” we show how different pieces of a puzzle could be brought together in order to provide both, a tool for analyzing interactions between social and ecological dimensions as well as a decision support instrument for sustainable policy advice. The presented approach includes different topics such as forest ecosystem assessment, drivers of deforestation, livelihood analysis, opportunity costs, payments for ecosystem services, governance issues, and land use change models.

SESSION 15

S15: GERMAN AND EUROPEAN TROPICAL ECOLOGY AND BIODIVERSITY RESEARCH IN PERU

Chairs: Lily O. Rodriguez & Reiner Zimmermann
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PATTERN AND PROCESS IN ANDEAN BIODIVERSITY

Maximilian Weigend[1], Federico Luebert[1], Corinna Treydte[1], Constantin Poretschkin[1], Tim Boehnert[1], Jens Mutke[1], Juliana Chacón[1]

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Studies in the past years have provided numerous novel insights into Andean biodiversity along the entire Andean chain in Peru. These studies have been carried out in close collaboration with Peruvian colleagues, especially in the generation of novel primary data (specimen records). Biogeographic studies based on georeferenced specimen data - including data from several Peruvian herbaria - reveal detailed patterns of diversity and endemism, highlighting the particular importance of the relatively small Andean forests in the northern part of the country. However, large collection gaps are revealed, especially on the eastern slope of the Andes. Similarly, studies in arid southern Peru (Moquegua) show that diversity has also been underestimated there and that the common assumption that there is a dramatic species turn-over towards Chile may be largely an artefact. Across the Andes, new species are continuously being discovered at all elevations. In face of pressures from mining, agriculture and climate change, detailed species distribution patterns and a profound understanding of diversity patterns are urgently required in order to provide a basis for formulating conservation priorities.

FRIDAY 11:00

ANNUAL TREE GROWTH DYNAMICS AND WATER USE ALONG AN ALTITUDINAL GRADIENT AT THE ISOLATED WEST AMAZON MOUNTAIN RANGE „EL SIRA“ IN PERU

Armin Niessner[1], Reiner Zimmermann[1], Sabine Remmele[1], Manfred Küppers[1], Luis Valenzuela[2]

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Annual tree growth dynamics and water use of dominant forest tree species from the West Amazon Mountain Range El Sira in Peru was studied, within a series of observation sites along an altitudinal transect reaching from 275 m up to 2230 m a.s.l. It covers pristine lowland, pre-montane, montane, cloud and elfin forests at the west flank of the cordillera El Sira, a completely isolated and unpopulated mountain range emerging from the surrounding Amazon lowland forests. Mean annual temperature decreases from 26 °C at the lowland forest to 15 °C at the elfin forest site, while precipitation increases from about 2500 mm to more than 6000 mm per year. This climatical gradient is accompanied by a decrease in tree species diversity from about 200 species/ha at the lowland forest to about 50 species/ha at the elfin forest. Canopy height decreases from about 40 m with emerging individuals up to 60 m at lowland to about 4 m at the elfin forest.

Radial stem growth rates of dominant tree species in each forest type were observed with point dendrometers from 2011 to 2015. Additionally in 2013 xylem sap density was observed at the lowland forest, cloud forest and elfin forest, and compared with daily variations in stem diameter. Mean annual radial increment decreases from about 5 mm at the lowland forest (up to 12 mm) to 2 mm at the elfin forest (up to 6 mm). Within all sites different patterns of annual stem growth were observed, although seasonality in increment was more pronounced in lowland forest species and continuous increment was more common at elfin forest tree species.

Brief periods (several days) of stem shrinkage are coinciding with consecutive days of no precipitation. This indicates a high variation of the wood hydraulic status of the stem to water supply shortages from the roots while transpiration is obviously maintained. We assume that the occurrence of prolonged periods of drought, -as expected by future climatic changes in the Amazon Basin-, will result in drought damage to lowland forests as well as montane tropical elfin forests.

ESTACIÓN BIOLÓGICA QUEBRADA BLANCO – RESEARCH OPPORTUNITIES IN THE PERUVIAN AMAZON LOWLANDS

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Founded by the Proyecto Peruano de Primatología (Peruvian Primatological Project) in 1984, the Estación Biológica Quebrada Blanco (EBQB) is run by the German Primate Center (DPZ) since 1997. Despite its closeness to the major Amazonian city of Iquitos (90 km), it is located in primary forest where anthropogenic disturbance is largely restricted to the margins of the small Blanco stream. Within the study area, there is a gradient from land inundated for a few days to weeks during the rainy season to non-floodable terra firme-forest, and within the terra firme forest there are gradients of soil fertility. A small part of the study area is covered by secondary forest regenerating from a buffalo pasture abandoned since 2001. Research at EBQB has largely focused on the ecology and behaviour of small and medium-sized New World primates, with an emphasis on primate-plant interactions. Preliminary inventories are available for trees (>20 cm dbh), ferns, amphibians, birds, non-flying mammals and bats, but detailed ecological studies on taxa other than primates are scarce. EBQB is open to researchers from all fields of tropical ecology. Collaborative projects on organisms other than primates and involving Peruvian partners are particularly welcome.

AMAZONIAN PEATLANDS: VULNERABILITY AND OPPORTUNITIES FOR CONSERVATION AND LONG-TERM CARBON STORAGE

Katy Roucoux[1], Ian Lawson[1], Timothy Baker[2], Denis Del Castillo Torres[3], Frederick Draper[2], Ouit Lahteenoja[4], Michael Gilmore[6], Euridice Honorio Coronado[3], Thomas Kelly[1], Edward Mitchard[5], Corine Vriesendorp[7]

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Peatlands recently described in the Peruvian Amazon store substantial amounts of below-ground carbon (BGC). They harbor endemic plant and animal species, support the regional economy and represent areas of cultural and spiritual importance for local communities. The full range and importance of this suite of values are still poorly understood but it is clear that these ecosystems now face an unprecedented level of threat. In this poster we map and evaluate the threats to the largest peatland complex in Amazonia, the Pastaza-Marañón basin in Peru. The hydrological balance of these peatlands, critical for their carbon storage and ecology, is primarily threatened by conversion to agricultural uses, new roads and railways, dams/hydroelectric projects and climate change. We identify opportunities for avoiding or mitigating these threats to ensure the long-term function these peatlands as an area of carbon storage and to prevent the degradation of these ecosystems reaching the alarming levels of their counterparts in SE Asia. Peatlands do not figure in Peru's existing regional strategies for biodiversity conservation or climate change (e.g., Loreto's *Estrategia para Diversidad Biologica* or *Estrategia para Cambio Climatico*) although they are considered within Peru's national wetland conservation strategy (*Estrategia para Conservación de Humedales*). Research priorities include providing regional and national agencies with a comprehensive map of Amazonian peatlands, improving our understanding of the sensitivity of Amazonian peatlands to climate change (especially via its effect on flood/drought periodicity), and establishing an effective peatland monitoring and management programme.

GLOBAL CARBON MARKETS, DEFORESTATION AND THE LIVELIHOODS OF SMALLHOLDERS IN THE PERUVIAN AMAZON

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Reducing tropical deforestation is a necessary condition for mitigating climate change, and could become an important source of revenue for developing countries through financing mechanisms such as REDD (Reducing Emissions from Deforestation and forest Degradation). But what is at stake for those people actually responsible for deforestation? The question is particularly relevant in Peru where forest cover is lost largely due to the fine-grained conversion to agriculture by smallholder farmers. Incentives to reduce deforestation could potentially provide additional income for farmers as a reward for forest conservation, but they may also curtail their access to and use of land. We examine the implications of REDD for smallholders in the Peruvian Amazon by using a case study of the Alto Mayo Conservation Forest (AMCF) in Peru. This pilot REDD project is funded through the sale of carbon credits in the voluntary market, thus offering a window into the relationship between local processes of land use change, and decisions and actions by state actors, NGOs and international carbon brokers. Based on interviews with key state and private actors, we found that private REDD projects such as AMCF are distinct from an eventual national REDD strategy: currently REDD is a means through which private NGOs fund local conservation and social development projects, but nationally REDD funds are planned to be funneled into large-scale reforms, e.g. of land use planning. For smallholders, participation in current REDD projects may result in modest gains despite the relatively low value of carbon in international markets, largely because REDD funds buttress long-standing interventions and complement other sources of funding. The planned implementation of a national strategy, on the other hand, does not consider smallholders as direct beneficiaries; instead, it may fundamentally alter some of the key ways in which they to access land, particularly those who lack formal land titles. In sum, the current project-level approach appears to be good for smallholders, but it is unlikely that it can be scaled up or make a significant dent on deforestation; conversely, a national REDD strategy has the chance to finance the reforms needed to address the drivers of deforestation, but it paints an uncertain picture for smallholders' livelihoods.

TROPICAL ECOLOGY AND BIODIVERSITY RESEARCH IN PERU: AN OVERVIEW

Lily Rodriguez[1,2]

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Peru ranks among the ten most biodiverse countries of the world. Since the 18th century, from Humboldt up to now, many researchers have been assessing and studying different aspects of the ecology and biodiversity of this tropical country. With an analysis of over 100 scientific papers, we present an overview of the state of the art, the research questions across ecosystems and taxa. We also identify some challenges (related to accessibility, permits and partnerships) gaps and opportunities and sites studied to m improve the knowledge and strenght collaborations, including with neighboring countries. This should contribute to a greater understanding of the diversity, uniqueness and the functioning of biodiversity and ecosystem services, of the terrestrial ecosystems of the Andean - Amazonian region and the Pacific coast.

SESSION 16

S16: PATTERNS AND PROCESSES OF SPECIES DOMINANCE IN TROPICAL FORESTS

Chairs: Gabriel Arellano & Manuel J. Macía
Contact: gabriel.arellano.torres@gmail.com

PATTERNS OF DOMINANCE IN TREE COMMUNITIES VARY ACROSS THE MAJOR BIOMES OF LOWLAND TROPICAL SOUTH AMERICA

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Amazonian forests are exceptionally diverse in terms of the numbers of tree species present, but recent studies have demonstrated they are generally dominated by relatively few species compared to their total species richness. The Amazon represents one of the principal biomes in lowland tropical South America, rain forest, but there are others. Seasonally dry tropical forests and savannas also occupy large geographic areas of lowland tropical South America. Here, we examine patterns of dominance in these two drier biomes and compare and contrast our results with those from the rain forest biome. While having relatively few species compared to rain forests, savannas in South America seem to show similar dominance patterns, in terms of the proportion of species that represent the majority of individuals. In contrast, seasonally dry tropical forests do not show this pattern. Rather, different dry forests seem to be dominated by different species. This may be due to the fragmented distribution of seasonally dry tropical forests in South America, which contrasts with the continuous distribution of the Amazon and most South American savannas (i.e. those in the Cerrado).

FRIDAY 13:30

HYPERDOMINANCE IN AMAZONIAN FOREST CARBON CYCLING

Sophie Fauset[1], Michelle O. Johnson[1], Manuel Gloor[1], Timothy R. Baker[1], Abel M. Monteagudo[2], Roel J.W. Brienen[1], Ted R. Feldpausch[1], Gabriela Lopez-Gonzalez[1], Yadvinder Malhi[4], Hans ter Steege[5], Nigel C.A. Pitman[6,7], Oliver L. Phillips[1]

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The extraordinary diversity of Amazonian forests conceals that tree abundance is strongly skewed towards relatively few 'hyperdominant' species. In addition to their diversity, Amazonian trees are a key component of the global carbon cycle, assimilating and storing more carbon than any other ecosystem on Earth. Using a unique dataset of 530 botanically identified forest plots, including 229 where biomass dynamics have been monitored through time, we address whether hyperdominance is relevant for carbon cycling.In particular, we ask whether the functions of storing and processing carbon are concentrated in a small number of species, whether the most dominant species for carbon cycling are also the most abundant, and whether dominant species are characterized by specific functional traits. We find that dominance of forest function is even more concentrated in a few species than is dominance of tree abundance. Whilst those species that contribute most to biomass and productivity are often abundant, species maximum size also has a critical role. When assessing the data on a regional basis, we find that species that dominate carbon stocks are productivity across the basin are typically more restricted to a small number of Amazon regions than species that dominate stem numbers, suggesting a stronger environmental constraints on the ability of a species to dominate a community's metabolism than only to persist in it.

WHY RIVERS MAKE THE DIFFERENCE: A REVIEW ON THE PHYTOGEOGRAPHY OF RIVER WETLANDS IN THE AMAZON BASIN

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While the importance of rivers in biogeographic pattern is globally recognized across climates and vegetation zones, little attention has been paid to their role in the phytogeography of the Amazon basin. This is particularly surprising as the Amazonian "wet-scape" - including the largest and most water voluminous rivers on Earth - supports the highest levels of freshwater biodiversity worldwide. It has also been pivotal to human civilization since pre-Columbian times. Here, we review knowledge on the importance of river wetlands on Amazonian phytogeography with special emphasis on trees - the dominant life form of tropical wetlands. Differing degrees of flooding represent major shifts in predominating ecological filters by altering the immediate abiotic environment through oxygen deficiency and related stressors, as well as by altering the bioavailability of diverse resources through complex phisico-chemical processes. In this way wetlands strongly influence the spatial distributions of species and their functional traits, acting as important corridors for invasion and range expansion of both native and exotic taxa. We content that these processes have shaped the biogeography of the Amazon flora over evolutionary time-scales. We also highlight the role of river wetlands as a prevalent driver of speciation and diversification in the Amazon basin.

MONODOMINANCE IN TROPICAL FORESTS: MODELLING REVEALS EMERGING CLUSTERS & PHASE TRANSITIONS

Martin Kazmierczak2, Pia Backmann1,2, José Fedriani2,3,4, Rico Fischer2, A Hartmann5, Andreas Huth2, Felix May1,2, Michael S. Müller2, Franziska Taubert2, Volker Grimm1,2, Jürgen Groeneveld1,2

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Tropical forests are a prime example of highly diverse tree communities. However, within such forests, large patches that are dominated by a single tree species sometimes occur. The myriad of presumed mechanisms that lead to the emergence of such monodominant areas is currently the subject of an exciting debate. We selected a combination of two promising mechanisms, i.e., the large seed mass and low dispersal ability of the candidate monodominant species, to develop a spatially explicit model in which seven identical species with long-distance dispersal of small seeds compete with one potentially monodominant species with short-distance dispersal of large seeds. Monodominant patches emerged and persisted only for a narrow range of species attributes showing all of the characteristic features of a phase transition from spatially mixed forests to a state where the candidate species outcompetes all other species. This indicates that percolation theory and in particular specific spatial configurations could, in combination with colonization-competition trade-offs, provide a main explanation for the emergence of mondominant clusters in species-rich tropical forests.

OLIGARCHICITY OR CO-DOMINANCE ACROSS SCALES IN TROPICAL FORESTS

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In species-rich tropical forests, description and classification of vegetation types is methodologically challenging and poorly developed. How to overcome the high patchiness and unpredictability of these ecosystems to grasp the 'main picture' is a major open question. Tropical forests seem to be dominated by a limited set of abundant and frequent species (the 'oligarchy hypothesis'), but it is unclear at which spatial scales this pattern applies. I.e.: To which scale the terms 'oligarchies' and 'oligarchs' refer? We performed an explicit evaluation of the spatial scales relevant for species-level and community-level oligarchic patterns along a 4000 m elevation gradient from the Amazon to the high Andean forests in the Madidi region of Bolivia. We found that the regional oligarchy was not a unique block of oligarch species dominating at the regional scale: in most cases the oligarchs included were representative of particular habitats or characteristically dominant at much smaller scales. We also found that oligarchicity or co-dominance is a phenomenon with two faces: (1) broad oligarchies that dominate communities with contrasting floristic composition. I.e.: the species turnover is high, but common species are common in different places. And (2) much narrower oligarchies: different communities can share the same species while being dominated by totally different sets of species, indicating that the oligarchs in one place are rare in the other, and *viceversa*. Our main conclusion is that oligarchicity or co-dominance is a general phenomenon, independent of beta diversity, that occurs at any geographical scale within tropical forests.

THE TREE DIVERSITY-PRODUCTIVITY RELATIONSHIP IN TROPICAL FORESTS - A PLOT-LEVEL STUDY IN ECUADOR AND A COMPARISON OF BIOMES

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Research into the relationship between species richness and ecosystem function has recently focused on forests, but not much is known for tropical forests. One would assume that positive diversity effects through complementarity, facilitation or sampling effects should be particularly pronounced in tropical forests with their generally high tree species richness. Experimental studies with tropical tree plantations differing in species diversity in Panama, southern China and elsewhere produced mixed effects. Here we present the results of an in-depth study of aboveground forest productivity (coarse wood production and fine litter production) in 84 plots of 0.04 ha (20 m x 20 m) in tropical montane forests (1000 – 3000 m a.s.l.) in two regions on the eastern and southern slopes of the Ecuadorian Andes, in which we related productivity to tree species richness and additionally to 10 measured soil chemical parameters, elevation and parameters of forest structure. Study aim was to identify the most influential abiotic drivers of tropical forest productivity and to search for a positive diversity effect. While various soil chemical and stand structural parameters controlled productivity together with elevations (as a proxy of temperature und partly also precipitation) in both regions, tree species diversity had no consistent influence. Thus, species-richer plots were in general not more productive than species-poorer ones. This finding is in line with the result of a biome comparison of NPP data from tropical moist forests and temperate broad-leaved forests of the northern hemisphere. When expressed on a daily basis, species-rich tropical forests were found to be on average not more productive than species-poor or monodominant temperate forests; the difference in annual NPP was fully explained by the longer vegetation period in the tropics, while the large tree diversity difference between the two biomes seemed to be of no relevance.

LONG-TERM FORESTS COMPOSITION AND DIVERSITY CHANGE ON THE EASTERN ANDEAN FLANK IN WESTERN AMAZONIA (ECUADOR)

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Neotropical forests communities have assembled over the last c. 10,000 years and contain long-lived species (100-1000's year life cycle). However, our understanding of Neotropical forests is based mainly on ecological observations collected over short-time scales (<30 years). The paucity of long-term (>100 year) data currently restricts our understanding of tropical forest composition and diversity. Trends in diversity are especially difficult to assess in the Neotropics due to the: (a) high number of taxa, (b) complex multi-level trophic interactions, and (c) large spatial and temporal scales. Here we present palaeoecological data from the eastern Andean flank obtained from sediment cores raised from Lake Pindo (1250 m a.s.l.; 1°27'S, 78°05'W), spanning the last c. 50,000 years. To explore the long-term dynamics of past forests we examined three key aspects of the fossil record: (a) pollen/spores (vegetation community composition and diversity), (b) charcoal (prevalence of fire), and (c) stable isotopes (primary productivity).

The last 50,000 years spans a major global climatic transition, from cold glacial conditions to warm interglacial conditions (between c. 15,000 and 10,000 years ago). The fossil pollen record from Lake Pindo reveals that: (a) throughout the last 50,000 years Melastomataceae species dominated the forest, (b) during the last glacial period a stable forest community existed that contained taxa today commonly found at higher (cooler) elevations (including *Podocarpus* and *Myrica*), (c) following the transition to globally warmer temperatures vegetation β-diversity (traits) increased, but species richness remained similar, and (d) during the last 3000 years there is a dramatic increase in the richness and diversity of the vegetation. The Lake Pindo record shows distinctive changes to the vegetation composition and diversity over the last 50,000 years, and that the vegetation of the last 3000 years is the most diverse and dynamic (high turnover).

TREE STRUCTURE, SPECIES COMPOSITION, AND DOMINANCE ALONG A SUCCESSION GRADIENT IN A CLOUD FOREST IN THE VENEZUELAN ANDES

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Very little is known about how dynamics of recovery after disturbance of Tropical Mountain Cloud Forests (TMCFs) impact their ecosystem properties. Current efforts to reduce the scale of human incursions into TMCFs could profit from a better understanding of the rates and trajectories of forest recovery that can be anticipated following forest harvest. We compare a pristine forest and a 34-year old succession forest in terms of forest structure, tree species richness, dominance, and composition. Results indicate that species richness per plot recovered early in the succession process. Species dominance decreases from ca. 50% basal area (*Alchornea grandiflora* and *Ruagea pubescens*) 10 years after clear-cut to ca. 35% basal area (*Zanthoxylum melanostictum* and *Alchornea grandiflora*) 34 years after deforestation. This strong dominance is not observed in the pristine forest where *Clusia multiflora* and *Retrophyllum rospigliosii* only represent 18% of the total basal area, suggesting a slow recovery of low species dominance. However, all species present at the start of the recovery process were also found in the primary forest plots. We suggest that this pattern also results from the lack of true pioneer or other high light demanding species in this TMCF region that rarely experiences large-scale disturbances. Species richness recovers earlier than basal area, probably as a result of slow growth due to radiation limitations. The results of this study have strong implications for understanding of cloud forest dynamics and their capacity to recover from large disturbances, as well as for diversity conservation and restoration strategies.

SESSION 17

S17: LINKING FUNCTIONAL TRAITS WITH ECOSYSTEM PROCESSES ALONG TROPICAL ENVIRONMENTAL GRADIENTS

Chairs: Imma Oliveras & Masha van der Sande
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TRAITS AND PROCESSES ALONG AN ENVIRONMENTAL GRADIENT IN THE ANDES: NEW INSIGHTS FROM THE CHAMBASA PROJECT

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In 2013 we conducted an extensive plant traits collection gradient along a 3300 m elevation gradient in the Peruvian Andes, focusing on ten sample plots where we had comprehensive measures of ecosystem productivity and carbon dynamics, and coupled with airborne measurement of lidar and canopy hyperspectral properties. This project was named CHAMBASA. Here we report a synthesis of key results and recent papers emerging from this work. This includes (i) an examination of how key morphological and chemical traits vary with elevation and why, in both their mean values and distributions; (ii) an exploration of new ‚hard' traits including leaf venation and leaf wax content and how they covary with other traits; (iii) an exploration of how feasible it is to scale up from field campaign sampling of traits to the wider landscape and samples by airborne remote sensing; (iv) an exploration of the links between plant traits and ecosystem processes such as carbon dynamics.

DOES TRAIT DIVERSITY INSURE THE LONG-TERM STABILITY OF BIOMASS AND PRODUCTIVITY IN TROPICAL DRY AND WET FOREST?

Masha van der Sande[1], Boris Sakschewski[2], Eric Arets[3], Werner von Bloh[2], Alice Boit[2], Marielos Peña-Claros[1], Kirsten Thonicke[2], Lourens Poorter[1]

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Diversity has been shown to increase biomass stocks and productivity in tropical forests. It is, however, still unclear how diversity determines the long-term stability of biomass stocks and productivity. The insurance hypothesis predicts that species respond differently to environmental fluctuations and in this way high diversity would insure long-term ecosystem functioning. This idea has been tested and verified by theoretical and experimental studies on grasslands and temperate forests, but has yet not been evaluated for highly diverse tropical forests. Whereas most studies have focused on species richness, the traits of these species, and thus the functional trait diversity, should better predict the community's response to environmental changes.

We used a process-based dynamic global vegetation model which incorporates higher levels of functional diversity (LPJmL-FIT), to evaluate how trait diversity influences the long-term functioning of tropical forests. More specifically, we test the hypothesis that decreasing the natural range of a leaf trait (specific leaf area) and a stem trait (wood density) decreases the long-term mean and stability of biomass and productivity in response to inter-annual climatic fluctuations, due to a reduction in insurance effect. If reduction in insurance effect indeed causes the loss of stability, then we would see a reduction in the asynchrony in species' responses (in terms of biomass or productivity) to environmental fluctuations. We tested these hypotheses for a wet and dry tropical forest, to evaluate how mechanisms underlying the diversity–stability relationship depend on climate.

Merian Award Applicant

LINKING HYDRAULIC ARCHITECTURE, ABOVEGROUND TREE GROWTH AND SAP FLOW VELOCITY IN TROPICAL LOWLAND AND MOUNTAIN FORESTS IN INDONESIA

Martyna Kotowska[1], Alexander Röll[1], Dietrich Hertel[1], Dirk Hölscher[1], Christoph Leuschner[1], Aiyen Toja[2], Bernhard Schuldt[1]

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Current research has shown that global variation in net primary production (NPP) can be largely explained by total stand biomass combined with annual amount of precipitation. While global temperatures are predicted to increase in large areas, precipitation is expected to become more irregular and scarce also in South-East Asia. Particularly here, natural tropical rainforest are most severely threatened by deforestation and land-use change. Knowing that large trees are not only the main target of logging activities, but are also showing higher mortality rates after extensive droughts, the consequences of ongoing land-use change on ecosystem functions are severe.

We hypothesize that there is a tight correlation between tree size as well as productivity and potential hydraulic conductivity (*K*P) in addition to actual water use. To reveal this relationship, we investigated wood hydraulic architecture, water use estimated from sap flux measurements and aboveground woody biomass increment for up to 205 trees of 68 species in moist lowland tropical rainforest on Sumatra and perhumid montane rainforest on Sulawesi. Our results demonstrate that the largest trees not only had the highest water use, but also showed the highest aboveground woody increment linked with highest *K*P values across all species. These findings emphasize that water use and productivity in tropical rainforests are essentially driven by large trees whose removal can severely affect the hydraulic cycle causing less precipitation recycling and thus leading to more frequent drought events and higher tree mortality creating a negative feedback loop throughout the wet tropics.

THE EFFECT OF DIVERSITY, TRAITS AND ENVIRONMENT ON BIOMASS DYNAMICS ACROSS NEOTROPICAL FORESTS

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Tropical forests store and sequester large amounts of caron, and are therefore important for global climate change mitigation. Few studies have, however, tried to disentable (a) biotic drivers of biomass dynamics in tropical forests, and those that have done so were at local scale and show contrasting results. During this presentation, I will show how abiotic drivers (climate, light, and soil properties) and biotic drivers (forest structure, species diversity, and community mean traits) shape biomass dynamics across Neotropical forests. More specifically, we tease apart some leading hypothesed explaining biomass stocks and dynamics: the niche complementarity hypothesis (through high species diversity), the mass-ratio hypothesis (through community mean traits), and environmental effects.

We evaluated 10 years of biomass dynamics for 180 plots across 24 forests. We tested (in) direct effects of (a)biotic drivers on biomass stocks and dynamics (biomass growth by recruiting trees and already established trees, and biomass loss due to mortality) using structural equation models. Our results highlight the importance of niche complementarity and, to a lesser extent, mass-ratio for biomass stocks and dynamics across Neotropical forests. Our results also indicate the need to look at different biodiversity attributes to better understand the role of biodiversity on climate change mitigation.

WHAT IS THE ROLE OF INTER- AND INTRASPECIFIC VARIATION ACROSS DIFFERENT ENVIRONMENTAL GRADIENTS?

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Ongoing global change is affecting ecosystem functioning of all biomes of the world. Environmental gradients are natural laboratories in which changes in the abiotic conditions and disturbance regimes that characterise may result in rapid changes on species composition and ecosystem productivity. Intra- and inter-specific variation can play a fundamental role in plant community responses to environmental change and community assembly. Here we quantify the strength and direction of inter- and intraspecific plant community trait responses along an altitudinal gradient in Peru and a forest-savanna vegetation gradient in Brazil. We measured the following leaf traits: Maximum photosynthetic capacity, N, P, K concentrations, leaf mass per area, dry mass content and leaf thickness. Traits were measured in all species contributing to 80% of the basal area in ten one hectare plots along the environmental gradient and in four one hectare plots along the vegetation gradient. We found different effects of intra- and inter-specific variations along the two environmental gradients.

DETECTING CARBON CYCLE PROCESSES FROM ABOVE: FIRST STEPS TOWARDS SCALING TO LANDSCAPES AND BEYOND

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Understanding the determinants of forest productivity comprises one of the grand questions in Ecology. While total photosynthesis (or Gross Primary Productivity) can be estimated with remote sensing, estimating the amount of carbon actually fixed into biomass per time (Net Primary Productivity, or NPP) has remained elusive. Even more elusive is how NPP will change with climate and across space, yet this interaction has large implications for the earth system under climate warming. Predicting NPP changes requires mechanistic understanding of the processes underlying NPP and their relationship with climate, composition, and other factors. In this study, we couple spectral reflectance data from the Carnegie Airborne Observatory with subcomponents of the tropical forest carbon cycle as measured in 36 Global Ecosystem Monitoring subplots across a transect from the Andes to the Amazon. We find that many subcomponents of the carbon cycle (leaf production, root production and respiration, and soil respiration among others) are well-predicted by spectral reflectance of the forest canopy, and that this predictive power comes from particular leaf chemical signatures. This study represents a first step towards understanding carbon cycle mechanisms across larger landscapes and regions.

SESSION 18

S18: KNOWING THE UNKNOWN, MAKING THE MOST OF SCANT DATA ON RARE SPECIES AND ECOSYSTEMS

Chair: Alice C. Hughes
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UNDERSTANDING ENDEMISM

Alice Hughes[1]

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Though rare species occur throughout the environment there are certain ecosystems which have particularly high numbers of rare and endemic species, due to the topography and biogeography of such regions. Though modeling the distribution of such species on an individual basis is almost impossible due small sample sizes and very small areas.

Here we explore methods to map and explore the distribution of such ecosystems, and how we can circumvent the possible issues around rare species. Using novel combinations of aggregating environmental, topographic and species data we can better understand the distribution of such systems and the probable degree of endemism, even without the need for exhaustive sampling.

During this talk we will take two main approaches, one an intensive analysis of probable patterns of endemism in the naturally fragmented karst ecosystems of Southeast Asia, which makes up around 800000km^2 of the region and which due to high levels of specialism and poor dispersal in much of it's biota also shows very high levels of highly localized endemism.

Secondly we work with the new "Redlist of Ecosystems' to review the probable localized endemism of various ecosystems relative to their topography, and explore various mechanisms that could be used to prioritise ecosystems with the greatest levels of endemism, and probable local risk of ecosystem level destruction or disruption.

KNOWING THE UNKNOWN OF SPECIES INTERACTION NETWORKS

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The interactions among species represent a crucial component of biodiversity. Sampling the network of interactions among coexisting species is labour intensive, and most, if not all, "complete" interaction networks are in reality incomplete. I will discuss three ways forward to circumvent this issue: 1) If *sampling* numerous networks across either space or time, and wanting to compare these despite of limited sampling and thus incomplete networks, which network metrics can you trust, and which can you not trust? Also, which modelling techniques should be used when comparing the networks? 2) Alternatively to sample networks, you may *infer* networks, either based one species traits or other alternative approaches. Here I suggest such alternative approaches using: A) *knowledge of local hunters (i.e. interviews)* in gathering biodiversity data, both species occurrence and their interactions with plants; and B) *Citizen science* could be another way of circumventing the huge sampling effort needed to sampling networks. I will discuss and illustrate above using various case studies from a range of terrestrial ecosystems, ranging from hummingbird-plant networks in Brazil and Colombia, frugivorous bird-plant networks across the world, big mammals and birds and their interactions with fruit producing trees in fragmented landscapes in Brazil, to fungi and their tree hosts in Denmark.

THE EFFECT OF LANDSCAPE AND ROCK TYPE IN THE GENETIC STRUCTURE, POPULATION DEMOGRAPHY AND PHENOTYPIC DIVERGENCE OF NEOTROPICAL MONTANE ORCHID

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Knowledge of the role of landscapes in shaping genetic connectivity and adaptation is essential for understanding the evolutionary processes that have shaped species diversity pattern in Neotropical regions. Neotropical montane ecosystems are highly heterogeneous but little is known about the major drivers of species divergence. In the present study, we examinedhow montane landscape is associated with genetic structure and gene flow and explored the effect of rock outcrop type in demographic structure, morphological variability and reproductive strategies of *Cattleya liliputana* (Orchidaceae). Nuclear microsatellite markers and next-generation sequencing were used for genetic analyses. Spatial Bayesian clustering and population-based analyses revealed significant genetic structuring and high diversity. Strong differentiation was found between populations over short spatial scales. Divergent genetic groups showed phenotypic divergence in flower traits and reproductive strategies. Approximate Bayesian Computation modelling suggested low gene flow between genetic groups at different rock outcrop and signs of population bottleneck. Demographic structure and reproductive investment was associated with rock outcrop type and may be a response to divergent selective pressures. Divergent habitat and restricted gene flow may be the main drivers of population differentiation. Therefore, genetic structure and rock type adaptation should be considered for an efficient conservation planning in Neotropical montane rock outcrops.

FOUR IN ONE: CRYPTIC SPECIES IN THE GENUS *MEGALOPREPUS* (ODONATA: ZYGOPTERA)

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Cryptic species still represent a great challenge for taxonomists. Unraveling and describing a significant percentage of this unknown biodiversity has enormous implications for conservation planning. In modern analysis of lineage divergence, critical criteria for species delimitation are investigated mutually, and concordant results in several characters finally allow species determination. Success highly correlates with the inclusion of complete species distributional ranges. However, *Megaloprepus* is a damselfly genus where diversification has been assumed for a long time but never proved yet.

In a comprehensive study, population genetic analysis of nine populations from southern Mexico to Colombia were combined with a morphological data set based on field collections and museum material. The analysis of three mitochondrial and one nuclear sequence marker resulted in high population structuring and a strict separation into three distinct groups (min. 10.3 % in CO1). The additional morphological assay included linear and geometric morphometrics of 67 individuals. Very interestingly this analysis was significantly separating the genus into four species groups, which differ in wing shape, coloration, and size. Three of those four groups are in concordance with the genetically investigated Central American and Pacific-Colombian forms. The fourth group only includes 100 years old individuals from the east side of the Andes belonging to the American Museum of Natural History. Consequently, these results strongly support a radiation of the genus *Megaloprepus* into four distinct lineagesthat are distributed across four geographically restricted and independent areas. As a consequence, we postulate the first cryptic damselfly species to our knowledge.

All over tropical America from Mexico to Peru *Megaloprepus* inhabits a narrow ecological niche. This strong adaptation could have favored a non-adaptive mode of speciation and therefore slow down morphological divergence. The diversification of the damselfly genus *Megaloprepus* may additionally provide insights into the highly complex pattern of biodiversity in Neotropical primary forests in general.

SCIENTIFIC POSTER SESSION - ABSTRACTS

DOES BABOON SEED DISPERSAL PROMOTE INVASION BY *OPUNTIA*?

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Several species of *Opuntia* have become invasive throughout dry areas of Africa and Arabia. The success of this invasion is due to its exploitation of *Opuntia* fruits and platyclades as food for people and livestock. The successful range expansion of *Opuntia* could also be based on invading seed dispersal networks. Here we provide tentative evidence that seed dispersal by hamadryas baboons, *Papio hamadryas*, can contribute to the range expansion of *Opuntia* in Eritrea. Baboons feed seasonally on *Opuntia* fruits and year-round on platyclades. While *Opuntia* seeds are occasionally preyed upon, they are more often dispersed through defecations. As baboons have long daily travel paths, but consistently use a few cliffs for sleeping, they can disperse seeds over large areas but also concentrate seeds at focal points. Seed dispersal of *Opuntia* baboons and other primates needs to be considered in conflict resolution between the interests of farmers who appreciate *Opuntia* as food for their livestock and conservationist who want to eradicate *Opuntia* in order to protect the autochthonous flora.

VEGETATION COMPOSITION AND FUNCTIONAL DIVERSITY ALONG ENVIRONMENTAL GRADIENTS IN A SOUTHERN AFRICAN SAVANNA

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Savannas are tropical ecosystems that cover about 15 - 35 % of the global land surface. They are characterised by a high seasonality and the coexistence of trees and grasses, which is driven by complex interactions of climate, fire, herbivory and land use. This interplay has already been subject of numerous studies but there is still an ongoing debate about the individual and synergetic contributions to the determination of vegetation patterns by means of structure and composition.
The following study is conducted along a southwest-northeast gradient in northeast Namibia, that reflects a variety of climatic conditions, vegetation types, land use and fire histories. We investigate functional and floristic differences as well as diversity patterns on seventy-five sites with a homogenous vegetation structure and similar soil characteristics (Kalahari sand) but contrasting environmental factors. Following a randomly stratified sampling approach we established three 25 x 2 m transects for each site to record every woody plant taller than fifty centimetres and measured functional traits, particularly in response to fire and herbivores, for plants taller than two meters. Therefore we estimated categorical defence traits (e.g. spinescence) and resprouting characteristics and measured quantitative traits (e.g. specific leaf area, relative bark thickness, bark moisture content and apical dominance index) for woody individuals. Analysis performed with classification methods, non-metric multidimensional scaling and an R-mode linked to Q-mode (RLQ) analysis provide deeper insights to the relationship between the trait structure and the environmental variables for each site and the whole gradient.
We hypothesise that fire is a main driver of plant diversity and expect a higher species and functional diversity on sites with intermediate fire and herbivory impact. Furthermore, we assume that there is high beta diversity between sites with similar disturbance regime on a species level and low beta diversity on a trait level. The findings of this study should contribute to a better understanding of the complex interactions of the environmental factors that determine the vegetation composition in savanna ecosystems.

TREES GOING UNDERGROUND: HOW GENETICS AND ENVIRONMENT SHAPE THE ZAMBEZIAN MIOMBO REGION

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An undulating mosaic of forests and grasslands characterizes the Zambezian region in southern Africa that gave space to the stunning evolution of woody species pairs from many tropical plant families. These pairs have in common being of similar morphology, except for one aspect: while one species is growing as a tree in forests, the sister taxon grows as dwarf shrub with huge underground biomass (suffrutex) in open grasslands, forming a kind of underground forest.
To investigate this phenomenon we chose *Syzygium guineense* Wall. complex (Myrtaceae) as model. This species occurs as tree, shrub or suffrutex in various habitats of the Zambezian region. A total of 33 populations were sampled in Angola, Namibia, Zambia and Botswana to analyze the relatedness of these forms. This study aims to characterize the genetic structure of the *S. guineense* complex in different environments. The analyses will show how far the phenotypes are genetically fixed or if they are local adaptive responses to ecological drivers such as soil conditions, frost and fire regimes, or herbivory.
The genetic relatedness of the populations is being estimated by sequencing and haplotype analyses of the chloroplast *trn*K region. Additionally their genetic profile is compared to a profile of selected functional traits to assess how plants morphology responds to the interplay of genetic and environmental drivers.
First results suggest that the populations of *S. guineense* can be assigned to at least six distinct haplotypes. Some of those are shared by populations with rather uniform morphology, yet the major haplotype is widely distributed across Angola and Zambia and exhibits high phenotypic plasticity, depending on the environment it is exposed to. Underground as well as aboveground phenotypes share this haplotype.
Thus *S. guineense* is an exciting example of how both genetic and ecological factors affect growth traits and produce extreme phenotypes as a result of adaptation to a complex tropical ecosystem.

INTRODUCING A NEW METHOD BY APPLYING MOLECULAR BIOLOGY TO THE ECOSYSTEM DAMAGE ASSESSMENT OF THE NATURAL TROPICAL FOREST OF SOUTH OF IRAN

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Persian Gulf War was occurred between Kuwait and Iraq since 1991. The environmental consequences of the war affected the ecosystem of many Asian and European countries. The current research is a part of the united Nation's project number 5000427 which started to implement 7 years after the occurrence of the Persian Gulf regarding the request of the United Nations Compensation Commission (UNCC) to trace the impacts of pollution resulted from the war. Studying areas were mainly located in tropical coastal zones of the Persian Gulf and Oman Sea which are covered by four broad provinces of Sistan o- Baluchistan, Hormozgan, Boushehr and Khouzestan (approximately 30% of Iran's area). This research was conducted mainly on four tree species of *Avicenna marina*, *Rhizophora mucronata*, *Ziziphus spina-christi* and *Prosopis cineraria*. 230 individual trees were sampled in total. After the preliminary studies, the cross sections of branches were separated for enzyme analysis. There cross sections included a few years before starting the war (as the control years), the war period (to determine entrance of the stress) and several years after the ceasefire (to reveal the denaturation and recovery period). The current study was conducted applying Bio monitoring and phytoremediation techniques using Peroxidase and Amylase enzymes. The result of the study indicates that Peroxidase and Amylase of the studies stands reacted to the environmental stresses at the time of war and were denaturized. In other words, it has taken some years until the enzymatic patterns of the above mentioned enzymes returned to the normal condition. These changes vary according to the species type and the intra- species sensitivities. To make the analysis more precise, the experiments were repeated on at least 10 individual stand of each species in 10 sites of the studied regions. Through the analysis of the Peroxidase and Amylase patterns, the damages to the forest ecosystem of south of Iran were evaluated. Additionally, the results of the study proved that we are able to determine the time of pollution entrance, the duration of environmental stress on the ecosystem and the recovery time of the ecosystem. The obtained results and the complementary studies of this research and the methods applied to determine the ecosystem stresses, received the certificate for the assessment of environmental damages.

Merian Award Applicant

CHANGE OF GENETIC DIVERSITY OF DOMINANT PLANT SPECIES COMMUNITIES IN TROPICAL LOWLAND RAINFOREST TRANSFORMATION SYSTEMS IN SUMATRA (INDONESIA)

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Indonesian tropical lowland rainforests are transformed to other types of land use systems due to the expansion of agriculture throughout the globe. The largest Indonesian island Sumatra experienced a transformation of about 70% of its forest cover until the year 2010 (Margono et. al. 2012). A common result of natural ecosystems conversion to managed systems is a loss of species diversity. In Jambi Province, Sumatra, tropical lowland rainforests are transformed into oil palm plantations, rubber plantations and an agroforest system called 'jungle rubber'. In this study, changes on the genetic diversity of plants caused by the different species composition and land-use system were analyzed.
Therefore, in 32 plots (50m x 50m) of these different ecosystems, 10 individuals of 10 dominant species were sampled and analyzed using anonymous AFLP markers.
Genetic diversity (Shannon Index) calculated for all species per plot, showed the highest values for the two tree-dominated systems forest and jungle rubber and lowest for oil palm plantations. The within plot variability was too high in order to detect significant differences among the land-use systems. By using a standardized method of calculating genetic distance within and among land-use systems the high variability within each plot was reduced. The standardized genetic distance differed significantly for all land-use systems at three spatial scales: among plots, among each land-use system within each region, but not among regions.
The low differentiation of forest species and the similar values to the plantation systems suggests a low genetic health status of the analyzed forest remnant plots. Agroforest systems are assumed to be able to restore biological and ecological processes and conserve biodiversity (Michon & de Foresta 1995) which was confirmed by these results of genetic diversity of dominant plant species. Our results on intraspecific variation will contribute to a comprehensive quantitative assessment of biodiversity concerning the impacts of tropical forest conversion to other land-use systems.

INVESTIGATION OF MACRO ALGAE AND SEAWEEDS BIODIVERSITY OF BUSHEHR COASTAL AREA

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The study was performed to investigate the biodiversity of macro algae and seaweeds in subtropical coastal areas of Bushehr in South of Iran in July and December 2014. Samples were collected from 3 stations using 0.5 m × 0.5 m (0.25 m^2) quadrants. Water temperature and salinity were measured on the sampling day during low tide. To ensure full area coverage, random sampling was done on cross sections in the form of zigzag. The aim of this study was to determine the biodiversity of macro algae and seaweeds by the identification of species and assessing their abundance and distribution in the study area using Margalef, Shannon-Wiener, Simpson, Hill and Sorensen indices. In this study, 24 species, including 23 marine algae and 1 seaweed species were identified; but the data analysis was performed on 21 species. The algae species belonged to 9 families. Among these species, the highest diversity was related to brown algae (9). Red algae (8), green algae (3) and 1 species of seaweed were next in line. Among the red algae, genus *Acanthophora* had the highest number of species. Among the green algae, genus *Codium* had the highest number of species, and among the brown algae, genus *Sargassum* included the highest number of species.The results of biodiversity indices show the stress and instability of the ecosystem. Also variance analysis between water temperature and the number of observed species shows the effect of temperature on the survival of the studied species ($p<0.05$). The results of biodiversity indices show that this region with subtropical climate as part of the Iranian waters of the Persian Gulf has poor algal flora. This can lead to a decline in fish stocks in the region. The warming of seawater caused by climate changes and environmental pollution, especially pollution caused by oil spills in the region and oil tankers in the Persian Gulf are two main factors of poverty of biodiversity, especially in marine plants in the coast of the Persian Gulf.

USING ACOUSTIC MONITORING TO AUGMENT RICHNESS SURVEYS OF BATS IN MONTANE CLOUD FOREST IN ECUADOR

David Siddons[1,2], Paulina Rojas[1], Fernando Jiménez[1], Miguel Angel Vizhco[1], Nina Farwig[2], Joerg Bendix[2], Roland Brandl[2]

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Surveys of bats are generally plagued with problems due to difficulty of registering all species in a particular area. It is known that acoustic methods can significantly improve the number of species registered during a survey as many species fly out of the range of traditional methods. We studied the capture efficiency of traditional methods of ground level mist netting against detection efficiency of acoustic recordings in montane cloud forest. To our knowledge there are no freely available Neotropical bat call libraries which makes identification of unknown calls difficult.

SHINY APP TO SIMPLIFY AND STANDARDIZE VALIDATION OF GEOREFERENCED DATA

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Validating georeferenced data held in international databases can be an extremely long and tedious exercise, and when many species are involved it will often fall to various researchers or assistants to complete the task. Previous experience suggests that not all validators are equally good at their job. While there are several methodologies published, this is the first online application that helps the user not only to validate data but also to store any changes made allowing cross-checking of changes. Our system currently allows users to either download directly from the GBIF website or use previously downloaded data. This tool will allow collaboration between laboratories and universities as the steps to validate data are incorporated into one user-friendly platform.

Merian Award Applicant

ARBUSCULAR MYCORRHIZAL COMMUNITIES IN SOUTH ECUADOR FROM 1000 M TO 4000 M

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Fungi are fundamental to the functioning of almost every ecosystem. In the tropical mountains they serve as one of the principal decomposers and they are involved in mutually beneficial mycorrhizal associations with most of the plants. Biodiversity and ecosystem functioning are threatened by land use and climate changes. However, the complex fungal communities in the biodiversity hotspots of the Andes in South Ecuador are far from being well understood. To develop monitoring systems which observe and detect changes in fungal communities, basic research along altitudinal gradients is necessary. Therefore we investigated the arbuscular mycorrhizal communities in a height gradient from 1000 to 4000 m, from the premontane forest (1000 m) over lower montane forest (2000 m) and upper montane forest (3000 m) to the páramo (4000 m).

ESTIMATIONS OF EVAPOTRANSPIRATION IN A TROPICAL MOUNTAIN FOREST

Paulina Alava Núñez[1], Brenner Silva[1], Joerg Bendix[1]

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A method is presented for the calculation of evapotranspiration using optical high-resolution image satelite in combination with meteorological data. We used the approach of Choudhury et al (1994), which calculates ET by multiplying the potential evapotranspiration (ET0) with the stretched vegetation index (VI): ET = ET0*VIs. The potential evapotranspiration (ET0) is a reference value calculated using the FAO Pemnan-Monteith method (Allen et al. 1998). Hourly meteorological data recorded from an automatic weather station in the study site (humidity, net radiation, temperature and wind) on a sunny day were used for ET0 calculations. We included the spatial variability in temperature and humidity by applying the approach of Fries et al. (2012), which combine meteorological data in relation to altitude gradient, land cover and elevation. We used the enhanced vegetation index (EVI) retrieved from a corrected WorldView-2 satellite image of November 2013 with 2 meters spatial resolution. Quality of evapotranspiration estimates at high-resolution is assessed using scintillometer data. ET (mm/hour) estimations are in accordance with the literature, but are lower than ET estimated with a scintillometer in the forest. However, we were able to identify the temporal and spatial variability. The highest peak of evapotranspiration was observed at 12:00h with a cessation of ET at 18:00h. In general, pasture shows lower average (2.31mm/day) with spots of very high evapotranspiration, while the forest shows a higher average (2.55mm/day) with areas of high evapotranspiration close to the ravines.

CLIMATE CHANGE IMPLICATIONS FOR TREE SPECIES IMPORTANT FOR LOCAL LIVELIHOODS IN SOUTHERN ECUADOR

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Appropriate forest management strategies in the tropical Andes are crucial to improve the interface between development and conservation. In Ecuador as well as in many other tropical countries deforestation and land use change, along with effects of climate change, can pose a major threat to biodiversity and ecosystem services, thus undermining the facilitation of socioeconomic development for local livelihoods. For this study, we assessed how climate change could affect potential distribution of commercially important native tree species in Southern Ecuador. We modeled past, present and future species distribution based on best available data from the Community Climate System Model (CCSM4) through the WorldClim datasets. All proposed tree species for this study were selected based on their importance for local livelihoods, either as timber or non-timber forest products. Past models were generated using environmental projections from the Mid-Holocene, about 6000 years ago, while future model was projected using the worst-case scenario (RCP8.5) for the year 2070. Our projections indicate that most species will experience a spatial reduction in their natural distribution for 2070 as result of a range shift towards higher altitudes. The combination of all three timescale models shows potential shelter areas where climate remains stable over the course of time. Another ongoing module of our study is attempting to answer how resilient some of these native species are to environmental change. To evaluate this, we are using three approaches, 1) molecular analysis to reveal genetic diversity among various provenances, 2) comparative dendrochronology studies from tree populations with dissimilar habitats and 3) seed germination tests under manipulated environments. We expect that our findings can be used to guide countrywide policy to promote region-specific species and provenances for planting, the development and implementation of sustainable land use systems, as well as suggestion of species-specific areas for conservation or sources of seed provenances.

Merian Award Applicant

TREE SPECIES DIVERSITY, STRUCTURE AND NATURAL REGENERATION IN TUMBESIAN DRY FORESTS

Jorge Cueva Ortiz[1,2], Carlos Ivan Espinosa[2], Patrick Hildebrandt[1], Bernd Stimm[1], Michael Weber[1], Reinhard Mosandl[1]

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Dry forests are among the most threatened tropical ecosystems worldwide (Quesada et al. 2009). The Tumbesian dry forest is considered to be one of the most biodiverse ecosystems but it is also affected by land use change and conversion to e.g. crop lands. For this reason, suitable forest management strategies are needed, which are able to provide income and take into account the effects of silvicultural interventions on species diversity or contain biodiversity forcing measures. However, little is known yet on basic characteristics of these forests.
In order to assess the diversity and structure we conducted a comprehensive inventory in two selected forest formations, namely deciduous and semi-deciduous forest types, according to altitudinal levels and three levels of tree density. We installed 24 cluster with 3 plots each, resulting in 72 plots of 60 x6 0 meters each.
Both forest types - deciduous and semi-deciduous - show similar structure, i.e. concerning basal area, amount of individuals per hectare and distribution of individuals by diameter classes. However, regarding the diversity we detected differences: the semi-deciduous forest shows a higher amount of tree species, which is caused by additional tree species on higher elevations.
In addition, we analyzed regeneration dynamics during dry and wet season in both forest types: Shannon indices indicate a higher uniformity of species diversity during the dry season; the generally higher values during the wet season in both types can be explained by more favorable conditions for germination in connection with an increased mortality during the dry season.

NUTRIENT AVAILABILITY DRIVES DISSOLVED ORGANIC MATTER CYCLING IN A TROPICAL MONTANE FOREST OF ECUADOR

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The tropical Andean forest in South Ecuador is experiencing improved nutrient supply because of steadily increasing N and episodic Ca and Mg deposition, as well as climate change resulting in reduced soil water content and longer dry spells, which accelerate organic matter mineralization. The observed N deposition in the past two decades is mainly attributed to biomass burning resulting from the conversion of natural forests to agricultural land in the Amazonian Basin. Nitrogen deposition favours microbial activity and is known to increase the turnover of easily degradable organic matter, but reduces that of more recalcitrant organic compounds. Increasing N richness can furthermore result in dissolved N losses to surface waters.
To understand the response of the forest ecosystem to increased nutrient input, we established in 2007 an interdisciplinary nutrient manipulation experiment (NUMEX). Since 2008, we have applied 50 kg ha^{-1} a^{-1} of N, 10 kg ha^{-1} a^{-1} of P, 50 kg + 10 kg ha^{-1} a^{-1} of N and P in a fourfold replicated randomized block design in the Reserva San Francisco at 2000 m a.s.l. We hypothesize that concentrations of dissolved organic matter (DOM) will decrease because of increased mineralization resulting from the stimulation of the carbon cycle by nutrient additions and expect an increased leaching of inorganic N from the organic layer.
In the organic layer, mineralization of total organic carbon (TOC) and dissolved organic nitrogen (DON) was stimulated by separate addition of P and simultaneous addition of N and P. However, concentrations of TOC and DON did not show a significant response to separate addition of N. These observations indicate that the availability of P plays a key role in the mineralization of DOM in the organic layer. We also detected a much higher NO_3-N leaching from the organic layer in the plots with separate N additions, but less leaching in the combined NP treatment, indicating that the increased P availability stimulates N uptake by plants and immobilization by microorganisms.
Our observations indicate that DOM cycling only changes if simultaneously to N availability also P supply is improved, while NO_3-N leaching increases only if N is separately added.

EFFECTS OF CONTINUED N AND P ADDITION ON TROPICAL MONTANE TREE ROOT ARCHITECTURE

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Plant growth and productivity are strongly dependent on the availability of water and nutrients in soils and the efficiency of roots in acquiring these resources. Studies on soil-root interactions in forest ecosystems indicate that fine-roots are very dynamic and highly sensitive to changes in soil nutrient concentrations. Specifically, root architecture plays a critical role in plants efficiency to acquire soil resources and ability to respond to changes in local soil conditions.

Atmospheric nitrogen deposition in the tropics is projected to increase drastically in the near future and contribute to changes in ecosystem processes. Thus, developing a good understanding of root architecture to root system functionality is an important tool in predicting changes in these systems.

The study was conducted within an ongoing NUtrient Manipulation EXperiment (NUMEX) in the South Ecuadorian montane tropical forest. Fine-root systems were sampled to investigate the influence of nitrogen (N) and phosphorus (P) additions (and their interaction) on root architecture of forest trees at 1000, 2000 and 3000 m a.s.l.

The findings suggest that montane forest trees may be P limited, particularly at higher elevations. Since not all species responded to nutrient additions, this suggests that the ability of a root system to undergo architectural plasticity is dependent on many factors, and not only on soil nutrient availability. Furthermore, given the observed responses and relatively recent implementation of the experiment, these findings indicate that tropical montane forests may be highly vulnerable to changes in nutrient inputs.

SODIUM SHORTAGE INCREASES NA RETENTION IN THE PHYLLOSPHERE AND AFFECTS DECOMPOSITION PROCESSES IN A TROPICAL MONTANE FOREST IN SOUTH ECUADOR

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Recent studies raise the hypothesis that Na shortage restricts decomposition and affects the carbon cycle in tropical forests. When Na concentrations in soils are low and the stands are far off-coast, they do not receive substantial Na inputs from the atmosphere. Since terrestrial plants have low concentrations of Na, which is not considered as an essential element, the demand of soil fauna may not be covered. Yet, in contrast to animals, little is known on Na demands of fungi and phyllosphere microorganisms.

We present results from a study on Na limitation in a montane forest ecosystem in South Ecuador, which is located on the eastern cordillera of the Andes. We tested the hypotheses that (1) the study area is characterized by low Na concentrations because of low deposition rates with incident precipitation (wind directions mainly from the Amazonian Basin), (2) decomposition processes are limited by fauna and fungal Na restrictions and (3) Na is retained in the canopy because of Na limitation of microorganisms in phyllosphere.

Since 1998 we measure Na fluxes in rainfall, throughfall, stemflow, litter leachate, litterfall and organic layer in a microcatchment under an undisturbed lower montane rainforest. Results reveal comparably low Na concentrations in the ecosystem and similar Na concentrations in throughfall and stemflow. Since Na fluxes are lower with throughfall than with incident rainfall, we conclude that Na is retained in the canopy.

To explore the role of the phyllosphere in Na retention we sampled leaves covered by phyllosphere microorganisms and leaves without phyllosphere cover from several tree species, which were sprayed with a NaCl solution containing 0.5 mg L-1 Na, corresponding to the Na concentration in incident rainfall in our study area.

Additionally, responses of litter decomposition to Na additions and the involved interaction of soil fungi and fauna were tested in a litterbag experiment at two sites (1000 and 2000 m a.s.l.). Results revealed enhanced decomposition rates following Na additions, though only in the presence of soil fauna.

These results might have future ecosystem implications, since our time series showed that total Na deposition decreased within the past 15 years from ca. 40 kg ha^{-1} a^{-1} to 10 kg ha^{-1} a^{-1}, suggesting a potential role of Na in regulating ecosystem processes.

NUTRIENT USE OF ANTS ALONG AN ELEVATION GRADIENT IN NATURAL AND DISTURBED MOUNTAIN RAINFORESTS IN SOUTHERN ECUADOR

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Land use intensification and climate change affect biodiversity and consequently important ecological functions. Ants play an essential role for the functioning of ecosystems by influencing functional processes, particularly predation. Ants forage to maximize their fitness by searching for food with essential nutrients. The relative availability of those nutrients varies in time and particularily space, which influences nutrient demands and structures abundance and species composition of ant assemblages. It is still not well understood how nutrient demands of ants change along elevation gradients and with disturbance in tropical mountain rainforests. Furthermore, the knowledge about how the spatial heterogeneity of nutrient availability translates into the composition of ant assemblages is limited. Therefore we analyzed the patterns of relative nutrient use in ant assemblages along an elevation gradient and between natural and disturbed mountain rainforests in Southern Ecuador. We quantified ant recruitment to five different nutrient types and we recorded changes in species richness, abundance and composition of feeding guilds. Considering the results of a similar study on Mt. Kilimanjaro we expected a shift in ant recruitment from carbohydrate- to lipid-based resources due to increasing energy demands with increasing elevation. Furthermore, we expected the relative use of amino acids to be lower in disturbed compared to natural forests due to the additional availability of nitrogen through remnants of cattle in the disturbed forests. In our study, species richness of ant assemblages declined with elevation in natural forests and showed a mid-elevation peak in disturbed forests. Contrary to our expectations, we found decreasing relative use of lipids with elevation in natural- and no pattern in disturbed forests, suggesting the existence of differences in nutrient availibility for ants, compared to the ecosystem of Mt. Kilimanjaro.

TEXTURE IMAGES DERIVED FROM REMOTELY SENSED DATA AS TOOL FOR MAPPING BIRD FEEDING GUILDS IN A TROPICAL MOUNTAIN FOREST

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Remote sensing derived image textures that reflect the vegetation structure are increasingly applied to map and monitor biodiversity in different ecoregions and across spatial scales. Special emphasis is put on birds as indicators of biodiversity since diversity and composition of bird assemblages is highly correlated to variables characterizing habitat structure. We distinguished between birds differing in habitat and diet specialization, as not all species are equally vulnerable to changes in vegetation structure. Consequently we expect stronger relationships of specialized avian habitat and feeding guilds to vegetation structure than of overall bird diversity. We used texture images of aerial high-resolution orthophotographs to model different habitat and feeding guilds of birds in a complex tropical mountain forest ecosystem in southeastern Ecuador. We used point count data of bird communities from 18 natural or disturbed forest sites differing in elevation and selected three measures as proxies for different aspects of bird diversity: (i) Shannon diversity as a measure of **α**-diversity, (ii) community composition as a proxy for combined **α**- and **β**-diversity, and (iii) phylodiversity for aspects of functional diversity. We will assess the model-based mapping of avian diversity using different texture metrics and moving window sizes on the normalized difference vegetation index NDVI, the physiological reflectance index PRI as well as the near infrared band NIR. First results of partial least squares regression unveiled predictive power of texture variables particularly for **α**- and **β**-diversity. Our analyses will contribute to the identification of certain avian guilds as spatial-explicit indicators for overall avian diversity.

ASSESSMENT OF AN ENERGY-BALANCE MODEL FOR EVAPOTRANSPIRATION MAPPING OVER THE ANDEAN PÁRAMO OF SOUTHERN ECUADOR

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Understanding of evapotranspiration (ET) processes over mountain environments is crucial, particularly due to the importance of delivering water related ecosystem services like potable water supply and hydropower support. For this reason ET can be considered as a functional indicator in terms of hydrological and climate change processes. The present study aims to assess the applicability of satellite-based and spatial-explicit evapotranspiration retrievals over an area ofneotropical alpine grasslands of the Andes (Páramo), near Cuenca (Ecuador), including rigorous validation with ET retrieved from water balance measurements. We implemented the energy-balance based model METRIC (Mapping EvapoTranspiration at high Resolution with Internalized Calibration) with cloud-free sets of Landsat 7 ETM+ and MODIS-Terra images (2013 ~ 2014). The study area, a micro catchment of the Cajas Páramo, covers an elevational gradient between 2800 and 3900 m a.s.l. Besides the model implementation, suitable algorithms that account for the topography and latitude of the Andean valleys were included (i.e. refinement of incoming radiation considering the slope and aspect of the terrain, temperature lapse corrections, roughness length and wind speed adjustments). In addition, a comparison with MOD16, which is a global coarse-resolution evapotranspiration product in monthly scale, was performed. Final results of METRIC ET (Landsat-based) showed good agreement with the outputs from water balance ET, at monthly and annual time steps. However, retrievals from METRIC (MODIS-based) and MOD16 product revealed a poor performance. The findings support the plausibility of the METRIC model when Landsat product is used. Future research includes the installation of an eddy covariance flux tower, combined with porometry measurements of native vegetation in order to validate the satellite-based ET maps at plot scale.

THE LOMBOK PROJECT: LAND-USE OPTIONS FOR MAINTAINING BIODIVERSITY AND EKOSYSTEM FUNCTIONS ACROSS HUMAN-MODIFIED TROPICAL LANDSCAPES

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Increasingly, tropical landscapes are dominated by disturbed forests, agricultural mosaics and other modified habitats, leading to concerns that biodiversity and ecosystem functions are being eroded and GHG emissions elevated. Commodity certification and policies such as REDD+ exist to manage these landscapes sustainably, but the extent to which they achieve this in the tropics is unclear.
As part of NERC's Human-Modified Tropical Forests programme the LOMBOK project is critically assessing the potential of policy options to protect both biodiversity and ecosystem functions across the Stability of Altered Forests Ecosystems (SAFE) landscape in Borneo. From our experimental set-up we will determine whether areas prioritised for biodiversity are also important for carbon, reduced GHG fluxes, and other ecosystem functions. The study is designed around a network of forested fragments and riparian reserves that remain after clearance for oil palm. Our core data is collected across 30 experimental plots in continuous logged forest, fragments, riparian reserves, mature and newly-established oil palm.
We combine surveys along the modification gradient with *in situ* manipulative experiments to detect patterns, and develop a mechanistic understanding of biodiversity-function linkages. Spatial analyses will then be used to assess the extent to which biodiversity (e.g. vertebrate species of conservation concern) co-varies with ecosystem functions (e.g. decomposition, predation and biogeochemical cycles). We will then model the impact of different policy scenarios on these conservation values and offer insights into how to design oil palm landscapes to optimise biodiversity and ecosystem function provision.

IMPACT OF RAINFOREST DEGRADATION ON THE BIODIVERSITY OF EPIGEIC AND SOIL INVERTEBRATES IN LOWLAND ECOSYSTEMS OF SOUTHERN COSTA RICA

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Many researchers suggest that disturbances in ecosystem and its soil may significantly alter biodiversity and species structure of arthropods communities. Even though much has already been said about the relationship between the degradation of primary ecosystems and loss of biodiversity, there are certain groups of organisms- i.e. soil invertebrates, and certain environments in the world – e.g. rainforests, in which the factors creating and shaping biodiversity still remain uncertain and need further research. One of these factors is the impact of human; the human caused pressure, affecting all organisms in modified ecosystems, not only contributes to changes in numbers of species and individuals within populations, but also alters species composition within ecological niches.

In order to check the meaning of human influence on natural ecosystems, we chose a research site in one of the most pristine and species rich areas in the world, situated within a world biodiversity hotspot – a Mesoamerican tropical lowland rainforest in southern Costa Rica, Piedras Blancas National Park, known wildly as the Rainforest of the Austrians.

The main goal of our research was to compare complexity and diversity of the organisms, creating soil and epigeic fauna in differently disturbed tropical ecosystems. We intended to show and explain an impact of human activities on biodiversity of invertebrates inhabiting these areas. The research focused on diversity of *Enchytraeidae, Collembola, Acarina, Coleoptera*, and *Blattodea;* and the experiments were conducted in four different habitats – primary forest, secondary forest, oil palm plantation and commercial pasture.

We managed to prove statistically significant differences in biodiversity of organisms between researched ecosystems. We also found interesting patterns describing the way how human caused disturbances affect and alter composition of species in a coprophagous niche. The research was conducted in July 2015 and the article describing these phenomena is still in preparation.

FINE ROOT BIOMASS ALONG AN ELEVATIONAL AND LAND USE GRADIENT IN MOUNT KILIMANJARO

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Assessment of carbon pools and fluxes in forest ecosystems are of key importance in the mitigation of global change effects. Fine roots are a main component of the carbon and nutrient cycle in forest ecosystems due to their high turnover rates and high biological activity, although they contribute little to the carbon stocks.

Fine root biomass in forest ecosystems is controlled by environmental factors and stand characteristics. Increment in elevation normally entails lower decomposition rates, driving to nutrient limitation and the consequent increase on fine root biomass. In tropical montane forest it has been shown that the shoot: root ratio decreases with elevation. There is a swift in the allocation of carbon from the aboveground organs to the root system, which becomes of greater importance in higher elevations. On the other hand, land use change affects forest structure and species composition, presenting important consequences on carbon pools. A decrease in fine root biomass with land use intensity has been assessed.

There is a lack of information about fine root biomass in tropical ecosystems, especially referring to the African continent. We study fine root biomass up to 40 cm depth in soil in Mount Kilimanjaro, as it presents a wide elevation range (866-4550 m) covering important natural habitats and different disturbed habitats with increasing land use intensity.

This study focuses on four hypotheses: (1) Fine root bio- and necromass increases with elevation until the afroalpine vegetation. (2) Changes in vegetation structure in the afroalpine zone decrease fine root biomass, although the shoot: root ratio increases in response to nutrient limitation conditions. (3) Land use change presents a negative relation with fine root biomass.

Our objectives are: (1) to quantify the contribution of the fine root biomass to the carbon pool of natural and disturbed habitats in Mount Kilimanjaro, (2) to analyze the effects of elevation and land use change on fine root biomass, and (3) to assess if there is a swift in the carbon allocation from aboveground parts of the plants to the root system with the elevation.

Preliminary results and conclusions will be presented to better understand patterns in carbon cycle in tropical ecosystems and to enhance conservation on Mount Kilimanjaro.

EVOLUTION OF HIGH NORTH ANDEAN MOUNTAIN BIOMES DURING THE QUATERNARY

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We show the evolution of mountain forest and tropical alpine grassland (páramo) in the northern Andes during the Quaternary period. Pollen records from 3 Colombian basins at elevations between 2550 and 2780 m show detailed accounts. Here, we present a new composite pollen record showing in >6000 pollen samples glacial-interglacial cycles reflecting global regime shifts, and dramatic changes in forest composition during the last 2.25 million years (Ma). The record shows immigration events, long-term ecological legacies, and ecological drift in species abundance. During most of the Quaternary interglacials taxon combinations and abundance differed from present-day and reflect no-analogue assemblages. However, distinct ecological ranges of many taxa allow inferences of past environmental conditions in the absence of modern calibration sets. Leading taxa in long-tern ecosystem assembly changes are *Alnus*, *Quercus*, *Hedyosmum*, *Weinmannia*, *Podocarpus*, *Miconia, Vallea* and *Morella*. Determinants include the closure of the Panamanian Isthmus, global scale climate change, and intrinsic species interactions within ecosystems. *Alnus*changed forests 1.01 Ma almost instantaneously whereas *Quercus* needed after immigration some 200 kyr to reach present-day (pre-anthropogene) cover. Parallel to forest evolution, we show the evolution of high-elevation and biodiverse páramo that developed from a species poor proto-páramo. For the deepest basin of Bogotá (586 m) we show that sediment accumulation started 2.25 Ma in a fluvial/fluvial-lacustrine system, changed (subsidence-driven) into a lake 1.4 Ma and changed into a wetland area 27 ka possibly due to sediment overfilling of the basin and/or tectonic activity. Other basins continued their sedimentary archive up to modern times.

UNTANGLING THE LIANA DOMINANCE HYPOTHESIS: ARE LIANAS INCREASING IN AN ASEASONAL NEOTROPICAL FOREST?

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Lianas compete with trees for above- and belowground resources thereby reducing tree growth rates, fecundity, and survival. Recent studies in Neotropical forests suggest that lianas are increasing in abundance thereby potentially reducing tree biomass; a scenario with implications not only for forest ecosystem function and species composition, but also climate change. In 2003 and 2013 all Myristicaceae trees in the 50-ha Yasuní Forest Dynamics Plot were surveyed for liana infestation in their crown. We tested the hypothesis that the proportion of trees infested with lianas increased between 2003 and 2013 in line with the increasing liana dominance hypothesis. Contrary to expectations there was a slight but significant reduction in the proportion of liana infested trees from 35 to 32%. Liana infestation was dynamic with a large proportion of trees losing or gaining liana load over the 10-year period. Trees with >25% crown cover by lianas in 2003 suffered reduced growth rates and increased mortality compared to liana-free trees. No evidence for an increase in the proportion of liana infested trees is potentially due to the aseasonality of Yasuní, which removes the competitive advantage lianas enjoy over trees during dry seasons due to their efficient capture and use of water. We propose further research of long-term liana dynamics from aseasonal forests is required to determine the generality of the increasing liana dominance hypothesis in Neotropical forests.

Merian Award Applicant

THE CONTRIBUTION OF SHADE TREE MANAGEMENT ON THROUGHFALL AND MICROCLIMATIC CONDITIONS IN COCOA PRODUCTION SYSTEMS

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Cocoa production in agroforestry systems (AF) has advantages concerning environmental matters, however, little is known about vertical water fluxes. AF with various strata mimic forest structure which in turn is closely related to precipitation throughfall and microclimatic conditions. Tree management, such as pruning, can change conditions drastically within a short time, affecting natural habitat and crop performance. In this study we evaluated the impact of stand structure on microclimatic characteristics and throughfall in three different cocoa productions systems, comprising full sun monocropping (MONO), AF, and a successional AF as part of the project *Farming System Comparison in the Tropics* of the FiBL in Alto Beni, Bolivia. Within stand temperature and relative humidity were recorded and throughfall was collected as bulk deposition over two years. Stand structure was evaluated by tree species diversity, planting density and canopy assessment which also take pruning events into consideration. Throughfall was reduced to 54% in the AF in comparison to 12% in MONO. Relative humidity in AF was higher and temperature fluctuations were buffered compared with MONO. Depending on the intensity of the pruning, throughfall in the agroforestry system can become close to that in MONO reducing the microclimatic buffering of the canopy. Higher radiation within the system after pruning is desired to enhance flowering. Even though successional AF have a higher plant diversity and density than common AF they did not show lower canopy openness and higher interception due to their pruning management. Well managed cocoa agroforestry systems are highly dynamic concerning incoming light and water. Choosing pruning time and intensity is a tool to balance water and thus nutrient use of the cocoa under seasonal varying environmental conditions and permit growth of leguminous soil cover crops.

IMPACT OF LAND-USE & SOIL QUALITY ON SUSTAINABLE PRODUCTION OF COCOA IN NIGERIA

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Food security is becoming a crucial issue in Nigeria as a consequence of unreliable rainfall, marginal soil fertility and a low level of inputs resulting in declining crop yields. The southwestern region of Nigeria is the largest administrative region in Nigeria; it occupies about 30% of Nigeria with an estimated population of 40 million. Over 50% of the area is categorized as rural of which about 90% of the people depend on farming for their livelihood. Over 90% of Nigerian cash crop cocoa is produced in the cocoa belt of the Southwestern region, but both cash and food crops have consistently decline in the last few years. This phenomenon constitutes a threat to food security and calls for efforts to explain the downward trend and make recommendations for improvement. The objectives of this study were to evaluate the soils of some areas in Southwestern Nigeria for cocoa on one hand, and identify factors affecting cocoa yields on the other hand. A novel technique that combines soil survey with socio-economic analyses was adopted in the properties. Socio-economic surveys covered resource quality and constraints to agricultural food production, whereas soil sampling and analyses were carried out to assess contribution of soil to yield. Three locations having similar agro-ecological features were selected, namely Ibadan, Ife and Akure. Cocoa Farmers were randomly selected and interviewed on their farms using standardized questionnaires to elicit information on factors affecting crop yield. Relationships between cocoa yield and variables presumed to influence yield were determined using linear multiple regressions. Soil organic C, Age of farm soil, and Effective cations exchange capacity (ECEC) were identified as the major constraints to yield. Other variables are related to biophysical and management factors. It is recommended that emphasis should be placed on soil management techniques that conserve organic matter and enhance the nutrient and water holding capacity of the soils. Policies that would enhance sustainability of agricultural land use and crop marketing are also required.

MONITORING AND EVALUATION OF IMPACTS OF FSC FOREST MANAGEMENT CERTIFICATION

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Within in the FSC system and publicly accessible a large amount of information is generated about the outcomes and impacts of certification requirements on the level of each certified forest management operation. To assess more systematically those outcomes and impacts FSC certification triggers related to social, environmental and economic aspects of forest management, the organization sets up a Monitoring and Evaluation (M&E) program. This M&E framework might allow some level of generalization of the complexity of impact areas in forest management interventions, of the different commodities and services forest management provides in different parts of the world, and of FSC's stakeholder engagement. Consultations with stakeholders result in a theory of change for the FSC system and the identification of intended impacts. Related quantitative and qualitative impact indicators will be monitored on forest management level regularly. Some indicators will be monitored on case-specific levels only. In addition the new modular approach program of FSC allows identifying baseline data prior to certification interventions to allow a more clear attribution of forest management interventions to certification requirements. The paper will present FSC's M&E framework including research partners, preliminary results and invites to further research cooperation.

IMPACTS OF PRECIPITATION VARIABILITY ON THE DYNAMICS OF A DRY TROPICAL MONTANE FOREST

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Ecosystem structures of tropical mountain forests are under threat due to changes in climate and land-use. The dry tropical montane forest of Munessa-Shashemene in south-east Ethiopia is a prominent example of degradation and deforestation in the sub-humid tropics. In recent yearsan increasing number of precipitation events have been observed, mainly during the short rainy season. Moreover, the recent IPCC Assessment Report envisages an increase in total annual precipitation, accompanied by more frequent extreme weather events (drought, torrential rains) for the Horn of Africa until the end of the 21st century. To evaluate possible consequences for local forest ecosystems, we applied the process-based, individual-oriented forest simulation model Formix$_3$ to identify the influence of precipitation variability on the forest growth dynamics. We parameterised the model using field observation data including, for the first time, a tree-ring chronology of *Croton macrostachyus*. By using different levels of annual precipitation and intra-annual precipitation patterns, weanalysed explicit simulation scenarios focussing on both overall and species-specific aboveground biomass dynamics and tree species composition. We found that the model reproduces aboveground biomass productivity precisely under current precipitation conditions. Variations in precipitation cause ecological shifts in the conditions for tree growth. Biomass and species richness both increase with mean annual precipitation, with the effects stabilising over time. Our results emphasise the impact of the duration and frequency of periods of water limitation on forest structure and growth. Our model has a variety of potential applications including investigation of the impacts of climate variability on forest growth dynamics. It is thus a useful tool for extrapolating local growth measurements and succession, and perspectively, analysing impacts of different management strategies on dry tropical montane forests in Ethiopia.

FOREST SEEDS FOR ECOLOGICAL RESTORATION AND AGROFORESTRY IN HAITI

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Haiti and the Dominican Republic are located on the Hispaniola, a Caribbean island, where about a third of the island is Haitian territory. Among the environmental problems of Haiti, we highlight a heavy deforestation and strong soil erosion. Due to Haiti is a overpopulated land, there is a great pressure for charcoal production to domestic use and clearing of forest areas for cultivation. Additionally, Haiti presents frequent incidence of cyclones and step relieve. In this context, there is increasing demand for reforestation for environmental and economic purposes. To guide about the choice of species for seed and seedlings production, and lately reforestation, I carried out an inventory of tree species occurring in the Mapou River Basin. I registered the occurrence of native and exotic tree species, eater spontaneous or cultivated along the basin area, during five days of field work. 51 tree species were recorded, being 25 native and 26 exotic. About the exotic species, many are already naturalized occurring spontaneously in the natural landscape. There were not areas of native vegetation in an advanced stage of succession. Most of the vegetated areas showed extraction of wood for charcoal production or crops (corn, beans, pumpkin, castor bean, potatoes, etc.) The areas were characterized by the presence of arboreal elements present in the form of stumps with buds and agroforestry. Regarding agroforestry systems; the species used for canopy are *Inga vera*, *Persea americana*, *Mangifera indica*, *Grevillea robusta*,*Cecropia peltata* and *Citrus spp.* In the understory are grown mainly coffee and banana. The remaining area of Pine forest located above 800 *m.a.s.l.* was better preserved, however its current size is relative small in comparison with the original area. The pressure on native forests is extreme. Although many of the species still present in the landscape, they are slaughtered or pruned before the physiological maturation of the branches, compromising the seed and seedling production in wildness.

EXPERIMENTAL C AND N ENRICHMENT OF TROPICAL FARM SOIL FROM THE BRAZILIAN CERRADO (SINOP-MT)

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In the framework of the CarBioCial project, on-farm experiments have been performed to enrich tropical farm soil (Red Latosol) with different types of organic matter on the medium term. Here, we assess the effect of the organic matter addition on soil organic carbon, nutrients, and crop (corn) production. The applied organic matter types are either freely available (waste materials from farm production, e.g. passion fruit residuals, sawdust) or at low cost from nearby suppliers. We aim to identify a feasible combination of types, amounts and application methods of organic matter to improve efficiently soil carbon storage and/or crop production in the Brazilian Cerrado agroscape.
The experiment we present here was established in the Sao Valentim farm, municipality of Sinop. The experiment was set up in an area of about 1 ha. At the beginning of the experiment (Sep. 2012), we applied two different types of organic matter at variable amounts in a randomized scheme, with and without N-fertilizer, using two application methods; direct on the soil or with harrow incorporation. The effects on carbon storage were evaluated after one, two and three years of the addition. Our preliminary results show a positive response of soil organic carbon (SOC) contents to the organic matter addition.
Our outcomes provide information for the development of SOC enrichment schemes and carbon-friendly landscape management programs for farms, using local resources at local-regional scale in the Brazilian Cerrado.

LAND USE AND LAND MANAGEMENT DURING THE PAST CENTURY DETERMINE MANGROVE DYNAMICS IN NORTHWESTERN PUERTO RICO: THE CASE OF THE MARACAYO MANGROVE

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Political and economic decisions have determined throughout the history of Puerto Rico, an island in the Caribbean, land us for agriculture, livestock and urban sprawl. Knowing this history, this study is imperative to understand how these changes caused by the various uses and management affected adjoining wetlands. We studied the Maracayo mangrove, located in the municipality of Camuy in northwestern Puerto Rico. The study area has been through extensive changes in its use and management process throughout history. We aimed to reconstruct the history of the use and management of land in order to understand how these changes have impacted the area comprising the current mangrove. It is hypothesized that land use and management of these lands affected the hydrology of the area, resulting in increased salinity, providing the right niche for the development of current mangrove. The resources used were aerial photographs of the vegetation from 1930-2010, a collection of oral history of citizens who live adjacent to the grounds to see its state in the past, a report of the area done in 1979 by the Department of Natural and Environmental Resources of the Government of Puerto Rico and analyses of salinity, pH and conductivity of soils in three different sites in the mangrove. We concluded that the wetland underwent changes in ecosystem composition by ambitious elimination of sand dunes due to hydrological changes and marine effects. It seems that the area was a freshwater wetland. The oral history confirms the presence of springs in the past and present. Those springs, which due to land use change and elimination of sand dunes, increased salinity intrusion, as documented in the 1979 report, changing the habitat, therefore allowing a mangrove community to be established. The continuity of ecophysiological and hydrogeological studies of the area will allow for a predictive understanding of how the mangrove wetland will continue to develop.

HOW THE PESTICIDES CAN AFFECT THE MAINTENANCE OF THE BEEHIVE, AND WHAT ARE THE POSSIBLE CONSEQUENCES FOR POLLINATION SERVICES PROVIDED BY THEM

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In recent years, concern about the conservation of bees has grown dramatically, especially in densely landscapes occupied by economic activities. Several factors have been linked to this problem, including the use of pesticides. Contamination of bees often happens when they are foraging. Therefore, the size of the sprayed area influences the behavior of the colonies, because the larger and closer to the hives is the area the greater is the exposure of forage and greater is the internal contamination of the beehive. This contamination can be lethal or can cause sublethal effects. However, these adverse effects can be reduced with friendly agricultural practices to pollinators that counteract the effects of conventional agriculture. The general objective of this project consists in understand how the pesticides, affect the maintenance of the beehive, and what are the possible consequences for pollination services provided by them. Many of the relevant issues here are issues that take into account relationships between the bees and their space and as the system, elements vary in time this dynamic system can be described by individual based models (IBM) object-oriented. Therefore, we created a model using the IBM to have access to the individual; associated with a set of EDO; used to describe and encapsulating the dynamics within the hives, events which not need to be explicit. In the IBM, an array was built to represent the environment. It is composed by a mosaic of vegetation, where a single generic type of plant, attractive to the pollinator, represents the flora, and there is a gradient of contamination. In this landscape, the hives are distributed and serve as a source of bees that forage during the simulation. The agents (bees) enter into contact with the chemicals, depending on the amount of flights and of the place visited, they can be contaminated with a lethal/sublethal dose or not get contaminated at all. Due to the complexity of the phenomenon, validation is being made with the use of data already published and with the insertion of a differential equation model already validated and published. Thus, the hybrid model was built with real data, minimizing potential errors and increasing the reliability of the result.

CONSERVATION OF SOCIOECOLOGICAL PRODUCTION LANDSCAPES: THE CASE OF THE OPEN ONLINE COURSE OF THE UNIVERSITY OF THE PHILIPPINES – OPEN UNIVERSITY

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Socioecological production landscapes or satoyama as adopted during COP 10 in Japan are traditional landscapes characterized by subsistence farming and secondary forests prevalent in East Asia and tropical Southeast Asia. It is known in various names throughout East Asia and Southeast Asia. Three distinct satoyama landscapes are identified in the Philippines: 1) satoyama with rice farms, 2) satoyama with rice and other crops and, 3) satoyama with corn farms.

At present, these landscapes suffer from overutilization and an alarming biodiversity loss. Open Online Course (OOC) on satoyama has been offered at the University of the Philippines Open University (UPOU) to enhance conservation of this endangered landscape. The modules are as follows: 1) Introducing satoyama, 2) Practical ecology and biodiversity conservation, 3) Sustainable agriculture, 4) Nature, culture and heritage, and 5) Satoyama field study. This Satoyama OOC is a non-degree course offered online for free to the entire public. Hopefully, this course will help inculcate the concept of the satoyama landscape bringing about social transformation and subsequently, environmental rehabilitation, particularly in the tropics.

PALAEOECOLOGICAL STUDIES OF UPPER MONTANE ARAUCARIA FOREST AND GRASSLANDS IN SOUTHEASTERN BRAZIL

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Araucaria Forest is one of the most endangered ecosystems in Brazil, being reduced to approximately 3% of its original area, with less than 1% of primary vegetation, which is concentrated in the rise of the mountains. The High Elevation Grasslands are restricted to high altitudes in mountains of southeastern Brazil.

The reconstruction of past vegetation, climate, fire and human impacts, applying pollen, charcoal and sediment analysis of environmental archives provide important information in the understanding of ecosystem dynamics in respect to climate change and human impacts, especially the use of fire. This is important for the planning of strategic actions of management for conservation the ecosystems and their biodiversity.

First palaeoecological studies and historical information have already shown that in southeastern Brazil, especially in the study area, this is the Serra da Bocaina National Park region, has been strongly affected by human activities. Here we present the first result of our study on a 228 cm-long sediment core from a small swamp in a valley of Araucaria Forest and Grassland. First radiocarbon dates indicate that the sediment core is 600 years old allowing to perform a very high resolution pollen and charcoal record to investigate the effect of European colonization and modern human impact in the Serra do Mar mountains of southeasten of Brazil.

A DETAILED RECONSTRUCTION OF THE LATE HOLOCENE DEVELOPMENT OF AN AMAZONIAN PEATLAND

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Amazonian peatlands are carbon dense ecosystems which also contribute to the biological diversity of the western Amazon. The aim of this study was to collect sufficient data to produce the first detailed developmental model for an Amazonian peatland, Quistococha, near Iquitos (Peru). Quistococha peatland covers an area of c. 490 ha and transects of cores totalling c. 5 km were used to establish the shape of the underlying topography and the visible peat stratigraphy. Inferences about peatland developmental processes are combined with a detailed palaeoenvironmental reconstruction drawing on new and previously published data in the form of six pollen diagrams, 29 peat cores, a lake sediment sequence, and 22 radiocarbon dates from across the peatland. These data therefore form the basis of one of the most detailed conceptual models of peatland development for any tropical peatland site. The data from Quistococha also constitute the first multiple-core study of an Amazonian peatland, and show that a well-placed single core can represent the main vegetation changes, although multiple cores add valuable detail to the picture of site development. Peat initiation at Quistococha occurred in two main phases during the early period of peatland development (2,400-1,900 cal yr BP), and five main phases of peatland development are described. Lateral growth mostly occurred through 'primary mire formation', where peat begins accumulating simultaneously across a site: the expansion of Quistococha therefore differs from many temperate and sub-arctic peatlands, where primary mire formation is mostly confined to coastal areas. Differences in the subsurface topography are shown to have affected vegetation development, and likely resulted in higher beta diversity than present during the early stages of Quistococha's development.

MAURITIA WETLANDS IN NORTHERN SOUTH AMERICA: A PALYNOLOGICAL STUDY OF THE GRAN SABANA REGION (SE VENEZUELA) WITHIN A NEOTROPICAL CONTEXT

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Mauritia flexuosa L.f. is one of the more widely distributed Neotropical palms and is intensively used by humans. This palm can grow in tropical rainforests or can develop a particular type of virtually monospecific communities restricted to warm and wet lowlands of the Orinoco and Amazon basins. It has been proposed that, during the Last Glacial Maximum (LGM), the Mauritia swamp communities were restricted to the core of the Amazon basin from where they expanded favoured by the Holocene warmer and wetter climates. It has also been suggested that some of these palm communities might have been the result of human dispersal during the last millennia. Here, we evaluate both hypotheses using the case study of the Venezuelan Gran Sabana (GS) region, where the *M. flexuosa* swamp communities (locally called morichales) are common and well developed. The morichales did not reach the GS until the last 2000 years, as manifested by sudden increases of *Mauritia* pollen parallelled by similar trends in charcoal particles as proxies for fire. During the last two millennia, the situation was very similar to the present, characterised by extensive burning practices affecting savannas and savanna-forest ecotones but rarely morichales (selective burning). This strongly suggests that human activities could have been responsible for the penetration of the morichales to the GS. A meta-analysis of the available records of *Mauritia* pollen across northern South America shows that this palm has been present in the region since at least the last four glacial cycles. During the LGM, *Mauritia* was likely restricted to few but widespread sites of favourable microclimatic conditions (microrefugia) from where the palm expanded during the Holocene. During the last 2000 years, *Mauritia* underwent a remarkable expansion in northern South America, which includes the GS. It is proposed that humans could have played a role in this regional expansion of *Mauritia* communities.

THE SEA LEVEL CHANGE RECONSTRUCTIONS INFERRED FROM MARINE SEDIMENT CORES IN SOUTHERN BRAZIL

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The wetlands in the costal area have developed a special ecosystem for the biodiversity of vegetation and habitats for different life forms of animals in the low land of the Atlantic Rain Forest. Their development and degradation could be influenced by many aspects, such as sea level change, precipitation and freshwater input. From this study, several marine sediment cores were studied to reconstruction the water condition and sea level change along the coastal of southeast Brazil. The results indicate that the wetlands in the costal area of Atlantic Rain Forest are greatly influenced by marine and the sea level change could be reconstrcuted. The interactions between Brazil current from the tropical region and the cold Mavinas currents from the south could also influence the temperture and precipitation in the wetland.

Merian Award Applicant

CHANGES OF MANGROVE VEGETATION AFTER DESTRUCTION AND REGENERATION IN THE BARRA VIÉJA LAGOON (CIÉNAGA GRANDE DE SANTA MARTA, COLOMBIA)

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The lagoon system of the Ciénaga Grande de Santa Marta (Colombia) was exposed to adverse hydrological conditions during the second half of the past century. As a consequence 56 % of the mangrove forests died. In the Barra Vieja lagoon, a little water body behind the beach ridge, mangroves perished immediately after the construction of the Barranquilla-Ciénaga Road (1955 to 1960) due to the interruption of water exchange with the nearby Ciénaga Grande. The construction of two box culverts under the road (1989 and 1995) renewed the water exchange between the two water bodies and made mangrove regeneration possible. The comparison of aerial photographs taken at different times from 1953 to 2013 and studies of the initial mangrove regeneration gave evidence about differences between the original and the regenerated mangroves. Before road construction, mangroves of the Ciénaga Grande were in connection with the Barra Vieja lagoon where they formed two stands separated by a channel. Additional mangroves were found at the lagoon border. Mangroves of one of the two sites formed a dense forest of triangular outline and showed four little mangrove islands in front of the northern top. The second site passed over to a sand dune with bare patches in its center. After the construction of the road all mangroves died with exception of those growing on the beach ridge. About eighteen years after its beginning mangrove regeneration was completed. Differences with regard to the distribution of mangroves were seen in the first site. The little mangrove islands and the triangle disappeared. Instead, mangroves formed three strips parallel to the road and separated by narrow ditches. The second site maintained its shape, the covered area increased and bare patches were hardly visible. Our studies suggest that varying edaphic factors and erosion by wind and water contributed to the changes observed.

LAST CA 2800 YR HISTORY OF THE JAVA SEA ENVIRONMENT RECONSTRUCTION BASED ON THE ORGANIC-WALLED DINOFLAGELLATE CYSTS

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To obtain a better insight into the short-term local environment fluctuations in the Java Sea coastal waters off SE Kalimantan (Indonesia) during the late Holocene, a 134 cm-long sediment core collected ~50 km off the Pembuang River mouth and covered the time between ca 2850 and 990 cal yr BP was investigated for independent palaeoecological proxies including organic-walled dinoflagellate cysts, pollen and biogeochemical parameters, e.g. organic carbon (C_{org}), total nitrogen (N_{tot}) and calcium carbonate ($CaCO_3$) contents as well as carbon and nitrogen stable isotope composition ($\delta^{13}C$, $\delta^{15}N$). Sediments consist of mixed terrestrial and marine organic matter, are characterised by low nutrient uptake and suggest generally low river discharge that is supported by very low pollen and spore concentration (256 pollen grains g^{-1} and 20 spores g^{-1} at maximum, respectively). Foraminifera and coccolithophores dominated the plankton over dinoflagellates and diatoms. Dinoflagellate assemblages are composed mainly of transparent oxidation resistant species that belong to *Operculodinium* and *Spiniferites* genera with a minor contribution of *Impagidinium (Imp. strialatum* mainly). Amount of brown colored, both round and piredinoid cysts, is low and decreases from bottom of the core to top. Palynological and biogeochemical data appeared to be well-correlated and synchronously reflected changes in the marine environment. After 2480 cal yr BP, ventilation of waters apparently intensified. The typical offshore dinocyst association had been gradually replaced by a coastal-water one between ca 2040 and 1530 cal yr BP that is most likely attributed to El Niño-induced seasonal differences between dry and wet periods of the year. After 1530 cal yr BP, a more pronounced influence of the Pembuang River was indicated by an increased $\delta^{15}N$ and decreased $\delta^{13}C_{org}$ that is supported by the occurrence of nutrient sensitive *Lingulodinium machaerophorum* and *Nematosphaeropsis labirinthus.*

8000 YEARS OF ENVIRONMENTAL CHANGE FROM LAKE LANOTO'O, SAMOA (POLYNESIA)

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The environmental history of the Polynesian Islands remains poorly understood due to a paucity of study sites. Consequently there is continued debate regarding the relationship between climate and environmental change, as well as the timing and impact of the first people, on the islands. Archaeological evidence (pottery) indicates that people were on the island of Samoa by c. 3000 years ago; however, it is possible that populations were living on the island significantly before this time. To provide new insight into past environmental change on Samoa a 247 cm long core was raised from Lake Lanoto'o in 2014 using a cam-modified Livingstone corer. Preliminary age estimates suggest that deposition was continuous and that the base of the core is c. 8000 years old. Palaeocological analyses of subsamples from the Lake Lanoto'o sediment core provide new information on: (i) vegetation (pollen and seeds), (ii) fire (micro- and macro-charcoal), and (iii) lake status (algae).

Pollen/spore data indicate that, at the regional level, the vegetation community composition was relatively stable during the last c. 8000 years. However, notable indicators of a change in the local vegetation are the appearance of an unknown seed macrofossil at c. 3000 years (81 cm), and a rise in tree fern spores and fern sporangia (macrofossils) during the last c. 1000 years (31 cm). The calculated area of the charcoal particles found in the Lake Lanoto'o core suggests that the frequency of fire events close to the lake altered greatly during the period of sediment accumulation: c. 8000-3000 years ago (257-81 cm) one event, c. 3000-1200 years ago (81-37 cm) two events, and c. 1200 to modern (37-0 cm) fire was a continuous feature on the landscape around the lake (at the level of detection). The abundance and composition of the algae assemblage indicates a similar lake status through most of the period of sediment accumulation in Lake Lanoto'o apart from the period c. 5200-4200 years ago (138-112 cm). This preliminary palaoecological analysis of the Lake Lanoto'o sediments does not suggest humans were having a major ecological impact on Samoa prior to 3000 years ago, but also does not preclude an earlier human presence on the island.

VEGETATION CHANGES AND HUMAN IMPACT INFERRED FROM AN OXBOW LAKE IN SOUTHWESTERN AMAZONIA, BRAZIL SINCE THE 19TH CENTURY

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As a first palaeoecological approach on late Holocene vegetation changes on the Acre River floodplain, our study focuses on the different changes in vegetation inferred from the sediment deposits in the oxbow lake Lago Amapá, including the expansion of Rio Branco City and the influence of the Acre River on the lake. Radiocarbon dating, pollen and X-ray fluorescence spectrometry (XRF) data were used for this pilot study to investigate the potential of oxbow lakes in western Amazonia for palaeoecological research.
Radiocarbon dating of older sediments failed due to re-deposition of organic material but a historical map suggests that lacustrine deposition started at 1900 AD. We detected two periods of changes in sediment and vegetation, dominated by pioneer taxa especially Cecropia. The first period around 1900 AD is documenting an initial oxbow lake, with regular fluvial input (high Ti) and low accumulation of organic matter (low inc/coh ratio). During that period Andean pollen taxa originating from Peruvian Andean headwaters were deposited. A fully lacustrine phase started about 1950 AD and is characterized by prolonged periods of stagnant water (low Fe/Mn ratio). The increase of pioneer taxa, sedimentation rates and a reduction of most of the XRF element counts point to a period during which Lago Amapá was a more isolated lake which was flooded only during exceptional severe flood events and is catching mainly anthropogenic disturbances. The extensive human influence during this period was assumed by 1) the high occurrence of pioneer taxa and the absence of charcoal which could indicate changes in vegetation possibly as a result of logging, 2) the Ca and Ti/K ratio which reflect changes to a local sediment source, and 3) comparison of Landsat images from the last 30 years which shows broad changes in vegetation cover and land transformation in the peripheral areas of the oxbow lake.

OVERVIEW OF QUATERNARY POLLEN RECORDS IN CENTRAL AND SOUTH AMERICA, CARIBBEAN AND MEXICO

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For over a decade the general impression of research on past and present pollen–vegetation relationships has been incomplete in most of the Neotropics. Continental-scale synoptic studies often missed out on the vast majority of potentially available studies and data. Here we present an inventory of palaeoecological research in Central and South America, Caribbean and México, in terms of pollen records and modern rain samples. With a set of maps, we show that there are over 1400 cores and sections with palaeoecological data and more than 4800 modern samples. Some biomes and regions have a relatively high research density while the scarcity at others offer opportunities for future research. An increasing number of records are sustained by geochronological control points for age modelling, and multi-proxy studies are taking the lead over single proxy publications. This compilation of research shows the numerous innovative topics currently being explored to increase our understanding of palaeoenvironmental settings and modern vegetation-pollen relationships. To impulse divulgation and collaboration, we present the newly developed website and interactive map interface, where this inventory and corresponding reference database is publically available. Researchers and students are invited to pinpoint their new studies and publications, making interactive use of this platform for increased detectability and awareness on available publications.

PERFORMANCE OF A NEW CLIMATE MODEL (CHELSA) IN TROPICAL MOUNTAINS

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Climate models are an important tool for species distribution analyses and biodiversity research. High resolution data on temperature and precipitation is so far mainly based on an interpolation of recorded data from climate stations. Tragically, climatic stations are especially scarce in areas harboring high biodiversity such as tropical rainforests. The reliability of such high resolution climate data to predict species distributions in the tropics has therefore been often questioned in recent years.
Here we present the new freely available climate model CHELSA (Climatologies at High resolutions for the Earth's Land Surface Areas) on a global scale. CHELSA is a quasi-mechanistic, statistically downscaled model based on a global circulation model (ERA-interim) for temperature and precipitation between 1979 and 2015. It specifically acknowledges the high non-linearity of precipitation patterns with altitude and includes important predictors for precipitation such as global wind fields, cloud condensation levels and cloud water content.
Based on examples of highly specialized wet and dry adapted species, we can show that species distribution models based on CHELSA are more reliable and have higher explanatory value in tropical mountains than previous models.

THE AMAZON RAINFOREST EXPANSION AT THE BOUNDARY OF HOLOCENE AND PLEISTOCENE

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The boundary of Holocene and Pleistocene that occurredbetween 12-11 k yr BP is characterized by extreme climate change from a colder Younger Dryas to the warmer Holocene. Although the oxygen isotopic composition of planktonic foraminifera recovered from a marine sediment core in a region of Amazon River discharge shows that the Amazon Basin was extremely dry during the Younger Dryas, terrestrial palaeo-palynological records from north-eastern, eastern and south-eastern regions around Amazon rainforest show an increase in pollen percentage of arboreal vegetation. Here we review and discuss results of 8 terrestrial records to reconstruct the climate of Holocene and Pleistocene episode based on vegetation history.

Merian Award Applicant

ECOLOGY OF BIRD COMMUNITIES ALONG AN ELEVATIONAL TROPICAL GRADIENT IN PAPUA NEW GUINEA

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Elevational gradients continue to provide an attractive setting for biodiversity studies and serve as a heuristic tool and natural experiment in the study of community ecology. Here we present robust quantitative data on bird communities along a complete *undisturbed* rainforest elevational gradient. Our aim was to describe bird communities in detail and inspect various aspects of their ecology and patterns along elevational gradient. Our gradient is located on the slopes of Mt Wilhelm in the Central Cordillera, spanning from the lowland floodplains of the Ramu river (200m) to the tree line (3700m). We collected bird community data at eight sites (500m elevational increment) during five independent surveys – in dry, wet seasons and extremely dry sesaons (El Nino event). We used point counts, mist-netting and random walks throughout the area to survey birds. We divided all recorded birds (more than 40,000 individuals comprising 248 species) into five feeding guilds (frugivores, frugivore-insectivore, insectivores, insectivore-nectarivores, and nectarivore). We examined patterns of species richness, density, range size and distribution of birds. We further describe patterns in functional diversity and seasonal movements of birds. Data indicate that species richness and abundance of birds is highest at the lowest elevations and decreases steeply for all birds together and for frugivores. However, the diversity and abundances of insectivores remains constant until 1700 m a.s.l. and then decreases with increasing elevation. The patterns in frugivore-insectivores and insectivore-nectarivores are more similar to those of insectivores rather than frugivores. The similarity index for all bird communities is a logarithmic function of their difference in elevation, decreasing more steeply for insectivores and other insect-eating groups than for the frugivores. We observe overall highest species turn-over at mid-elevations (between 1200-1700m), and highest abundances of insectivorous birds at 700–1700m. Extreme droughts during of El Nino even in 2015 had significant effect on bird communities, especially on frugivorous birds at lower elevations. Finally, we discuss effect of phylogeny and spatial auto-correlations on our results.

DIVERSITY OF VASCULAR EPIPHYTES ALONG GRADIENTS OF ELEVATION AND ANTHROPOGENIC INFLUENCE AT COFRE DE PEROTE, VERACRUZ, MEXICO

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Vascular epiphytes are a conspicuous and highly diverse group in tropical forests, contribute substantially to tropical plant diversity and their diversity varies considerably along elevational gradients. Epiphytes are particularly vulnerable to the loss of primary habitat and anthropogenic changes of forest structure. This study aims at analyzing the diversity, distribution and floristic composition of vascular epiphytes along gradients of elevation and anthropogenic disturbance at the eastern slopes of Cofre de Perote (Veracruz, Mexico). Here, we studied eight different study sites in elevational belts of 500 m each between sea level and 3,500 m. The elevational gradient covers six types of natural vegetation: 1) semi-deciduous forest (0-500 m), 2) tropical lowland oak forest (500 to 1,300 m), 3) humid montane forest (1,400-2,400 m), 4) pine-oak forest (2.400-2.800 m), 5) pine forest (2.900-3.400 m) and 6) fir forest (3.500-3600 m). Fifteen plots of 20 x 20 m were established in each elevational belt; five plots each in old-growth forest, disturbed forest and secondary forest. Epiphytes were sampled on one mature tree per plot from the base to the outer portion of the crown, using the single-rope climbing technique. Additionally, we recorded the presence of all epiphytes in the understory, using collecting poles and binoculars. A total of 297 morphospecies were found along the elevational gradient. Orchidaceae was the most species-rich group (79 spp.), followed by Pteridophyta (75) and Bromeliaceae (57). Other groups, such as Piperaceae, Araceae and Cactaceae, were less represented with 20, 19 and 16 species, respectively. Surprisingly and contrasting other elevational gradients, the highest number of epiphyte species (74) was found in the 500-1300 m belt and orchids were particularly well represented. Further diversity peaks occurred at 2,000-2,500 m (56-53 species), respectively, which was due to the significant contribution of ferns in the humid montane forests.Further studies are planned to get a clearer picture related to diversity and distribution of vascular epiphytes and their response to environmental disturbance.

FIRST PLOT BASED RICHNESS DATA OF FERNS AND ANGIOSPERMS ALONG ELEVATIONAL GRADIENTS IN MYANMAR AND THE HIMALAYAS

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The mountains of northern Myanmar belong to the Southeast Himalaya-Yunnan Biodiversity Hotspot, but the flora is virtually unknown. Between 2012 and 2014, three research expeditions aim at a first assessment of plant species richness along elevational gradients (Natma Taung National Park/ Hponyin Razi). The main goal of this project is the first plot-based assessment of fern and angiosperm species richness along elevational gradients in the southeast Himalayas at the transition zone from the Paleotropic to the Holarctic floristic realm. Additionally we established climate stations at four elevational steps to measure temperature, air humidity, and precipitation. On the long run, this project is an initial step and capacity building for further research activities on the flora and vegetation of Myanmar.

We sampled four plots of 20 x 20 m^2 at every elevational step of 200m between 400m and 3050m on Natma Taung and between 400m and 4035m on Hponyin Razi up to mountain tops within the alpine belt.

Species richness for ferns show hump shaped patterns at both study sites in contrast to the angiosperms, which show a linear decline in both transects with increasing altitude. The highest species number of ferns on Natma Taung was observed at 2400m, whereas the richness peak on Hponyin Razi was situated considerably lower at 1200m, although this mountain range is by far higher. Moreover, total rarefied species richness is by far lower on Natma Taung than on Hponyin Razi, although reaching further south towards the tropics. These differences in fern diversity patterns between mountains relatively close to each other may be explained by the climatic configuration of the region with dry central valleys in the south and probably by migration pathways within the mountain range in the north.

This Myanmar-initiated research project contributes to the "Flora of Myanmar". Mountain biodiversity transect studies should be extended to all other mountain areas of Myanmar to understand patterns and drivers Myanmar's flora. The present joint research is organized under a "Memorandum of Understanding" between Ministry of Environmental Conservation and Forestry and Philipps University, Marburg from 2012 until 2017 with the intention to extend and widen the scope to other fields of biodiversity research.

VEGETATION PATTERNS ON SEVEN HIGH-ANDEAN SUMMITS: RESULTS OF TWO VENEZUELAN SITES OF THE GLORIA CLIMATE CHANGE NETWORK

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The GLORIA network has been documenting the impacts of climate change on alpine vegetation since 2001. Venezuela jointed the GLORIA-Andes network in 2012. Basic information has been collected on vegetation diversity and structure at two mountain ranges: Sierra Nevada de Mérida (Gavidia, 4 summits, 3820-4270 m) and Sierra de la Culata (Piedras Blancas, 3 summits, 4200-4600 m). Data was collected following the GLORIA field manual for permanent plots (www.gloria.ac.at) Species richness declined with elevation from 69 species at 3800 m to 14 species at 4600 m. Shrubs and grasses were dominant in Gavidia with deceasing importance of shrubs at 4270 m. Whereas shrubs and rosettes dominated in Piedras Blancas at 4200 m, which changed to a rosettes and herbs dominated vegetation at 4400 m, at 4600 m mosses and lichens were dominant. Giant rosettes of the *Espeletia* complex were among the 10 most abundant species in all summits except the highest. The identity of these plants changes along the elevation gradient. Our results indicate that vegetation structure differ among mountain ranges and change with elevation. These facts provide diverse scenarios useful to follow and understand the impacts of climate change on these unique and threatened ecosystems.

GRADIENTS AND DRIVERS OF AMAZONIAN TREE BARK AND LEAF LITTER BEETLE DIVERSITY

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Insect species richness in tropical rainforests is in focus but the forest habitat compartment tree bark is poorly studied, especially for hyper-diverse orders like Coleoptera. This study contributes to closing this gap.

In order to detect diversity patterns, drivers and gradients of Coleoptera assemblages, tree bark was sampled by barkspray method in a lowland rainforest in French Guiana. 160 tree trunks on 16 plots were sampled in 2011 and 11 plots (110 trees) were resampled in 2014 in the Réserve Naturelle Les Nouragues. Additionally, the litter fauna was sampled in 2014 on seven plots (70 samples) at each respective tree base. The Coleoptera were analyzed according to their spatial beta diversity, using similarity indices and correspondence analysis techniques (CA, CCA). 2224 beetle individuals out of 577 morphospecies and 50 families were counted in this study. 354 morphospecies and 1377 individuals were found in bark samples and 241 morphospecies and 847 individuals in litter samples. 1080 morphospecies were predicted ($Chao_2$) for the bark and 545 morphospecies for the litter, showing no saturation and indicating that litter beetle diversity was lower and more predictable than the corresponding tree bark fauna. Tree bark turned out to harbor a distinct fauna, with only 18 overlapping morphospecies with the litter which is only 3 %. Thus, the tree bark represents an own compartment in a forest ecosystem and is not just a continuation of the nearby litter stratum. Furthermore, the litter fauna was more homogenously spread over the study area than was the bark fauna, which was more stochastically distributed over the trunks. It can be concluded that under island biogeographical aspects, tree trunks are „*islands in a sea of litter*".

ALLOMETRIC SCALING RELATIONSHIPS IN THE MORPHOLOGY OF TEMPERATE AND TROPICAL ARTHROPODS

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Temperature is known to be an important ecological factor affecting morphology, physiology and behavior of all living organisms. Effects of temperature are becoming more topical with models predicting considerable climatic shifts in near future. Previous studies applying generalized temperature-related rules to arthropod taxa were faced with the challenge that there are different parameters to assess body size for arthropods such as body mass, length, height and head length. We therefore aim to provide a generalized approach for temperature and biomass related studies, as well as providing an unprecedented taxonomic range of allometric regression models for arthropods describing length-mass, area-mass and volume-mass scaling relationships. Over 6500 individual animals were collected in two climatic zones, i.e. temperate (Central Germany) and tropical regions (Sumatra, Indonesia). Live body mass, length, width (head, thorax and abdomen), area, outline and height were measured for all Individuals which were identified to family level. The data will allow to test (1) if scaling relationships differ between different taxonomic groups, (2) if arthropods, in general, have smaller adult body sizes in warmer climates and (3) if observed patterns can be applied to higher taxonomic levels. Our study will provide a more generalized approach to estimating body mass of arthropods by using parameters for taxa- and temperature-specific allometric scaling relationships. Future studies can use these parameters to accurately determine body size and biomass of tropical and temperate arthropods.

NATIONAL PARK MANAGEMENT IN AFRICA - PROTECTING BIODIVERSITY IN THE FRAMEWORK OF DEVELOPMENT COOPERATION

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Germany is investing in the framework of development cooperation serious amounts of money in African National Parks. The *GFA Consulting Group GmbH* is often the implementing agency for the invested funds into the parks (KfW funding mechanisms, GIZ projects in and around National Parks) and selects and supports the teams to do the national park co-management and deliver support for the national institutions.
The poster will present some of the biodiversity rich parks in Africa, where *GFA Consulting Group GmbH* is active (e.g. in the Democratic Republic of Congo, Cameroon Central African Republic), the approaches in the different parks to protect and maintain biodiversity and options for researchers to join.

BAT CONSERVATION IN CUSUCO: TRENDS OF ANNUAL MONITORING OF THE CLOUD FOREST FAUNA

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Tropical highlands represent a small portion of the overall bat richness in the Neotropics. However, these highlands have been less studied and are currently under extreme anthropogenic pressure due to deforestation. Moreover, progress towards nature protection in developing countries usually falters due to lack of financial resources, technical capacity or stakeholder collaboration. Since 2006, bat surveys has been conducted to determine certain trends (such as species richness and composition), extracted from the monitoring data collected during years in Cusuco National Park. Survey is dedicated to compare trends between the different habitat types in the area, using standardized methods to monitor the effects of anthropological disturbance on cloud forest diversity over time. Key strengths of the approach include the capacity to address local scale ecological patterns, anthropogenic impacts, and management needs. In bat research, long-term monitoringin tropical cloud forests are scarce, we only must situate our research in a broader conservation context and evaluate the outcomes of management decisions.

SESSION 12-P4 - FREE TOPICS

A STANDARD PROTOCOL FOR WOODY PLANT INVENTORIES AND SOIL CHARACTERIZATION USING TEMPORARY 0.1-HA PLOTS IN TROPICAL FORESTS

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The use of both uniform woody plant inventories and laboratory soil analysis methods facilitate data sharing and improve the understanding of large-scale biological patterns in tropical forests. Temporary small 0.1-ha plots are fast and cheap to install and are being increasingly employed in the tropics. We present a standard protocol for woody plant inventories and soil characterization using 0.1-ha plots. This protocol gives specific recommendations on the size and shape of a 0.1-ha plot, taxa to be included in the inventories, minimum stem diameter cut-offs, evaluation of multiple stems, and height estimation. In addition, we make a number of recommendations on soil sampling and analysis, which are very much required in tropical forest ecological researchissue requiring standardization in floristic and ecological research. Our suggestion is to measure simultaneously Al and nutrients with after Mehlich-3 extraction, followed by inductively coupled plasma spectrometry, and to measure C and N through total combustion. pH, texture and bulk density can be measured with standard manual methods. Finally, we include some guidelines to create and maintain standardized databases and proper metadata. All the proposed recommendations are compatible with those already employed in the (standardized) establishment of large plots. Each recommendation represents a reasonable trade-off between investment and data quality, and allare oriented to obtain low-cost standardized baseline data that could be very useful in a broad range of studies when used together.

SESSION 12-P5 - FREE TOPICS

CAMTRAPR: AN R PACKAGE FOR EFFICIENT CAMERA TRAP DATA MANAGEMENT

Jürgen Niedballa[1], Alexandre Courtiol[1], John Mathai[1], Azlan bin Mohamed[1], An The Truong Nguyen[1], Rahel Sollmann[1,2], Andrew Tilker[1], Seth Wong[1], Andreas Wilting[1]

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Camera-trapping is a widely applied method to study the ecology and biodiversity of medium-sized to larger terrestrial mammals and is particularly valuable in challenging environments. Operating a grid of camera-traps day and night can easily accumulate tens of thousands of photographs in a short period of time. Therefore, transforming raw images into a data base suitable for analyses involves a high amount of manual input; a time-consuming, tedious and error-prone task. We developed the R package ‚camtrapR', which streamlines camera-trap data management and minimises manual input while providing sufficient flexibility to be compatible with different survey designs. It provides a complete workflow for camera-trap data organisation and management, species and individual identification from images, extraction and tabulation of data from images, visualisation of results and flexible export of input files for subsequent analyses, particularly within occupancy and (spatial) capture-recapture frameworks. Thus, the ‚camtrapR' package offers an efficient platform for reliable, reproducible and flexible camera-trap data management that seamlessly links data acquisition and data analysis in camera-trap based wildlife studies.

SAMPLING FOR REGRESSION-BASED SPATIAL PREDICTION: CLOSING THE GAP BETWEEN STATISTICAL DESIRES AND OPERATIONAL APPLICABILITY

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With respect to sampling for regression-based digital soil mapping, the above all aim is to ensure that the spatial variability of the soil is well-captured without introducing any bias, while the design remains feasible according to operational constraints such as accessibility, man power and cost. Representativeness of the sample concerning the population to be sampled needs to be guaranteed in any regression-based modelling approach. Four selected sampling designs were adapted to show that basically any design may be optimised to represent the n-dimensional predictor space of a particular area, while selecting points is only permitted from a small accessible sub-area or from outside the area. Sampling efficiency may be evaluated based on the representation of the predictor space. However, not only each predictor's probability function but also the interaction between predictors may have to be considered, to select a representative sample. Instead of sampling a previously un-sampled area with limited accessibility, the four sampling designs may also be used to subsample an existing dataset and, thereby, optimise a suboptimal dataset based on the predictor space of the area which shall be mapped.

THE EVOLUTIONARY HISTORY OF CENTRAL AFRICAN RAIN FOREST PLANTS: PHYLOGEOGRAPHIC INSIGHTS FROM SISTER SPECIES OF THE LIANA *HAUMANIA* (MARANTACEAE)

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The origin of high species diversity and its geographic distribution in the tropical African lowland rainforest is still a matter of debate. The rainforest refuge hypothesis claims that Pleistocene glacial – interglacial climate cycles might have fostered speciation by forcing rainforest plants to retreat into localized refuge areas of stable climate thereby isolating populations which in the following developed into independent species. Currently, the sites of such assumed refuges are inferred based on current patterns of species diversity and endemism, and gross historical changes in vegetation cover are supported by palynological data.

To gain further independent and more detailed evidence for the rainforest refuge hypothesis, we here analysed the phylogeographic pattern of two sister species of lianas from the genus *Haumania* (Marantaceae) distributed from Lower Guinea (Western Central African forest) to Congolia (Eastern Central African forest).

Data from plastid DNA sequences, AFLP and microsatellites (SSR) support an allopatric divergence scenario with *H. danckelmaniana* originating in Lower Guinea and *H. liebrechtsiana* in Congolia, concordant with different rainforest refugia. Subsequent population expansion then probably led to the current range overlap in Gabon where species occasionally hybridize. The intraspecific genetic structuring of *H. danckelmaniana* suggests ancient range fragmentation in at least three populations that may also highlight former forest refugia in Lower Guinea. Very deep differentiation is observed between populations of *H. liebrechtsiana* from Lower Guinea and Congolia, which might be due to a very old divergence and/or a massive introgression in Lower Guinea by *H. danckelmaniana.*

This study highlights that Lower Guinea and Congolia, which were defined as distinct centres of species endemism, can also correspond to differentiated gene pools within species.

TAXONOMIC REVIEW OF *HOFFMANNIA* SW GENREE. (RUBIACEAE) IN VERACRUZ STATE

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Hoffmannia Sw. is one of the biggest genres of Rubiaceae family (Hamelieae), it has nearly 100 different species in the world. Most of them are distributed in mountain areas South of Mexico and Central America; the objective of this study was to review *Hoffmannia* genre in Veracruz. The methodology mostly consisted in looking over the samples at the herbarium MEXU, ENCB, XAL, XALU, MO and F. Also, considering morphological complexity of the genre, conglomarate analysis were made using grouping method UPGMA, integrating presence-absense of 97 morphological characters, 7 types of flora and different altitude levels of 100-2200 m snm where these species were recorded; in the obtained results, 15 species of which *H. arqueonervosa* is a new one, four of them are new records (*H. cuneatissima, H. phoenicopoda, H. regalis* and *H. wilsonii*) and five are endemic of Veracruz (*H. arqueonervosa, H. minuticarpa, H. orizabensis, H. sp1, H. sp2*), also, in the analyzes performed it was observed that most species diversity is found between 500-700 y 1500 m snm, in deciduous forest, high evergreen forest and oak forest, according to this and with recent studies, the primary flora of forests has been decreased by more than 90% with small conserved fragments remaining, being the secondary flora the one that occupies most of the surface in the state. Because of this, the small fragments remaining must be protected, since 80% of the species of *Hoffmannia* are primary flora and just 20% are present in secondary flora, therefore primary flora conservation and protection is needed where recorded species are distributed in the state.

REPRODUCTIVE BIOLOGY OF *SPATHIPHYLLUM COCHLEARISPATHUM* AND *SPATHIPHYLLUM ORTGIESII* (ARACEAE) IN LOS TUXTLAS, VERACRUZ, MEXICO

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The reproductive biology of *Spathiphyllum cochlearispathum* and *S. ortgiesii* (Araceae) was studied in the region of Los Tuxtlas, Mexico. Both species live in close vicinity but are not sympatric (riparian habitat vs. forest understory), show different flowering patterns and a long anthesis (16-43 days). With more than 60% of all visits the pollen-foraging bees *Plebeia* sp. (Meliponini) and *Apis mellifera* (Apini), were the most frequent visitors of *S. cochlearispathum*. Besides this, male *Euglossa viridissima* (Euglossini), which collected floral scent at the inflorescences, were rare visitors (< 10% of all visits). All three visitor species were observed in both phases of anthesis. In contrast, *Trigona fulviventris* (Meliponini), another pollen-foraging bee dominated visits in both phases of anthesis in *S. ortgiesii* (> 90% of all visits). The two plant species showed differences in intensity, emission cycle and composition of floral scent. Between 21 and 42 compounds were identified in the floral scent of *S. cochlearispathum*, whereas only three compounds (predominantly 2-Phenylethanol) were detected in *S. ortgiesii*. Most major compounds in *S. cochlearispathum* match the floral scent composition of plants of the euglossine pollination syndrome, e.g. perfume orchids. Our experiments showed that the studied plants are neither autonomously autogamous nor apomictic, indicating that both species require the service of pollinators for reproduction. While the main pollinators of both species were pollen-foraging bees that usually visited all inflorescences of a cluster, the foraging behavior and duration of visits by *E. viridissima* suggest the promotion of a greater pollen-flow by this bee, ensuring higher gene variability. In addition, the results indicate that the floral scent composition and apparently the specific habitat are important in the reproductive isolation of the species.

SESSION 12-P10 - FREE TOPICS

OCCURRENCE OF *BACILLUS CEREUS* IN RAW MILK WITH REFERENCE TO ITS MOLECULAR PROFILE DIVERSITY

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The present study aims to clarify the molecular diversity of *B. cereus* isolated from milk and its susceptibility to lysozyme. A total of 153 individual raw milk samples were randomly collected. Bacteriological examination was carried out according to standard methods. In vitro susceptibility of *Bacillus* species to lysozyme was done for all isolates (No=153). ERIC-PCR fingerprinting was done for 10 *B. cereus* strains. It was found that 61 (39.9%) of milk samples were positive to *B. cereus*. Susceptibility to lysozyme was the highest in *B. cereus* (47.5%) among other *Bacillus* species. Molecular fingerprinting produced patterns of 11 major bands. Dendrogram revealed 3 main clusters. Dendrogram of PCR insert through ERIC fingerprinting could differentiate 10 isolates of *B. cereus*. It could be concluded from this study that the isolated *B. cereus* clones have diversity in terms of molecular profile and sensitivity to lysozyme.

SESSION 12-P11 - FREE TOPICS

FIRE FREQUENCY AND ITS EFFECT ON THE HABITAT USE OF FOUR-HORNED ANTELOPE AND SAMBHAR IN DRY DECIDUOUS FOREST IN INDIA

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Forest fire and grazing are considered as the main anthropogenic disturbances that have a wide range of effect on the herbivores through the modification of their habitat by altering food quality, quantity and cover for the protection from the predators. We assessed the impact of different fire frequency and grazing intensity on the habitat of two species in tropical dry deciduous forest in Kumbhalgarh Wildlife Sanctuary, Rajasthan, India.
Using a combination of remote sensing, GIS techniques and field methods, three fire frequencies from 13 years Landsat data (1999-2011) and three grazing intensity were from field methods were extracted. A total of 27 belt transects were laid representing the combination of different fire frequencies and grazing intensity. Indirect as well as direct signs of both the species were recorded for over two years covering two seasons (Pre-monsoon and Post-monsoon). Relative density of both the species shows that the Sambhar was found across all the areas covering different fire frequencies and relatively high in low and medium fire frequency but was absent from the areas having high grazing intensity. Four-horned antelope was found to be high in high fire frequent areas but was absent from the high and medium grazing. We conclude that both the species have different habitat requirements in terms of availability of food and cover. Sambhar require high grass/shrub cover interspersed with trees which is the result of low to medium fire frequency and low to medium grazing intensity while Four-horned antelope requires small grass in its habitat which is the result of frequent fire with low grazing. It can also be seen that the habitat of Sambhar and Four-horned Antelope are not overlapping because of different habitat requirement. Different herbivore species require different disturbance regime for their suitable habitat in the current scenarios but effective wildlife management should include management of these two major disturbances for the management of their habitat.

THE APPROPRIATE TECHNIQUE FOR WATER QUALITY ASSESSMENT IN OIL PALM PLANTATIONS

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Oil palm cultivation in Indonesia has seen continuously growth to meet national and global demands. However, the expansion of oil palm has led to environmental impacts such as deforestation and peatland degradation. To reduce environmental impacts, the Roundtable on Sustainable Palm Oil (RSPO) has become a major certification body for palm oil and "Best Management Practices" (BMPs) have been developed and used to protect water and soil qualities during palm oil planting activities. However, there is limited monitoring of water quality and insufficient methods for assessing biological properties of the aquatic environment.

Using aquatic macroinvertebrates are a cost-effective method to evaluate the physical and chemical aquatic conditions. Methods based on macroinvertebrate are also efficient on abnormal aquatic phenomenon that suffered from pollution sources. The biological monitoring working party (BMWP) score has been developed with water chemical indices for monitoring temperate stream quality. BMWP methods have been modified for use in tropical areas such as Malaysia, Thailand and Vietnam. Here we investigate the differences between the different regional BMWP scores and assess whether a general score is appropriate to use in Indonesia, where regional score is yet to be developed.

SPIDER DIVERSITY IN THE OIL PALM LANDSCAPE

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Oil palm is one of the most rapidly expanding agricultural crops, and conversion of rainforest to oil palm plantations is now one of the primary threats to rainforest species diversity, particularly in Southeast Asia. Despite the prevalence of oil palm agriculture in tropical biodiversity hotspots, we know comparatively little about biodiversity and ecosystem function within plantations themselves. In this study, I compare the diversity and community composition of spider species in a tropical forest in Sumatra, Indonesia before and after conversion to oil palm plantation. Spiders, as top arthropod predators, are critical to ecosystem function, and are known to contribute to pest control within many agricultural systems. Yet few if any studies have been carried out investigating their contribution to ecosystem function within the oil palm landscape. I address this lack of knowledge with spider samples collected from oil palm plantations as part of the Biodiversity and Ecosystem Function in Tropical Agriculture (BEFTA) project in Sumatra, Indonesia.

Merian Award Applicant

LONG-TERM EFFECTS OF CROP RESIDUE APPLICATION ON SOIL BIOTA ACTIVITIES AND FUNCTIONS IN OIL PALM AGROECOSYSTEMS

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Empty fruit bunches (EFB), the oil palm residue left after extraction of the palm oil, are increasingly used as an organic fertilizer and mulch substrate in oil palm plantations. EFB addition to the soil has been shown to increase nutrient availability and crop yield compared to conventional chemical fertilization. These changes involve soil biota, which alters soil ecosystem functions such as decomposition and nutrient mineralization. Here we examined the long- term effects of EFB application on soil biological activities and functions in an Indonesian oil palm plantation. EFB was added to replicate field plots at rates of 30, 60 and 90 ha^{-1} yr^{-1} 15 years prior to this study, with comparison plots receiving conventional chemical fertilization. EFB application did not result in significant changes in earthworm density but a decrease in earthworm biomass. The majority of earthworms belonged to endogeic species *Pontoscolex corethruru*. EFB application significantly increased soil mite density, soil fauna feeding activity and soil microbial respiration compared to chemical fertilization. Soil mite density positively explained soil fauna feeding activity. Soil mite density and microbial respiration were independent of EFB application rate, while soil fauna feeding activity was higher in EFB application with lower rates. While EFB application is not widely implemented within the oil palm industry, this study suggests that it has the potential to become an important method of increasing soil fertility and reducing dependence of chemical fertilizers, in-line with sustainable oil palm production and certification.

Merian Award Applicant

ECOLOGICAL RESTORATION IN AN OIL PALM LANDSCAPE: EARLY PERFORMANCE OF TREES PLANTED IN A BIODIVERSITY ENRICHMENT EXPERIMENT

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Transformation of rainforest into large-scale mono-cultural oil palm plantations has led to dramatic losses in biodiversity and ecological functions. While there is broad consensus that the re-establishment of diverse habitats and the restoration of ecological multi-functionality in oil palm-dominated landscapes is an urgent need, there is little knowledge on how this can be implemented in a way that is ecologically and economically equally effective.
In order to investigate the general underlying mechanisms and specific management strategies of biodiversity enrichment with trees, we established 56 experimental tree islands within a large-scale mono-cultural oil-palm plantation in the province of Jambi (Sumatra, Indonesia) in December 2013. We systematically varied plot size (5x5 m to 40x40 m), tree species diversity (zero to six) and composition of a total of six multi-purpose tree species, which are native to Sumatra and which deliver a variety of products (fruits, latex, timber) to local people. Based on time series of mortality and growth of the planted trees during the critical establishment phase of the experiment, we evaluated the suitability of the chosen species for mixed-tree plantations in oil palm plantations. We report an overall establishment success of the experiment after the first 21 months. Total mortality rate was 31%, but varied significantly among the species (ranging from 19 to 64%). Over the first 18 months, we found significant differences in height and diameter increment among the species (mean relative growth rates ranged between 3.7 and 8.5 for height and 3.8 and 10.2 for diameter). Tree species composition, plot size and intra- and interspecific competition do not appear to significantly affect tree survival and growth at this early stage of the experiment. However, in the near future, we expect a shift of the main factors driving the establishment success and growth trajectories from species-specific life history traits to inter- and intraspecific competition for resources.

A WIN:WIN TROPICAL LANDSCAPE RESTORATION: EVIDENCE FROM COCOA AGROFORESTRY SYSTEM

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Ghana is one country that comes to mind when cocoa is mentioned. Cocoa constitutes 85 % of the foreign export earnings from the agricultural sector and employs over 800,000 families. Ghana loses 65,000 hectares per annum with cocoa farming been alleged as a contributing factors. The current trend indicates that cocoa farmers in Ghana are drifting from forest shaded system to the no shade. This system is adding up to the high rate of deforestation, biodiversity loss, input demand, short productive life and low yield over time. It is quite apparent that with dwindling forests for new planting, cocoa agroforestry holds the key to future outputs and productivity in cocoa production. There is a gap in knowledge on understanding interactions between native tree species and cocoa. The research therefore aims at determining the yield trends in cocoa under different forest trees level. Multi stage sampling technique was employed to selected 200 cocoa farmers in the study area. Data obtained from the respondents were analyzed using descriptive statistics and inferential analysis. The yield curve model was also adopted to determine the yield trend under the various cocoa agroforestry systems. From the analysis, the R square value obtained under the no shade, low shade, medium shade and heavy shade are 77%, 61%, 53% and 56%, respectively. The highest average yield per hectare was attained for the no shade in year 16 (794 kg ha^{-1}), for the low shade in year 22 (696 kg ha^{-1}), for the medium shade in year 19 (735 kg ha^{-1}) and for the cocoa under heavy shade in year 15 (546 kg ha^{-1}). The conclusion of the study is that, although the no shade cocoa system has higher yields, it is input demanding, environmentally unfriendly and has short productive life. Therefore the most effective way of maintaining the remaining forest cover, optimizing ecological, economic, and social outcomes and therefore need to be promoted in Ghana.

BEE DIVERSITY RESPONSES TO LANDSCAPE COMPOSITION IN THE ANDES OF COLOMBIA

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Landscape composition has a great influence on the provision of ecosystem services such as crop pollination by bees, which seems to be enhanced by higher proportions of natural habitat in productive landscapes. However, bee diversity has been largely assessed in the productive matrix, and available information derives primarily from temperate countries with extreme levels of habitat loss. The aim of this study is to evaluate bee diversity in natural habitats in relation to its area and quality in a fragmented landscape in the Andes of Colombia. The study area is composed mainly by sub-Andean forests and grasslands for livestock. Bee diversity, vegetation structure and floral resources were recorded in 20 sites representing a gradient of natural habitat area within a 500 m radius. Bee sampling was carried out in forest edges along 150 m - transects using three methods: netting, pan-traps (blue, yellow and white) and chemical baited-traps. Additionally, in order to assess the use of the grassland matrix by bees, they were collected in eleven 150 m-transects (100 m from any forests), by netting and pan-traps. A total of 2390 individuals were collected in forests and 879 in the grassland matrix. Bee assemblage in forest edges were dominated by the family Apidae (75%), particularly tribu Meliponini (48%), whereas in the matrix, family Halictidae was dominant (61%). Preliminary results indicate different responses to habitat quantity within the bee assemblage; Meliponini diversity show a positive relation with forest quantity whereas Halictidae diversity responds negatively. From the 63 species registered, 24 genera and at least 10 species were recorded for the first time to the study area, representing a significant knowledge contribution to the bee diversity and their ecology in Colombia and the Neotropical region.

IMPACT OF EMERGING CHARCOAL PRODUCTION IN THE MIOMBO WOODLANDS OF CHITEMBO, SOUTH-CENTRAL ANGOLA

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Charcoal is one of the main sources for domestic energy in most African countries, due to high costs of electricity and limited access to alternative sources of energy. The global charcoal production was estimated in 47 million tons in 2009, with an increase of about 9% since 2004. This trend was strongly influenced by Africa, with about 63% of the global production. In Angola, nearly 40% of the population lives in rural areas where charcoal trade is often the most important source of income.
The current study was carried out in the municipality of Chitembo in south-central Angola. Data collection was done per kiln site and semi-structured interviews were used to obtain data from charcoal producers on livelihood strategies, incomes derived from charcoal, use of forest resources, and species harvested for charcoal production. Vegetation data were collected within ten nested 20 m x 50 m plots. All trees with girth ≥ 15 cm were measured, the species were identified by their local name and scientific name.
The objectives of the study were (a) to quantify the charcoal production in the study area, (b) to analyze itssocioeconomic importance for local livelihoods, (c) to identify the tree species most affected by charcoal production and (d) analyze their population structure.
30 charcoal producers were interviewed. On average the number of trees harvested is 110 ± 14 to produce 54 ± 9 bags of charcoal. Based on the total number of bags produced per kiln (1529 bags) multiplied by the expected kilns produced per year (125) we estimate 191.125 bags corresponding to 19.112 tons of charcoal per year produced by the 30 entrepreneurs. This estimation may even be conservative. For most producers, charcoal is the main source of income after agriculture. The production meets the demand of the urban centersof Angola. *Julbernardia paniculata*, *Brachystegia spiciformis*, *Cryptosepalum exfoliatum* and *Burkea africana* are the most sought-after species. The vegetation data showed that *J. paniculata* was the most frequent species per plot, followed by *C. exfoliatum*, *B. africana* and *B.spiciformis*. The population structure showed little regeneration in closed stands, only few individuals were found in lowest diameter classes, with the exception of *J. paniculata*. The target species showed also few individuals in the largest diameter classes.

Merian Award Applicant

VEGETATION CHARACTERIZATION BY EDAPHIC AND PHYTOSOCIOLOGICAL ATTRIBUTES, PINDORAMA BIOLOGICAL RESERVE- SP- BRAZIL

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The Polo Centro Norte-APTA, Pindorama, Brazil is an agriculture research center that has 523 hectars of experimental areas and tropical seasonal semideciduous native forest remnants. The forest area which is 141 hectars was designed as the Pindorama Biological Reserve by the state law nº 4960 / Jan 6th,1986 and the vegetation of the Pindorama Biological Reserve was classified as seasonal semideciduous. The majority of the remnants in São Paulo state, Brazil, have small size, due to fragmentation with edge effects .The preservation of these forest areas is very important for local biodiversity preservation because they have many endemic species surrounded by agricultural cultivated areas. These species are arranged in a natural setting of successional mosaics is a complex areas and their existence is conditioned by several factors as climate, soil, altitude, light, water availability. To preserve and stimulate forest plantation in the surrounding areas there is a ssek for data of forest species phytosociology, their relationship and environmental influence on their existance. This study aimed to characterize the vegetation in the Biological Reserve of Pindorama, SP and rhe existance of edge efect and non-tree species infestation, using multivariate statistics techniques, based on physical and chemical soil properties and Phytosociological descriptors. The characterizing of the vegetation of the Reserve was made in in 65 plots of 400 m^2 evaluating soil attributes (physical analysis, pH, organic matter, phosphorous, potassium, calcium and magnesium, potential acidity, basis saturation) and altitude . In a quadrant 100 m^2 randomly chosen in the parcel the phytosociological describers as basal area, height and number of trees with diameter at breast height (DBH) ≥ 5 cm and and the non-tree species infestation was determinated. The hierarchical clustering based on soil attributes divided plots into two major groups and five subgroups to determine characteristics of vegetation, species diversity by the Shannon index (H ‘) and the Pielou coefficient (J). The multivariate statistical analysis was a very helpful tool to evaluate the soil influence on species ocurrance. It was observed that plots with soils that presented higher percentage of clay and higher fertility had higher infestation of non-tree plants and lower species diversity, basal area and height of tree species.

BUILDING COMMUNAL CAPACITIES IN THE AMAZON ALONG FOCAL: A STRATEGY TO HALT AND REVERSE DEFORESTATION

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The Peruvian Amazonian region is one of the most biodiverse regions in the world. However, protected areas, such as Cordillera Azul National Park, are increasingly threatened by human expansion and land-use changes. In order to confront this development, the NGO Cima supports local communities in elaborating land-use plans of their territories to prevent further deforestation. By using GIS data, qualitative interviews and survey data we evaluate the effectiveness of this instrument in two districts: Chazuta and Shamboyacu, in three dimensions: political output, social outcome and ecological impact. Based on Elinor Oström's (1994, in Pomeroy Ed) eight criteria for resource use management, the dimension of political output shows that communities established earlier achieved clear limits and use zones of their territory. While the design of the land-use plan aims at developing the instrument within existing organisational structures, it often prevents a broader participation and the interconnection to external influences and higher tier policies. In the social outcome, community members stated that planning efforts helped solving and prevent conflicts on land-use and property issues. A general recognition and acceptance within the population to respect community areas and forests was reached in most of the communities. Howeve, there was a general preference of community members for not to involve their neighbours in implementing resource use rules. As ecological impacts, a decreasing deforestation in the older communities in Chazuta is contrasted with a continuous deforestation in the rapidly growing communities in Shamboyacu. Overall, it can be said that land-use plans helped to reduce deforestation rates from slopes, rivers and sites of conservation. However, eventually effectiveness in reducing deforestation rates will strongly rely on the control of continuous immigration and incentives from higher political levels.

EVALUATION OF THE ABUNDANCE AND FREQUENCY OF THE REGENERATION STATUS OF THE PRIMARY FOREST IN THE CUC PHUONG NATIONAL PARK IN VIETNAM

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Regeneration of tree species plays a crucial role to ensure the sustainability of forest is more significant when it comes to the multiple functions of forest and their conflicts such as animal browsing, wood harvesting and the sustainable uses of non-timber forest products by the indigenous people. The aim of this research was to analyze the regeneration status in the primary forest. The fieldwork was conducted in the Cuc Phuong National Park (CPNP), located in northern Vietnam. 32 concentric sample plots were established in the primary forest for the inventory practice. Then, in each plot a circular concentric plot of 1.5m radius was established to determine the regeneration. The frequency and abundance and the number and name of the regeneration species was registered on the inventory forms. The whole fieldwork took around three weeks and the information was provided by the core zone inventory in CPNP. The data were collected from inventory forms and were transferred later on to Microsoft Excel for further analysis. In this study, the Importance Value Index (IVI) of the species found in the inventory was analyzed. Furthermore, the population structure of the primary forest was evaluated based on the inventory data. The results indicated that *Streblus macrophyllus* is the most abundant regeneration in the studied area. Moreover, there is no regeneration for 23 tree species out of 75 species found in the sample plots. If the current biodiversity status continues, there might be a biodiversity loss of some plant species in the near future.

A COMPARISON OF BIOMASS, PRODUCTIVITY AND LEAF FUNCTIONAL TRAITS BETWEEN TERRESTRIAL FERNS AND TREES ALONG AN ANDEAN TROPICAL ELEVATIONAL GRADIENT

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Altitudinal gradients in biomass, productivity and foliar characteristics have been studied for trees and vascular and non-vascular epiphytes in a number of transects in neotropical and paleotropical mountains. However, less is known about elevational change in other groups of primary producers such as terrestrial ferns and herbaceous plants along tropical mountain slopes.In this study, we evaluated leaf properties, biomass and biomass increment of terrestrial ferns and trees along an elevational transect from 400 m to 4000 m. The study was performalong an elevational gradient in a tropical mountain ecosystem in NE Ecuador.

As a preliminary results, we found a systematic difference in specific leaf area (SLA) between fern and tree leaves (fern SLA being c. 40 cm^2 g^{-1} < than tree SLA) along the elevational gradient, reflecting the different light regimes of both life forms. The linear SLA decreases with elevation point to the production of thicker (and smaller but longer-living) leaves and fronds in the uppermost forests.

Since the foliar N concentration remained invariable and foliar P increased with elevation in our transect, one would assume that the SLA reduction was mainly caused by other factors than nutrient shortage such as the unfavorable thermal regime at high elevations which demands for more robust leaves with extended longevity. However, we found a significant SLA decrease with increasing soil C/N ratio for the trees (but not the ferns) which makes it likely that N shortage is at least an additional factor causing tree leaf SLA to decrease with elevation in this transect.

We found a striking difference between ferns and trees with respect to the patterns of altitudinal change in biomass and productivity, which is clear evidence in support of the hypothesis that both plant groups are growth-limited by different factors. While biomass and productivity of trees decreased with elevation, in ferns it peaked at 2000-2500 m, suggesting that factors (soil and air humidity, light availability) other than nutrient availability should play a key role for terrestrial ferns.

PARAMO RESPONSE TO HUMAN INFLUENCE: A TRAIT-BASED APPROACH

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The high Andean grasslands or paramos in the Northern Andes have been increasingly affected by human activities since the middle of the last century. Disturbances may affect the functional structure of plant paramo communities by a reduction or an increase of trait variability and range (Mason et al. 2005). These changes provide insights in community responses to ecological degradation; species might go through different processes that lead to new arrangements of the community. Trait values have been used as a proxy to understand the mechanisms of community assemblage; trait range is seen to reflect environmental filtering (underdispersion), whereas trait evenness may be a signal for competition (overdispersion) (Weiher & Keddy 1995). We hypothesized that plant paramo communities would show convergence due to controlling effects of resource availability (Wilson 2007, Körner 1999). On the other hand, modest disturbances might contribute to more variation (less convergence) in trait range and evenness.

The present study reports the first approach that collected values of continuous traits of vascular plants in paramo communities along a gradient of human impact related to fire, located in the southwest of Colombia. Plant height and specific leaf area were selected as traits related to productivity. A total of 132 vascular plant species were encountered in 32 plots of 25m^2. Functional diversity was analyzed using the mean, range and evenness (kurtosis) of the trait values for all species and we tested separately for the most abundant growth forms. To test the effect of disturbance, null models were applied, restricted and not restricted for human impact. Environmental filtering and limiting similarity were found in paramo communities. Disturbance had an effect on paramo communities by reducing SLA range and kurtosis, for all growth forms and for tussock, giant rosettes, and basal rosettes. Disturbance effects on plant height were only significant for tussocks. We hypothesize that disturbance offers productive plants the opportunity to use post-disturbance conditions (e.g. open space, increased nutrient availability) to settle and/or maintain vital populations in disturbed local paramo communities.

EFFECTS OF ALTITUDE AND TIME ON ARBUSCULAR MYCORRHIZAL FUNGAL COMMUNITY DYNAMICS: A CASE STUDY FROM THE SOUTH ANDES OF ECUADOR

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Evidence has been provided that nitrogen (N) and phosphorus (P) additions to the soils of a tropical mountain forest in South Ecuador affect the diversity and composition of arbuscular mycorrhizal fungal (AMF) communities. It has also been reported that different taxonomic groups (e.g. Diversisporales versus Glomerales) react differently to the addition of N versus P additions. However, little is known about the influence of altitude and time on these responses. As part of an ongoing nutrient manipulation experiment (NUMEX), our group is analyzing AMF communities along an altitudinal gradient and its response to N and P additions. Soils within NUMEX plots were bi-annually supplemented with moderate amounts of N and P in a randomized block design since 2008. NUMEX is replicated at three elevational sites (1000, 2000 and 3000 m). Sub-samples of soil and roots from the 2000 m site were collected in 2010 and 2013 while samples from all three sites were collected in 2015. DNA extracted from roots of these samples is being analyzed targeting the large subunit rDNA (LSU) region with Illumina sequencing techniques in order to establish how altitudinal gradients affect responses of AMF communities to nutrient additions in this tropical mountain forest. A comparison between samples collected at different years in the 2000 m site will also be performed to gain insights into the effect of the duration of fertilization on AMF community responses. This poster will highlight our latest findings of this exciting experiment.

FROM IDENTIFICATION TO FLORISTIC COMPARISON OF CAATINGA-FORESTS

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Sergipe is the smallest state of Brazil, belonging to its Northeastern region. However, on its area of approximately 22.000 km^2 (1,7 Mio inhabitants) Sergipe holds a rich diversity of vegetation types, together with a rich species diversity that is recently investigated within the project “Flora de Sergipe”. The total plant species number of Sergipe state is much higher than from former estimates.
Identification tools are needed to tackle the difficult task of species inventories in study regions of all scales. In this study, the Lucid 3 Builder was applied to build an interactive multiple entry key to the Caatinga genera of the Grota do Angico Natural Monument, SE, Brazil (2.183 ha). The key contains 99 genera from 43 plant families and uses 35 features with 153 states in total for the determination process.
Such keys, based on a matrix of characters and taxa, enhance the online publication of taxonomic treatises, which is the basis for a successful field work. This contribution wants to make the keys more popular among ecologists, because they are still more familiar to taxonomists and poorly valuated by the scientific community.
Moreover, vegetation data has been collected in the same study region, with space-for-time-substitution in research on succession. The first results of the sampling (40 relevés of 20x20m distributed in five strata) will be shown.

SESSION DAAD - ALUMNI P1

POTENTIAL LONG-TERM EFFECT OF FARM HERBICIDE APPLICATION ON ARTHROPOD DIVERSITY AND ABUNDANCE

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One of the major mainstays of rural folks around forested areas in Ghana is vegetable farming. To maximize profit and reduce cost of tiling farmlands, it has been a recent practise for farmers to resort to the use of herbicides for land clearing and subsequent weed control after the land is cultivated. Many farmers thus rely heavily on herbicides for land clearance and weed control. However, this practice has the potential of reducing the diversity and abundance of both arthropods and plant resources. In this study, we investigated the influence of herbicides on plant and arthropod diversity and abundance using farmlands as test cases. We collected arthropod diversity and abundance data using 1 m x 1 m quadrats on herbicide treated plots at different doses and untreated plots. Our findings points to a potential reduction in both arthropod diversity and abundance in the long term. A relatively small dose of herbicide serves as a threshold at which arthropod diversity and abundance is affected. We conclude that though farmers reduce the cost of land preparation by the use of herbicides, they may potentially wipe out important arthropod species.

SESSION DAAD - ALUMNI P2

THE EFFECTS OF LAND USE CHANGES ON BELOWGROUND CARBON LOSS IN TRIPA PEAT SWAMP FOREST

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Tripa Peat Swamp Forest (TPSF) located in Nagan Raya and Aceh Barat Daya Districts, Aceh, consists of 60,657.30 ha. TPSF has been credited as the natural ecosystem that is efficient in protecting and mitigating natural disasters, but its presence has rapidly decreased as a result of conversion to agriculture (mostly oil palm), illegal logging, drainage and fires. To obtain detail information on the belowground carbon stock due to land use changes in TPSF, study had been conducted from May to August, 2013. Study was based on three peat dome formations, i.e. Dome A, B and C and four types of land uses, i.e. primary forest, secondary forest, oil palm plantation, and open land. Samples were taken from 16 plots/transects and 65 sub-plots. In each sub-plot a five cm peat sample was collected from the middle of each depth interval 0-15cm, 15-30cm, 30-50cm, 50-100cm, 100-300cm, and at 200 cm intervals at peat depth exceeding 300 cm, until it reached the mineral substrate. The results showed that the average peat depth, water content and soil bulk density were 361.28±26.48 cm, 72.96±0.85% and 0.174±0.07 g cm^{-3}, respectively. The average of C and N concentration were 29.36±0.91% and 1.47±0.12%, respectively. Total below-ground carbon stock from 2007 to 2013 in primary forest and secondary forest decreased nearly to 19,627,165 Mg and 6,765,395 Mg, respectively, contrast to the oil palm plantation and open land increased nearly to 21,241,959 Mg and 908,740 Mg, respectively. However, the increase in the oil palm plantation and open land were mostly due to the increase in the total area of oil palm plantation to 17,091.33 ha and open land to 1,929.63 ha during 2007- 2013. Total below-ground carbon stock lost from 2007-2013 in the entire TPSF were 4,241,861 Mg. Total below-ground carbon stock lost from 2007-2013 in the entire TPSF were 4,241,861 Mg.

SESSION DAAD - ALUMNI - P3

GUADALUPE DAM CATCHMENT, A FORESTED AND BIODIVERSE RURAL TO URBAN REGION NEAR MEXICO CITY

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The territory of Guadalupe dam catchment is located in the central part of Mexico, on the northern portion of the Sierra de la Cruces mountain range, abutting Mexico City in its lowest parts. With a high altitudinal interval (2200-3750 m a.s.l.), a medium catchment size (38,000 hectares) and a high population (ca. 1,2 million inhabitants), it has a unique natural beauty in the higher parts where you can highlight its mild climate, many water bodies and crystal clear streams, vast and well-preserved vegetation cover and forests of oaks, firs and pines, together with some productive activities like potatoe and wheat agriculture, extensive livestock breeding, trout farming, silviculture and ecotourism. Biodiversity is fairly high, with an estimate of 1,500 species, mainly plants, animals and fungi, many of which are endemic. At medium altitudes semi rural villages appear, with traditional maize croplands, intensive greenhouse agriculture and most of the population activities related to the tertiary sector: services and commerce. In the lowest areas of the catchment, it is mainly a densely populated urban area with circa 80-90% of the people living inside Guadalupe in which contrasting living standards make different uses of the land. Governance is complex with local communities and “ejidos” at the first level, together with municipalities. State and national regulations underline general policies and it belongs to the great metropolitan area of Mexico City.

Culturally, the territory has presence of the Otomi ethnic group that settled in the region in the late sixteenth century, of which we can still appreciate their cultural, culinary and architectural craft dispersed throughout some regions of central Mexico. Currently the territory of Guadalupe watershed has an important social and economic backwardness due to the lack of jobs and low levels of education, which has resulted in increasing levels of migration to larger cities and the United States. It is one of the goals of our research to promote local development strategies from a better understanding of land use, biodiversity and ecosystem services provision, together with local environmental education and rural tourism activities in order to improve the living conditions of the people based on their daily activities and natural resources.

SESSION DAAD - ALUMNI P4

LAND USE CHANGE AND SUSTAINABILITY THROUGH RECIPROCAL WATERSHED AGREEMENTS IN THE BOLIVIAN FORESTS

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In order to conserve critical ecosystems and improve the quality of life of the Bolivian people, our project is working in key regions to provide clean water and protect the country’s biodiversity ecoregions such as the Amazon, Yungas, Bolivian Tucumano Forest, Inter-Andean dry forests, Chaco and the Chiquitano dry forest. Our actions are been developed with a long-term vision for the conservation of ecosystem goods and services that support healthy communities and maintain biodiversity through the implementation of Reciprocal Water Agreements (RWA), that are based on the twin pillars that 1) protecting upstream forests will help maintain water supplies in quantity and quality, and 2) downstream water users need to contribute to such forest protection. The success of the RWA is based on its simplicity, where downstream communities agree to increase their drinking water rates in order to feed a local water fund that will later be invested in the protection of upstream vegetation that helps to provide water of sufficient quantity and quality. Upstream land owners who agree to protect their forests, receive in-kind compensations packages, such as beehives or fruit trees, to compensate them for the opportunity costs of preserving their natural vegetation, as well as to improve their family economy and their quality of life through environmentally friendly alternative income sources. This has been accomplished in partnership with local stakeholders such as municipalities, water cooperatives, irrigators associations, private institutions and international cooperation. This scheme has generated many benefits for both the environment as well as local livelihoods. To date, the RWA have benefited around 3,200 families who are conserving around 180,000 ha of forest in 36 Bolivian municipalities.

SESSION DAAD - ALUMNI - P5

CARBON STOCKS ASSESSMENT OF A REFORESTATION SITE IN MARGINAL UPLAND IN LEYTE (PHILIPPINES)

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Marginal uplands are characterized by unproductive soils and with low biodiversity. These areas can be a good storage of carbon for climate change mitigation and in improving the microclimate in the site if rehabilitation measures will be put forward. The study was conducted to quantify the biomass and carbon storage of a grassland area now planted with seedlings of native trees in Inopacan, Leyte. We measured the biomass and carbon in vegetation and, soil organic carbon before and after reforestation. Also, the study aims to assess soil's physical and chemical properties and quantify its changes following a land use change from grassland to a young reforestation site (2 years after planting). The site was planted with native trees namely: white lauan (*Shorea contorta*), yakal saplungan (*Hopea plagata*), tanguile (*Shorea polysperma*) and guisok-guisok (*Hopea philippinensis*). Bulk density and SOC values were compared between two land uses, wherein samples were collected at various depths; 0-10 cm, 10-20 cm, and 20-30 cm. Results showed that aboveground biomass dominated by grass, *Imperata cylindrica* and shrubs namely: *Melastoma malabathricum* and *Chromolaena odorata* and seedlings of native trees was 93Mg ha^{-1} while below ground (roots) was found to be 64 Mg ha^{-1}. The total carbon stock above and below ground is 56 MgC ha^{-1}. Organic carbon in the soil was found to have 81 MgC ha^{-1}. Significant difference was observed for bulk density following land use change through paired-sample T-Test using least significant difference test at $p<0.05$, and no significant difference was observed for soil organic carbon stock after reforestation. Both grassland and reforestation site have significant difference at various depth (ANOVA; $p<0.05$). In a reforestation site, SOC values ranged from 1.35% to 2.25%, while Nitrogen content has values ranging from 0.18% to 0.76%. Findings showed that land use change could bring significant effects on different biomass, carbon storage and soil parameters but is also influenced by time of establishment and the activities in land use management.

SESSION DAAD - ALUMNI - P6

ENDANGERED SPECIES IN ENDANGERED ECOSYSTEMS: ASSESSMENT OF ENDEMIC BUTTERFLIES IN VENEZUELA

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Venezuela is considered a megadiverse country, but many taxonomic groups remain underrepresented in conservation efforts. Butterflies are among the most popular invertebrate groups, but are still poorly studied in the country. I completed a preliminary conservation assessment of Venezuelan butterflies, compiling available information on their hostplants, distribution, potential habitat and population data from different sources. I created a checklist of known species within the country, and estimated the potential distribution for a subset of species with enough detailled data. The total number of butterfly species known to the country (1440) is comparable with the number of bird species (1418), but there is a larger number of endemic butterflies species (124 or 8.7%) compared with the number of endemic birds (48, or 3.4%). However, while all bird species have been assessed in the Venezuelan red book of fauna, only 35% of butterflies had enough data for a preliminary assessment. Yet, the number of butterflies that can be considered threatened (8 CR, 20 EN, 8 VU, according to IUCN criteria and categories) or near-threatened (20 NT) is similar as the number of threatened and near-threatened birds. Most of the threatened taxa are found exclusively within restricted páramo or cloud forest ecosystems in the venezuelan Andes and other mountain ranges, which are threatened themself. Although these habitats are widely represented in the national protected area network, few real conservation and management actions are implemented, and uncontrolled economic activities, fires and climate warming are still present as major threats for both threatened ecosystems and endemic butterflies. The preservation of endemic butterflies in Venezuela requires broad habitat protection measures and specific conservation measures for protecting hostplant stands and connectivity between viable populations.

SESSION DAAD - ALUMNI - P7

DROUGHT FORECASTING, ASSESSMENT AND WATER ALLOCATION STRATEGIES UNDER CLIMATE CHANGE: THE 2011-2015 DROUGT PERIOD IN NORTHEAST BRAZIL AND THE WATER CRISIS OF THE CANTAREIRA SYSTEM (SÃO PAULO)

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Projections from global climate models have broadly indicated increases in drought for the Northeast Brazil. However, few if any studies have detailed the potential impacts of a warmer world specifically on the climate, hydrology, and socioeconomic conditions of Northeast Brazil. The droughts of Northeast-Brazil have led to starvation, mass exodus and social conflicts, and their eventual prediction remains a central concern. The vulnerability of agricultural production due to water deficit and the development of large-scale multi-purpose water supply systems implies that drought analysis is required at a regional scale. In this sense different methods and models have been developed. Reservoirs were the traditional response to droughts for more than 100 years. However, water use was uncontrolled and free, and primary users participated minimally in water management decisions. This study intend to be a first step in better understanding how climate change will translate to water scarcity, and how the drought-prone and rapidly developing Northeast-Brazil could adapt through more flexible water management and allocation strategies.

The evaluation showed that broadly, the Northeast Region would experience reductions in mean annual precipitation combined with increased mean annual evapotranspiration, ultimately suggesting an increased likelihood of droughts over the coming decades in the region. Different approaches for the drought prediction of Northeast-Brazil have been tested by modelling the time series of precipitation by the use of neural network for reference stations. The controlling of drought effects can be done in Northeast-Brazil by appropriate management of the reservoirs. For the evaluation of the risk by droughts stochastic simulation models can be applied. The developed methods were applied the various hydrographic basins in northeastern Brazil in the current 2011-2015drought period. Part of the methodology was also applied to the Cantareira System in São Paulo, which supplies much of the metropolitan area, comprising more than 12 million inhabitants.

SESSION DAAD - ALUMNI - P8

SUBSTITUTION OF A TRADITIONAL DIET AS A RISK FACTOR FOR SOCIO-ENVIRONMENTAL HEALTH IN RURAL AREAS OF CENTRAL MEXICO

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Poor eating habits have large health, environmental, social and economic implications. Conversion of land to heavy agricultural systems jeopardizes the existence of a rich and diverse, low-impact agricultural tradition, erodes ecosystem services (ES) and diminishes the structure and function of natural systems. It poses a risk on rural population by cutting down their social roles, and reducing the variety and nutritive content of the food available. This research aims to develop an interdisciplinary methodology to understand the factors influencing the change of metabolic state in Mexican rural inhabitants that have substituted a traditional diet in favour of industrialized ones; and how the socio-environmental changes have impacted the provision of ES in a low-intensity, traditional farming system. An educative program with children and women is included. The region is strongly and diversely populated, from ethnic indigenous groups to some of the world's biggest urbanizations. Using blood glucose measures and body mass index as proxies for the nutritional metabolic state, along with tracking surveys of people's dietary intake, we analyze the nutritional state of selected rural populations. Socio-economic assessment of daily activities and the characterisation of the ES provided by the areas, are used to draw a much better picture as well. Rural inhabitants have gradually turned their diet to high consumption of ultra-industrialized packaged foods, poor in nutrition value. Mexico is at the top of countries' statistics with major overweight-related problems, increasing diseases such as type II diabetes and hearth failure. Also, by heavily industrializing the production of food, the link between people and nature fades out, people loosing their ability to feed themselves and to understand and care about natural environmental processes. We believe that encouraging people's valorization for traditional practices will benefit both society and environment.

SESSION DAAD - ALUMNI - P9

COMMON RESOURCE MANAGEMENT BY DIFFERENT USERS WITH DIVERSE INTERESTS: A SUSTAINABILITY

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Natural resources, property rights, institution and distributional implications have become major focus of discussion and debate in common property resource (especially water, grazing land and forests) dependent rural areas of developing countries, where resource management has been considered as one of the most viable option for combining poverty reduction, enhancement of local level economic development and biodiversity conservation. But how to prevent their overexploitation is important. Though people are the users of those resources, institutions play very important role to maintain sustainability issue. Many renowned researchers like Balland & Platteau (1996) and Ostrom (1990) and many others demonstrated that local user groups can formulate institutions, so, they have the greatest incentives to maintain the resource base over time. Remind these concepts; the present study has been conducted in a South west area of Bangladesh where water management is a crucial issue. A considerable portion of Shrimp farmers are collectively repairing and desilting the canals as they are getting supply of water through those canals. Sometimes, groups of farmers discuss, negotiate and even bargain with other institutions to open or close the sluice gates. Those farmers who are joining; they contribute money and labour for water management. Some of them have formed formal organizations. Though many state organizations have not been performing these tasks successfully, it cannot be assumed that farmers will be willing or able to take the responsibility voluntarily. We need to carefully examine their willingness to take part and to identify factors that create incentives for users' involvement. It has been found that different social, economic and institutional factors like number of common resource users, infrastructure like distance from market, existence of different associations and organizations, trust among the users, leadership category, ownership of nearby resources, meetings and discussion among themselves, socioeconomic heterogeneity – affect natural resource management. The reason that some users take part and some not in natural resource management remains an issue of public choice analysis. It has been found that advantageous people who do not feel scarcity are detached from the affairs of the management activities. Sometimes they take part in the process to increase their good will, so they are more likely to contribute to be eminent and more powerful. Once they gain power, take the control over whole resources. The disadvantageous people, if they are rich, get benefit from the resource, they want to engage in management till it is cost effective for them. For the same reason, poor leave the management activities. It could be recommended from the resource that state level institutions must be strong in term of good governance and, or a third party could be employed or involved in case of natural resource management.

SESSION DAAD - ALUMNI - P10

INSECT DIVERSITY CONSERVATION: STATUS OF THE TROPICAL ECOSYSTEM IN NIGERIA

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With a rapid surge in human population, there has been concomitant increase in anthropogenic threats to biodiversity, especially for ecologically-important groups such as insects. With the loss of about 79% of its forest cover, Nigeria ranked as the nation with the highest rate of forest loss in 2005. How these and other environmental stressors affect insect biodiversity is yet to be fully understood. Nigeria, like most of the countries in the tropics is a treasure trove of insect diversity; however, limited information is available on the taxonomy, ecology, genetics and biogeography of its insect fauna. This dearth of background scientific knowledge impedes successful insect conservation policy and practice. Even though a National Biodiversity Action and Strategic Plan has been formulated in line with the targets of Convention on Biological Diversity, these clear knowledge gaps have to be recognized and filled for sustainable progress to be made in insect conservation. This review identifies the key challenges to insect diversity conservation in Nigerian ecosystems. The need to provide sufficient baseline information on the taxonomy, species distribution and ecology of Nigerian insects at both eco-regional and national scales is proposed. Well designed and targeted insect diversity surveys as well as citizen science programs are suggested as potential approaches to accumulating necessary baseline data to drive conservation of insects in both aquatic and terrestrial ecosystems in the country.

SESSION DAAD – ALUMNI - P11

PLANTS SUPPRESS THEIR EMISSION OF VOLATILES WHEN GROWING WITH CONSPECIFICS

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Plants mostly grow in multi-species communities rather than monocultures yet most studies on plant volatile emission in response to insect herbivores focus on single species growing as individual plants. It is not yet known how intra- and interspecific plant competition influence volatile emission. In a greenhouse experiment, we investigated the volatile emission by red clover (*Trifolium pratense*) growing alone, with a conspecific, or with an individual of the naturally co-occurring orchard grass, *Dactylis glomerata*. When *T. pratense* grew together with a conspecific, both total and herbivore-induced emission of volatiles was significantly reduced as compared to *T. pratense* growing with *D. glomerata* or growing alone. This reduction in emission occurred despite the fact that there was a significant reduction in *T. pratense* biomass due to competition with *D. glomerata*. Possible effects of species interactions on infochemical networks in natural communities are discussed.

SESSION DAAD - ALUMNI - P12

ROLE OF SOIL COVER AND WILD VEGETATION IN MAINTAINING BIODIVERSITY AND BENEFICIAL FAUNA IN THE OLIVE GROVES

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Wild plants of olive orchards in Tunisia have been recorded, collected and analyzed for their role in the attraction and protection of natural enemies of major pests of olive trees. This study conducted at four geographically distant orchards and maintained according to different driving modes, allowed to draw up a preliminary list of useful cultivated or spontaneous vegetation in the olive ecosystem in Tunisia. Indeed, this study demonstrated that *Chrysanthemum coronarium* (Compositae) hosts *Eupelmus martelli* (Hymenoptera, Eurytomidae) and *Eupelmus urozonus* (Hymenoptera, Eupelmidae), two parasitoids of larvae and pupae of the olive fly *Bactrocera oleae*. Also, *Malva aegyptia* (Malvaceae), *Anacyclus clavatus* (compositae) and *Meliotus messanensis* (Fabaceae) were found to give shelter respectively to *Chelonus eleaphilus* (Hymenoptera, Braconidae) *Apanteles* sp. (Hymenoptera, Braconidae) and *Angitia armillata* (Hymenoptera, Ichneumonidae) which are three parasitoids of the olive moth *Prays oleae*.

SESSION DAAD - ALUMNI - P13

USES OF TREES IN THE MEXICAN TROPICS

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Trees have had a fundamental role in the developing of civilizations, providing materials such as wood and firewood, food and medicines, as well as environmental services like erosion control, flood regulation, water filtration and cultural and religious values. However, the tropical forest is disappearing at an alarming rate. One of the main causes of this rapid loss is the change in land use, from forest to other uses such as livestock rising and sugar cane agriculture. These economic activities need great extensions of land. The ranchers usually leave some remnant trees from the previous forest. Therefore, this group of people configures the landscape through their decisions on which trees to leave and which one to cut down. The remnant trees are key for ecological connectivity (*step-stones*) and as important points for maintaining the potential of regeneration of the forest.
The objective of this research was to document the knowledge of ranchers about trees and their uses, and the changes in their communities. We conducted semi-structured interviews in several locations of the coast of the Gulf of Mexico, where the predominant landscape consists on pastures with few remnant trees. We used the snow-ball method (i.e. one interviewee suggest another one due to his/her experience and knowledge in the topic) to find the key informants. In Jamapa, México, we found 14 men and 5 women ranchers. They mentioned 68 trees species, which we collected and identified in the herbarium. Over 90% of the interviewees were above 40 years old. The species mentioned belong to 27 botanic families, where Fabaceae, Moraceae and Malvaceae are the most represented. We classified the uses of trees in 22 types including the ones for wood, extractive and non-extractive uses. Some of the uses are almost extint.
The current lifestyle in the site of study is becoming similar to urban even though it is a rural area. In the past the community made a more intensive use of trees (i.e. building houses, eating wild fruits, extract materials for tools, and so on), which needed a broader knowledge about them. Nonetheless, there is an erosion of this knowledge in the present time, especially because the younger generations are not interested on land labor, agriculture or livestock rising anymore. The jump to the next generation is uncertain as these youngsters will be in charge of taking decisions over those lands they will inherit soon from their parents and grandparents. Losing the knowledge would probably end up on a poor valorization of trees and consequent loss of the environmental services they provide.

SESSION DAAD - ALUMNI - P14

COCOA PRODUCTION FOR SUSTAINABLE DEVELOPMENT IN FOREST REGIONS? THE CASE OF A PRODUCERS ASSOCIATION IN SATIPO, PERÚ

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Cocoa production has been stablished as a profitable alternative for producers from the amazon area. The International Cocoa Organization (ICCO) forecasts that by 2020, the world will have a deficit so the demand will be unsatisfied. The Peruvian Association of Cocoa Producers (APPCacao) has even calculated that Peru needs 200 thousand more hectares of cultivated lands to obtain a 9% share of the world market. But where are the suitable lands for cocoa production in a tropical country? In the Poster I present, I argue that there is a need to involve the producers since the birth of a project aiming to attack cocoa producers' problems, in order to realistically find the best strategies to satisfy their needs whilst providing incentives for forest conservation.
In this case I explore the initial and final situation of a group of cocoa producers after a 2-years participative project. The Logical Framework (LogFrame) is used to design, implement, monitor and evaluate a project that implements capacity strengthening, technology change, a micro-credit platform and organizational strengthening. The results obtained showed up that producers develop their own effective rules-in-use, for continuing activities after the 2-year project, when the external financial support ended. The yields increased and, likewise, the quality of the final product increased as the fields were transitioning to an organic production. The producers organized in an association, sold over 200 Tons and their income is obviously increased but, over and above, the producers' negative incentive to change their fields to full-sun coffee production or forest clearing was reduced.

SESSION DAAD - ALUMNI - P15

PROGRESS IN RICE RESEARCH ACTIVITIES IN EASTERN AND SOUTHERN AFRICA

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Rice (Oryza sativa L.) is the world's most important staple crop, feeding half of the global population. In Africa, its importance is evident from the continent's highest consumption growth rate when compared to the rest of the world. Rice consumption in Africa has increased by more than 34% compared with 8% in Asia and 10% as the world average. This has seen Africa become a big rice importer in international markets, accounting for more than 29% of global imports. The paddy productivity in eastern and south African (ESA) countries is below 2 t ha^{-1}, however, there islarge suitable land areas and resources with a congenial environment that have not been fully utilized. This paper discusses the progress that has been made in rice breeding and diversity studies by International Rice Research Institute (IRRI) in ESA, in the last 7 years.

SESSION DAAD – ALUMNI - P16

THE STATUS OF RARE TREE SPECIES FOLLOWING LOGGING IN A TROPICAL LIMESTONE FOREST, NORTHERN VIETNAM

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Rare tropical tree species are endangered due to the disappearance of old-growth forests. Although some undisturbed old-growth and formerly logged forests are protected today, the extent to which rare tree species persist and regenerate in such logged forests is often unclear. In a forested area over limestone in northern Vietnam, we studied the status of five rare tree species after decades of selection logging and subsequent nine years of full protection, in comparison with an un-logged forest. Three of the studied species are largely restricted to limestone hills (*Excentrodendron tonkinense*, *Chukrasia tabularis* and *Garcinia fagraeoides*), while two of the species have a wider distribution (*Parashorea chinensis* and *Meliantha suavis*). The bigger trees of the study species had lower densities and/or differences in the diameter distributions between the two forest types, indicating that these species had formerly been cut. The regeneration stem density of the study species was much lower (46% in *M. suavis* to 80% in *P. chinensis*) in the logged than un-logged forest. In the un-logged forest, we found clear relationships between ecological factors and regeneration density in four of the five study species; e.g., the regeneration of *E. tonkinense* increased with increasing rock-outcrop cover ($r = 0.6$, $p < 0.01$). Such relationships were almost absent in the logged forest. Our results suggest that the studied rare tree species still existed as adults after logging and there was regeneration but at low densities. We assume that the potential for recovery remains, which further justifies the full protection of this and other restoration areas.

SESSION DAAD - ALUMNI - P17

WOMEN AND FOREST MANAGEMENT IN RURAL COMMUNITIES IN THE SOUTH WEST REGION OF CAMEROON

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Forests provide a wide range of services necessary for human survival in developing countries especially in rural communities. This rich resource however, has witnessed continuous degradation and deforestation leading to challenges on the livelihoods of rural people. Cameroon government in a bid to reduce deforestation and improve on rural livelihoods has adopted a participatory approach to forest management encompassed in the 1994 forestry legislation.
This paper aims to examine the role of men and women in forest activities and its impact on livelihoods in the rural communities of the Korup national park and Bechati forest areas. It also examines the gender dimensions of income and expenditure in the research communities and how it varies within households.
The research was carried out in a participatory approach involving community members and other stakeholders. Some of the techniques used include structured and semi-structured questionnaires, focus group discussions, key informant interviews and participant observation. Qualitative and quantitative data analysis methods were implored to examine the issues raised.
Results show that participation of women in forest management issues is low compared to men and many reasons account for their low participation. The involvement of women was examined in activities such as forest protection, skill training and decision-making amongst others. Women and men have different rights, uses, interests and access to specific forest resources.
Emerging results indicate that, majority of men are involved in perennial crop production which generates more income compared to women who are more into annual crops usually for subsistence. Main sources of income in these communities include crop production, forest products like NTFPs, livestock and petty-trading.
Increase and effective participation of women in forest management could be enhanced if there is a change in traditional attitudes on the roles of men and women, a rethinking on policies and capacity building of especially women.

SESSION DAAD - ALUMNI - P18

REDUCING THE PRESSURE ON THE CRITICALLY ENDANGERED BLUE-EYED BLACK LEMUR BY MEANS OF EDUCATION AND TECHNICAL SUPPORT TO THE POPULATION

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The unique non-human primates with blue-eyes named *Eulemur flavifrons* occurs only in northwestern of Madagascar including the Sahamalaza National Park. The anthropogenic threats on this species is not to be neglected in the area leading them into the 25 most endangered primates and critically endangered species by the IUCN red list. We are considering that sustainable conservation of this species is possible through environmental education and technical support to the people.
Our aims are to strengthen and raise environmental awareness of young generation and adult people and to change their behaviour to improve population well-being.
We work in partnership with school, local community familiar with the environment and population surrounding the protected areas. In the high school of Antsohihy, 80 students have been involved to our activities “education and cleanup” and are motivated to the protection of the biodiversity.
We send message through different events (World Environmental Day, World Lemur Festival, Earth Day, Citizenship Day) and various tools and channels. During the World Lemur Festival, we transfer the idea of protection of the lemurs and their habitats by using masks of male and female blue-eyed black lemur, by doing a carnival, and by educating the public with a talk, an environmental quiz or a video projection. Many villagers (infant, young, adult…) have participated to the events.
We provide a capacity building training of the “Park Local Commitees” (CLP). Men and women were present during the training.
To reduce the pressure that local population may do to the forest, we offer them new alternative livelihoods for the development of the local community such as fish farming, yam production. The list of participants has been limited to 30-50 peoples.
All in all, education and improvement of living conditions are a sustainable development factor in the context of biodiversity. Thus, the implementation of measures to preserve the forest and its biodiversity requires a direct involvement of the population.

SESSION DAAD - ALUMNI - P19

CHALLENGES FOR PLANNING AND PUBLIC MANAGEMENT ABOUT THE "MOTHER EARTH" REGULATIONS

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INTRODUCTION

The LMELW establishes guidelines for planning and intercultural public managing about 'Living-Well' (GPIPM - Articles 48-51). They are based on the so-called "objectives of integral development as a meaning to achieve the Living Well". The Bolivian government still has pending tasks, which are summarized below.

OBJECTIVE

Analyze, from a social-legal-technical perspective- the feasibility of the GPIPM.

RESULTS

- Development of rules to the "zones of life" and "systems of life", can be made on the basis of two non-excluding alternatives: i) Studies of 'mapping' through a regulation of the LMELW; ii) A progressive characterization.
- About the integration of environmental cost/benefit categories into the integral cost/benefit analysis, there's an obstacle because the lack of technical skills -especially at decentralized governments- to generate information.
- The registration of components of Mother Earth requires a huge process of inventorying of the components and systems of LMELW and the structuring of a database; a task strongly demanding in time and budget.
- The LMELW introduces the criterion of "high strategic value" for the registration of state property goods. It's necessary to define an operational concept.
- The "System of Register and Indicative Framework for the Capacities of Regeneration of Components of Mother Earth" – SORIFCRC requires a specialized implementation, to achieve results through modeling and analysis.
- The creation of this statistical system should include the powers and functions of autonomous and decentralized levels, and information stored by different institutions (with all technical, economical and lack-of-legal competencies development demands).

METHOD

- Deductive, based on the contents of LMELW. Content analysis and expert consultation.

CONCLUSIONS

- The implementation of the GPIPM is highly demanding in time, budget and skills.
- Lack of exercise of legal competencies in planning and governance is threatening the right implementation of the GPIPM.
- There's a lack of knowledge about the conditions of statistical information currently, available to the establishment of a database

SESSION DAAD – ALUMNI – P20

APPLYING THE ECOLOGICAL INTEGRITY (IE) CONCEPT FOR THE MANAGEMENT OF THE BITA RIVER (EASTERN COLOMBIA)

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The Bita, direct affluent of the Orinoco, extends for over 500km in the Eastern plains of Colombia. Its isolated geographic location, sparsely populated basin and (still) limited economic development have contributed to its current conservation stausresulted in good conservation one of the rivers with the best conservation conditions in the country. Rich in hydrobiologic resources, among other ecosystem services (water regulation, high biodiversity, aesthetic values, recreation and tourism), it faces a scenario of agro-industrial and forestry developments, attracting investments from the country and abroad interested in acquiring areas and promote further development of projects with high territorial transformation potential, the Bita Basin has been identified as vulnerable to land-use conflicts, desertification and wildfires among other threats.

The proposed management strategy is called *Protected River*; based in the Ecological Integrity approach, it aims to preserve the continuity of the riverine system as a whole and focuses in the maintenance of the ecological flow, from an initial observed state or benchmark. Relevant geophysical, bio- ecological and social attributes are identified, including land ownership and current agribusiness projects. A territorial ordination schema based in a socio ecological approach is under formulation. It includes stakeholders, and generation and divulgation of scientific, technical and local knowledge aiming to promote the sustainable use of ecosystem services, through communication, research, education and value chain developments in order to improve income generating possibilities.

With this scenario in mind, an integral territorial management strategy is proposed. It goes beyond the standard protected areas approach, considering the area under analysis with its natural attributes together with the socio-ecological processes that are taking place in the region in order to build up the necessary social agreements.

SESSION DAAD – ALUMNI – P21

A MODEL OF SUSTAINABILITY ANALYSIS IN LA AMISTAD PANAMA BIOSPHERE RESERVE

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This poster is a part of my Dissertation about a valuation model of sustainability in a biosphere reserve. It was applied to the La Amistad Panama Biosphere Reserve (RBLAP), located in the northwest of the Republic of Panama, in Central America. The evaluation model is intended to be widely used in the analysis of whole sustainability and nature conservation status in any other biosphere reserve of the world. As the main methodology the indicators recommended by the United Nations Commission on Sustainable Development (CSD indicators) were used. They were chosen because they are the most complete set of indicators available at the moment. They have been discussed in extensive global consultations and adapted with consensus on the global agenda on this topic. This study also shows, in the sense of a didactic exercise, how recommendations on sustainable development issues were evolving in global forums, especially since 1980 with the publication of the World Conservation Strategy of IUCN (International Union for Conservation of the Nature) and the Brundtland Report of 1987 and subsequent United Nations conferences about development and environment. Based from these ideas, the concept of the Biosphere Reserve developed the own conceptual framework, or guidelines of sustainable development, beyond the biological issue of biodiversity conservation by itself. Thus, the RBLAP has a total of 56.3% of progress in sustainability, which is a low percentage compared to the acceptable minimum (>70%). In the pillar analysis, the best progress in sustainable development is the environmental pillar with 73.3%, 46.7% for social pillar and 36.1% for the economic pillar. The progress for the environmental sub-pillar about general-physical indicators was 71.64% and for the environmental sub-pillar of nature conservation was 75%. The synopsis of the study shows that if the CSD indicators are segregated into subpillars and themes then they can be used for the public and decision-makers, and of course, for development programs and projects in a biosphere reserve with the purpose to improve the levels of advances in sustainable development. The conclusions show that the whole set of CSD indicators used are adequate to properly assess sustainability, including analysis of nature conservation within a biosphere reserve, and therefore can be seen as the best way to incorporate a priority and biologically rich area (hot spots) within the global agenda of sustainable development.

SESSION DAAD – ALUMNI P22

BLACK SOLDIER FLIES DRIVEN-FEED: ACHIEVING THE RISING DEMAND FOR PROTEIN THROUGH RECYCLING ORGANIC WASTE

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Insect driven feed can substitute the costly components of traditional feed. Black soldier flies (BSF) among other insects are good candidates because of their high ability in transforming waste into high protein products. BSF are large stratiomyid with a global distribution. They inhibit moist tropic and sub-tropical regions and can tolerate extreme temperatures. They are not pests and in fact they deter the common houseflies that are normally linked to waste and low hygiene and health standards. Furthermore, BSF are natural decomposers and have been used for waste management within the context of bioconversion. The larvae of BSF can reduce a significant amount of food, animal and sewage waste into protein and when compared to livestock products they exhibit some advantages including their ability to convert feed into edible products much more efficiently. In addition, they produce less ammonia and greenhouse gases in comparison to traditional livestock and occupy less space.

There are many challenges to be addressed including the ability of harvesting BSF in a sustainable way that meets the global demands. In addition, legislation needs to be developed and food safety matters addressed as they were not considered before for food or feed.

The aim of this research is to measure the efficiency, health safety and nutritional value of feed produced from BSF larvae grown on various organic substrates including kitchen waste, chicken manure, cow dung, municipal (sewage) waste and brewery waste.

SESSION DAAD – ALUMNI – P23

USING STABLE ISOTOPES IN TREE-RINGS TO UNDERSTAND TREE PERFORMANCE

Paul Szejner[1], William E. Wright[1], Steve Leavitt[1], Russell K. Monson[1,2]

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Increasing evidence has accumulated indicating forest stress under moisture deficit, and associated impacts with wild-fires, insect outbreaks and mass tree mortality. These moisture deficit effects have impacts on the global carbon and water cycles. Therefore, a better understanding of the relation between carbon gain to water loss called the intrinsic Water Use Efficiency (*i*WUE)—inferred from stable carbon isotopes—can provide early insight into how trees are responding to environmental change. Documenting these responses will allow us to predict how tree growth and productivity will change regionally and at different time scales. Precipitation seasonality in tropical regions can be multimodal and different sections within a tree-ring can contain seasonal information. For example, a large number of tree and shrub species have different anatomical characteristics associated with annual rings. These anatomical differences are the expression of phenological processes related to photoperiod, temperature and water availability during the growing period. These differences have the potential of reconstructing past environmental conditions and tree performance at seasonal resolution. In addition to annual and seasonal growth measurements, the wood isotopic content can be used as a record of physiological processes and environmental factors experienced by trees during the growing season. Numerous studies in various ecosystems have found strong relationships between tree-ring Carbon and Oxygen isotopes and climate. Most recently we have discovered that seasonal changes in atmospheric humidity can affect the isotopic signature of organic matter in trees from temperate forests. We now intend to introduce and test a set of tools that can be used in tropical regions to understand how climate influences tree functioning, by studying stable isotopes in different anatomical parts of the tree ring, and to be able to address regional and seasonal differences in physiological response to climate and spatiotemporal patterns across tropical regions.

SESSION DAAD – ALUMNI – P24

CHALLENGES IN CONSERVING AND MANAGING COASTAL AND MARINE ECOSYSTEMS OF MYANMAR

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Myanmar shares common maritime boundaries in the Bay of Bengal with Bangladesh, India and Thailand. From north to south, Rakhine Coast, Ayeyarwady Delta and Tanintharyi Coast are the three coastal zones of Myanmar with a coastline of over 2,400 km. Myanmar hosts complex and diverse ecological and socio-economic systems. Coral reefs, seagrass beds and mangroves flourish mainly in the Myeik Archipalago. Estauries and mud flats are common in the Ayeyarwady delta while beach and dunes occur throughout the Myanmar coastline.

Records from the Myanmar's Ministry of National Planning and Economic Development Central Statistical Organization indicate high and rising human population pressure in coastal and delta areas. Moreover economic development plans are also placing pressure on Coastal resources. Threats like Coastal Land Use Change, overexploitation of Mangroves for fuelwood, charcoal production, overfishing, illegal, unreported and unregulated fishing, potential tourism development, climate change and natural disaster are threatening coastal ecosystem of Myanmar.

Those threatening factors to coastal ecosystem in Myanmar are correlated with a number of aspects involving: limited knowledge and understanding; capacity constraints; lack of environmental safeguards; undervaluation of resources; lack of comprehensive land-use policies and plans; gaps in legislations and weak enforcement; poverty and subsistence needs; lack of grassroots support for conservation; and global climate change. Government accept that the Integrated Coastal Management (ICM) is the best approach to conserve the sustainability of coast ecosystem and socio-economics development of costal dependent communities.

INDICATORS OF SUSTAINABLE FOREST MANAGEMENT IN THE TROPICS: BRAZILIAN AMAZON AND THE WORLD SCENERY

Ederson Augusto Zanetti[1]

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The Green Economy commitment of forest sector is measured by Sustainable Forest Management SFM Criteria & Indicators – C&I. For this work 3 Criteria and 2 indicators were used: Environmental – environmental considerations and cultivated biodiversity; Social - forest policies and legal instrument; Economical – socioeconomic aspects and international aspects. These C&I were evaluated considering four themes: history, objectives, actual status and problems. At the Brazilian Amazon the compliance level reached 50% (7th place). The analysis of 20 tropical countries portrayed the following classification on SFM advance: Brazil (68 %); India (67 %); Malaysia (63 %); Gabon (60 %); Congo (58 %); Myanmar (55 %), Thailand (51 %), Ivory Coast (49 %); Cameroon (46 %); Nigeria (42 %), Ghana (42 %); DRC (42 %); Colombia (41 %); Venezuela (39 %), Indonesia (36 %); PNG (34 %); Peru (31 %); Bolivia (31 %); Ecuador (30 %); Philippines (24 %). The main problem at studied tropical countries is the lack of social and economic inclusion. At Brazilian Amazon, the forest policy and legal instruments inputs limits to social and economic inclusion within the activity, mainly due to the use of a single silvicultural practice – selective cutting with natural regeneration, which should not be confused with SFM. Institutions need capacity building looking into enforcing a decentralized decision making process. Forest concession with the model used in Brazil facilitate public agents corruption, drive social and economic exclusion by concentrating large areas into the hands of a few selected companies, and initiate a cycle of forest degradation which ends by deforestation. The conclusion is for the feasibility of the used methodology to evaluate the advance of SFM implementation, allowing a measurement of regional policy effectiveness.

INFORMATIONS FOR PARTICIPANTS

CITY CENTRE

The city centre is about 10 minutes from the conference venue by public transport (see city map and public transport).

CLOAK ROOM

You may store your luggage in room 16-5 (near the registration). Please be aware that the university cannot take responsibility for any losses.

GTÖ GENERAL MEETING

The meeting will take place on Thursday, 25th February at 17:30 in MN08.

INTERNET ACCESS VIA WLAN

You can access the internet via the wireless networks of the University of Göttingen.
Two options are available:

1. Eduroam: Eduroam allows students, researchers and staff from participating institutions to obtain internet connectivity across campus. For further information visit www.eduroam.org
2. GoeMobile: Guest accounts will be provided for conference participants. If you have any questions please contact the IT-Office or the registration desk.

IT-OFFICE

The IT-Office is located in room 16-4 (near the registration desk).
Please hand over your oral presentation here and in time!

LUNCH

You can get lunch from 12:00-14:00 in the Nordmensa at the north campus. Please check also studentenwerk-goettingen.de/fileadmin/pdf/nordmensa_eng.html.
In addition, you will find the Italian restaurant “Mazzoni” opposite the conference venue (Hermann-Rein-Str. 2, 37075 Göttingen-Weende, 0551 - 3 40 84).

MAPS

On page 374 - 375 of this brochure you find both maps about the conference venue and the city of Göttingen.

ORAL PRESENTATIONS

The time slot for oral presentations is 15 minutes (12 minutes for the presentation and 3 minutes for the discussion). Please make sure that your presentation can run under Windows (MS Office 2010). There will be no MacOS or LINUX system available. Please hand over your presentation to the staff at the IT-Office upon arrival. The IT-Office will be open from Monday, 9:00 onwards. In case your talk is scheduled for the first sessions on Monday, please take extra care to arrive in time. All presentations need to be handed over to the Conference IT-Office no later than the afternoon of the day the presentation is scheduled! We ask that you arrive in your session at least 10 minutes prior to the start of your session time or visit it during an earlier break. This will allow you to meet and liaise with your chair person and to become familiar with the equipment in your session room.

PARKING

There are several parking lots on the Campus which are indicated on the "Map of Venue – University and important Rooms" on page 375 in this booklet.

PUBLIC TRANSPORTATION

To visit the city centre, please take bus number 21 or 22 directly from the Campus (bus stop Tammanstrasse) and get off at "Markt". To get to the main station of Göttingen, please take the bus number 21 or 22 (bus stop Bahnhof A).
You can find a detailed bus time table at the black board near the registration.

REGISTRATION DESK

The registration will be open from Tuesday 9:00 until Thursday 18:00.
Conference fees and additional bookings at the registration desk can be paid in cash and credit card (Master/Visa).

REGISTRATION FEES

The registration fee includes the attendance to all scientific sessions, coffee breaks and the Welcome Mixer on Tuesday evening. There are separate charges for the Conference Dinner and a voluntary CO_2 contribution as part of a carbon neutrality initiative.

RESTAURANTS, CAFÉS AND BARS

Göttingen has many good restaurants and bars.
Here is a small selection:

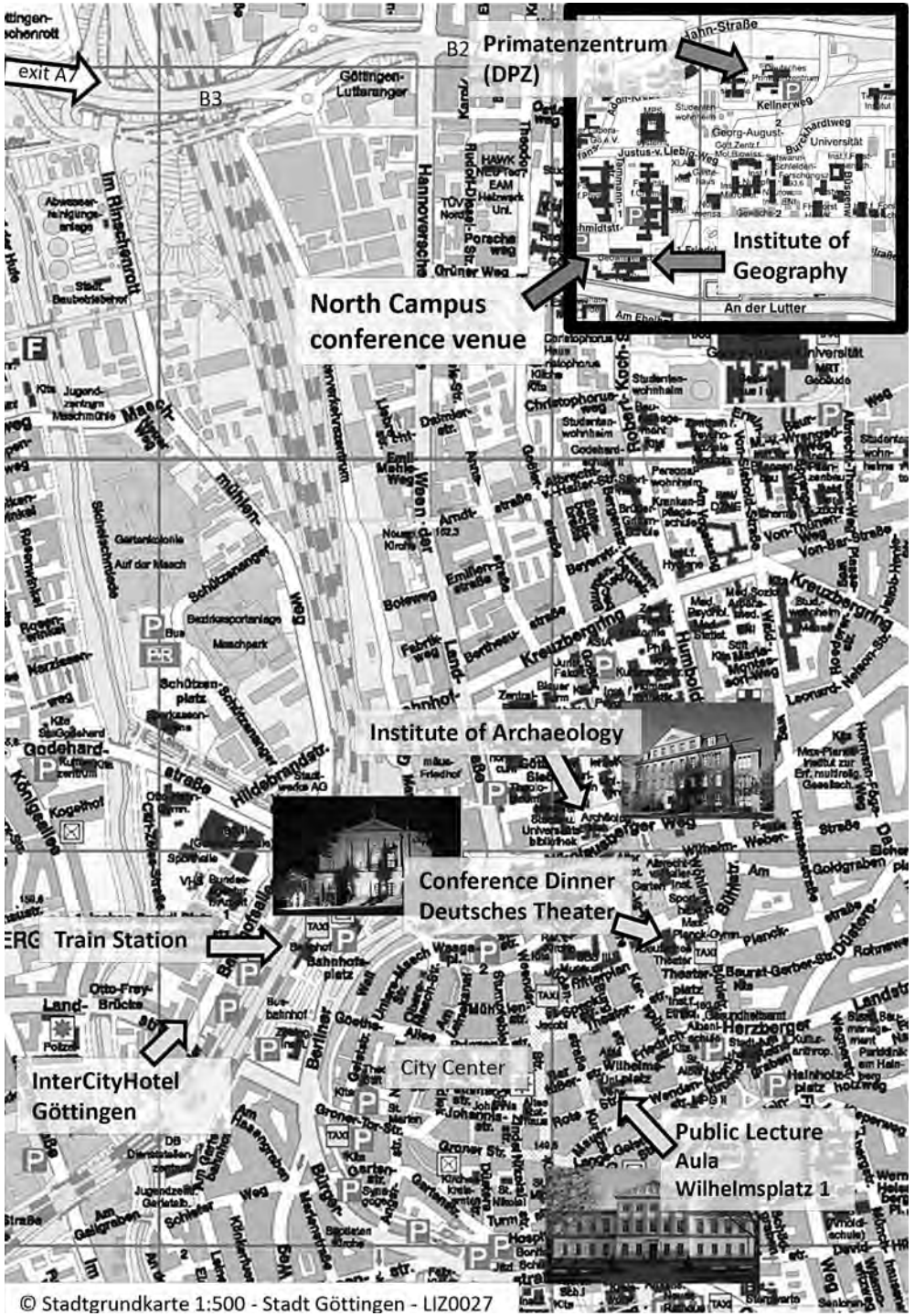
- Trattoria Salvatore, Theaterstr. 10, 37073 Göttingen, 0551 - 4886130
- Peking China Restaurant, Friedrichstr. 1 a, 37073 Göttingen, 0551 - 44323
- Ristorante Giordano, Bunsenstr. 17, 37073 Göttingen, 0551 - 50315710
- Mr Jones, Goethe-Allee 8, 37073 Göttingen, 0551 - 5314500
- Café Thiele am Markt, Weender Str. 26, 37073 Göttingen, 0551 - 485722
- Madras-Vanakam, Holtenser Landstr. 1, 37079 Göttingen, 0551 - 50080249
- Nudelhaus, Rote Str. 13, 37073 Göttingen, 0551 - 44263
- Sambesi, Wendenstr. 8, 37073 Göttingen, 0551 - 37075651
- Ristorante Fellini, Groner-Tor-Str. 28, 37073 Göttingen, 0551 - 4995936
- India Haus Göttingen, Kurze-Geismar-Str. 41, 37073 Göttingen, 0551 - 484548
- Alte Remise, Mittelstr. 3d, 37077 Göttingen, 0551- 3898544

TAXI NUMBERS

Here are some of the many Göttingen taxi numbers:
Hallo Taxi + Night taxi for women/Frauennachttaxi: 0551 - 34034,
Puk Minicar: 0551 - 484848, Taxi-Zentrale: 0551 - 69300

WORKING ROOM

One PC-Pool is located in the foyer. One working room is located in MN10.


exit A7
B3
B2
Primatenzentrum (DPZ)
Hahn-Straße
Institute of Geography
North Campus conference venue
An der Lutter
Institute of Archaeology
Conference Dinner
Deutsches Theater
Train Station
InterCityHotel Göttingen
City Center
Public Lecture
Aula
Wilhelmsplatz 1
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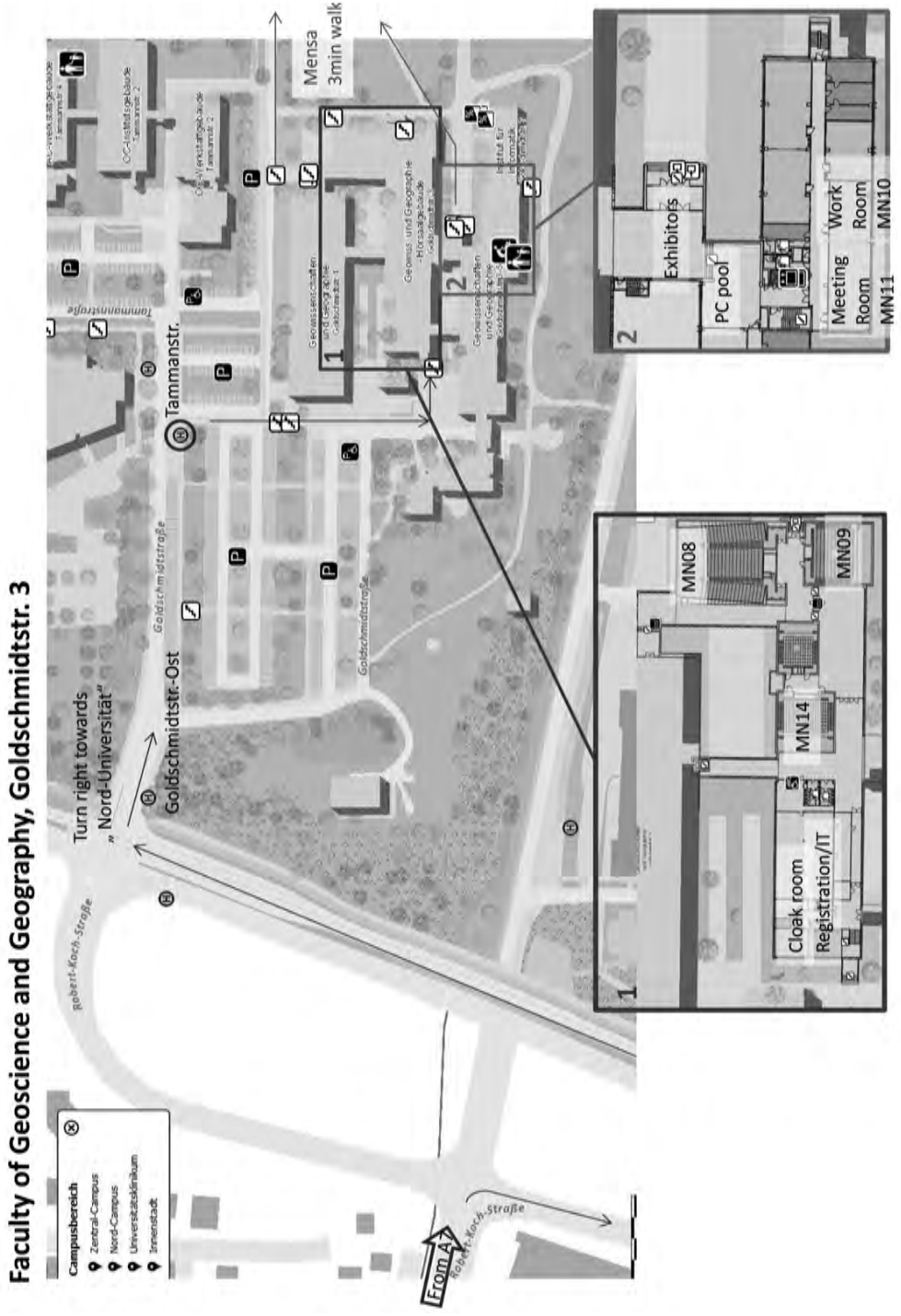

Faculty of Geoscience and Geography, Goldschmidtstr. 3
Mensa 3min walk
Tammanstr.
Goldschmidtstraße
Goldschmidtstr.-Ost
Turn right towards „Nord-Universität"
Robert-Koch-Straße
From A
Campusbereich
Zentral-Campus
Nord-Campus
Universitätsklinikum
Innenstadt
Exhibitors
PC pool
Meeting Room
Work Room
MN10
MN11
MN08
MN09
MN14
Cloak room
Registration/IT

INDEX OF PARTICIPANTS

Family name	First name	Organisation		Reference Page
Abraham	John	University of Cape Coast	GH	344
Abrahams	Mark	The University of East Anglia	UK	
Adams	Julia	Department of Plant Physiology, University of Bayreuth	DE	107
Adeoye	Olusola	University of Ibadan	NG	145
Adler	Marcia	Georg-August-University Göttingen	DE	
Alava Núñez	Paulina	Maburg University	DE	106, 280
Albrecht	Tomas	Charles University in Prague	CZ	17
Ali	Hoda Badry Mohammed	Faculty of Forest Sciences and Forest Ecology	DE	
Alizadeh	Kamaleddin	Department of palynology and climate dynamics	DE	162, 313
Alrutz	Martina	Universtät Göttingen	DE	
Amaral	Erika	Brasilia Environmental Station	BR	343
Amusan	Opeyemi Anthony	Amiesol Resources Konsults / FUTA	NG	295, 353
Anhar	Ashabul	Syiah Kuala University	ID	345
Anita	Syahfitri	Research Center for Biology LIPI	ID	
Arellano	Gabriel	(currently unemployed)	ES	251, 322
Armijos-Ojeda	Claudia	Lehrstuhl für Waldbau, Technische Universität München	DE	235
Aryee	Geogina	Rural Education and Agriculture Development International	GH	334
Ashton-Butt	Adham	University of Southampton	UK	209, 216
Atef Hussien	Nancy	Faculty of Economics ,Cairo University	EG	
Avila-Akerberg	Victor	ICAR-UAEMex	MX	346, 351
Axelsson	Petter	Swedish University of Agricultural Sciences	SE	
Backmann	Pia	iDiv - German Centre for Integrated Biodiversity research	DE	250
Barczyk	Maciej	Jagiellonian University, Kraków, PL	PL	290
Barkmann	Jan	Darmstadt Univ. App. Sci.	DE	112
Bautista Bello	Alma Patricia	Instituto de Ecologia (INECOL)	MX	326

Family name	First name	Organisation		Reference Page
Bayat	Mahmoud	research Institute of Forests and Rangelands(RIFR)	IR	197
Beck	Erwin	University of Bayreuth	DE	105, 106, 107, 109
Behling	Hermann	Uni Göttingen	DE	151, 156, 157, 162, 163, 165, 303, 306, 308, 310, 311, 313
Bender	Irene	iDiv Halle-Jena-Leipzig	DE	46
Bendix	Joerg	LCRS, University of Marburg	DE	89, 92, 94, 100, 103, 105, 106, 277, 278, 280, 286, 287, 288
Biagioni	Siria	Department of Palynology and Climate Dynamics Albrecht-von-Haller-Institute for Plant Sciences Georg-August-University Goettingen	DE	151,154,163
Bohr	Yvonne	Goethe University Frankfurt	DE	
Boissier	Olivier	Unemployed	FR	133
Boshier	David	University of Oxford	UK	70
Boutros	Minnattallah	GFA Consulting Group GmbH	DE	199, 320
Brahma	Biplab	Assam University, Silchar	IN	
Brambach	Fabian	Ecology and Ecosystem Research - University of Göttingen	DE	191
Brändel	Stefan	Institute of Evolutionary Ecology and Conservation Genomics	DE	76, 77
Bräuning	Achim	Institute of Geography, University Erlangen-Nürnberg	DE	93, 97, 297
Breidenbach	Natalie	University Göttingen/ Forest Genetics and Forest Tree Breeding	DE	275
Breier	Tiago	UFRRJ	BR	298
Brunke	Jennifer	University of Veterinary Medicine Hannover	DE	58
Buot	Inocencio Jr	University of the Philippines	PH	302
Butz	Philipp	Georg-August-Universität	DE	104

Family name	First name	Organisation		Reference Page
Cabrera	Marian	University of Amsterdam	NL	341
Camenzind	Tessa	Freie Universität Berlin	DE	98, 285, 342
Camperio Ciani	Giorgia	Vrije Universiteit Brussel	BE	201
Cardenas	Macarena	University of Reading	UK	153
Cárdenas	Glenda	University of Turku	FI	206
Carrillo-Rojas	Galo	Philipps-Universität Marburg and University of Cuenca	EC	288
Carvajal-Hernández	César Isidro	Universidad Veracruzana	MX	192
Cevallos Solorzano	Stefania	UCL/Belgium	BE	
Chavez Calvimontes	Veronica Lizet	Fundacion Natura Bolivia	BO	347
Choi	Sei-Woong	Mokpo National University	KR	
Claßen	Alice	University of Würzburg	DE	178, 182
Cohuo	Sergio	IGeo, TU Braunschweig	DE	167, 168
Come	Renezita	Visayas State University	PH	348
Corlett	Richard	Chinese Academy of Sciences	CN	37
Dalsgaard	Bo	University of Copenhagen	DK	266
Darras	Kevin	University of Göttingen	DE	221, 230
de Boer	Erik	University of Amsterdam	NL	164
Del-Claro	Kleber	Univeridade Federal de Uberlândia	BR	49, 50
Dexter	Kyle	University of Edinburgh	UK	247
Díaz Jiménez	Pedro	Centro de Investigaciones Tropicales, Universidad Veracruzana	MX	327
Diller	Juliane	Zoologische Staatssammlung	DE	
Dolman	Han	VU Amsterdam	NL	138
Draper	Frederick	University of Leeds	UK	159, 161, 242
Duenas	Juan	Freie Universität Berlin	DE	342
Eldie	Yahia	Al fashir University	SD	
Engel	Thomas	-	DE	
Engelbrecht	Bettina	University of Bayreuth	DE	55, 137
Ernst	Raffael	Senckenberg Natural History Collections Dresden	DE	
Fabian	Tobias	Karlsruher Institut für Technologie	DE	283, 285

Family name	First name	Organisation		Reference Page
Farwig	Nina	University of Marburg	DE	100, 102, 103, 277, 278, 286, 287
Fauset	Sophie	University of Leeds	UK	248
Feindt	Wiebke	ITZ, Ecology & Evolution, TiHo Hannover	DE	268
Ferreira	Diogo	Faculty of Sciences of the University of Lisbon	PT	202
Ferrer-Paris	José	IVIC	VE	349
Fiala	Brigitte	University of Würzburg, Animal Ecology and Tropical Biology,	DE	
Finch	Elizabeth	Queen's University, Belfast	UK	115
Finckh	Manfred	Biocentre Klein Flottbek, University of Hamburg	DE	57, 81, 228, 273, 336
Flantua	Suzette	IBED University of Amsterdam	NL	139, 165, 311
Fleischer	Katrin	INPA, Manaus, Brazil	BR	135, 136
Forget	Pierre-Michel	Museum national d'Histoire naturelle	FR	133
Forker	Melanie	TU Dresden	DE	343
Fornoff	Felix	University of Freiburg	DE	51, 52
Foster	William	University of Cambridge	UK	212, 214, 216, 222
Frank	Erik	University of Würzburg	DE	204
Freitas	Marcos Airton de Sousa	DAAD / ANA	BR	350
Fricke	Roman	Philipps University of Marburg, Animal Ecology	DE	113, 114
Garcia Ulloa	John	ETH Zurich	CH	224
Garitano-Zavala	Alvaro	Instituto de Ecología, Universidad Mayor de San Andrés	BO	
Gebauer	Jens	Rhine-Waal Universtiy of Applied Sciences	DE	61, 149
Gebert	Friederike	University of Würzburg, Department of Animal Ecology and Tropical Biology (Zoology III)	DE	184
Gebrekirstos	Aster	World Agroforestry Centre	KE	140
Gérard	Anne	Universität Göttingen	DE	220, 333

Family name	First name	Organisation		Reference Page
Geremew	Addisie	Vrije Universiteit Brussel	BE	82
Gomez Diaz	Jorge Antonio	Georg-August Universität Göttingen	DE	190
Gonçalves	Francisco	Herbarium of Lubango, ISCED-Huíla	AO	336
González Martínez	Tanya M.	UNAM / UAEM	MX	351
Gosling	William	University of Amsterdam	NL	152, 165, 253, 309, 311
Graefe	Sophie	Universität Göttingen	DE	104
Grass	Ingo	Georg-August-Universität Göttingen	DE	221
Greiner	Leonie	Philipps-Universität Marburg	DE	287
Grimm	Volker	Helmholtz Centre for Environmental Research - UFZ	DE	250
Grosiak	Marta	Jagiellonian University,	PL	290
Gu	Fang	plant science institute	DE	306
Guarin	Alejandro	Deutsches Institut für Entwicklungspolitik (DIE)	DE	243
Guarinello de Oliveira Portes	Maria Carolina	Department of Palynology and Climate Dynamcs	DE	303
Guenter	Sven	Thünen Institute of Int. Forestry & Forest Economics	DE	235, 236, 281
Gutierrez	Catalina	University of Freiburg	DE	335
Guzman-Jacob	Valeria	Georg-August-Universität Göttingen, Biodiversity, Macroecology & Conservation Biogeography Group.	DE	315
Hakim	Andi	Office Of Vice President of Republic of Indonesia	ID	
Hapsari	Kartika	University of Göttingen	DE	163
Haque	Sadika	Bangladesh Agricultural University	BD	352
Hardy	Olivier	Université Libre de Bruxelles	BE	64, 66, 69, 325
Hassler	Evelyn	University of Göttingen	DE	218
Haug	Ingeborg	Uni Tübingen	DE	279
Hein	Jonas	German Development Institute/ Deutsches Institut für Entwicklungspolitik	DE	143

Family name	First name	Organisation		Reference Page
Hertel	Dietrich	University of Göttingen; Albrecht von Haller Institute for Plant Sciences; Plant Ecology	DE	187, 259, 291
Heymann	Eckhard W.	Deutsches Primatenzentrum	DE	206, 241, 271
Hildebrandt	Patrick	Institute of Silviculture, TUM	DE	195, 281, 282
Hiller	Thomas	Institute of Evolutionary Ecology and Conservation Genomics, University of Ulm	DE	76, 77
Hiltner	Ulrike	Helmholtz-Centre for Environmental Research-UFZ	DE	297
Hinsch	Julie	CMEC, Uni of Copenhagen	DK	217
Hohnwald	Stefan	Physical Geography, Göttingen	DE	
Holle	Mukhlish Jamal Musa	Hokkaido University	JP	132
Hölscher	Dirk	Georg-August-Universität Göttingen	DE	104, 210, 220, 259, 333
Homeier	Jürgen	University of Göttingen	DE	95, 96, 98, 100, 252, 284, 340
Hooghiemstra	Henry	University of Amsterdam	NL	139, 165, 292, 311
Hořák	David	Charles University in Prague	CZ	179, 180
Hossaert-McKey	Martine	Centre d'Ecologie Fonctionnelle et Evolutive CEFE-UMR 5175, CNRS University of Montpellier - University Paul-Valery-Montpellier EPHE.	FR	42
Hugé	Jean	Université Libre de Bruxelles (ULB)	BE	86, 201
Hughes	Alice	Xishuangbanna Tropical botanical garden, Chinese academy of sciences	CN	265
Humlova	Anna	University of South Bohemia, Faculty of Science, Department of Zoology	CZ	181
Ilstedt	Ulrik	SLU	SE	
Ismail	Sascha A	University of Aberdeen	UK	60
Jang	Hyonchol	Goettingen University	DE	
Jansen	Patrick	Smithsonian Tropical Research Institute	NL	

Family name	First name	Organisation		Reference Page
Janssen	Thomas	VU University Amsterdam	NL	
Jones	Mirkka	Dept. Biology, University of Turku	FI	205, 206
Jurkschat	Lucas	Universität Göttingen	DE	319
Karger	Dirk Nikolaus	University of Zurich	CH	189, 312
Karmann	Marion	FSC International	DE	234, 296
Kashyap	Jyoti	TERI University	IN	196, 329
Kehinde	Temitope	Obafemi Awolowo University	NG	353
Kelly	Thomas	University of Leeds	UK	159, 160, 242, 304
Kettle	Chris	ETH Zurich	CH	59, 60, 63
Khamis Mohamed	Mohamed Adam	Al Fashir University	SD	
Khan	Khalid Ali	King Saud Univeristy Riyadh	SA	68
Khine	Phyo Kay	FB Geographie, Philipps Universitaet, Marburg, Germany	DE	316
Kieslinger	Julia	Friedrich-Alexander-Universität Erlangen-Nürnberg, Institut für Geographie	DE	
Kigathi	Rose Nyachomba	Pwani University	KE	354
Kim	Cholhun	Göttingen University	DE	
Kleinschroth	Fritz	CIRAD	FR	233
Kluge	Jürgen	University of Marburg, Dept Geography	DE	189, 316, 340
Knoke	Thomas	Technische Universität München	DE	90, 91
Konate	Souleymane	University Nangui Abrogoua	CI	227
Kotowska	Martyna	University of Göttingen	DE	259
Kouhgardi	Esmaeil	Islamic Azad University	IR	83, 276
Kramer-Schadt	Stephanie	IZW	DE	158
Kreft	Holger	Georg-August-Universität Göttingen	DE	215, 220, 312, 315, 333
Krömer	Thorsten	CITRO Universidad Veracruzana	MX	190, 192, 203, 315, 327
Kruijt	Bart	ALTERRA - Wageningen UR - Netherlands	NL	135, 136
Ksentini	Ines	Olive Tree Institute - Tunisia	TN	355
Kupers	Stefan	Leipzig University / iDiv	DE	137

Family name	First name	Organisation		Reference Page
Kurali	Anikó	Eötvös Lóránd University	HU	321
Kurniawan	Syahrul	Soil science department, Faculty of Agriculture, University of Brawijaya	ID	211
Küstner	Georg	University of Bayreuth; GCE	DE	
Kusuma	Yayan Wahyu Candra	Center for Plant Conservation Botanic Gardens - LIPI	ID	215
Lammers	Pina Lena	University of Hildesheim	DE	116
Lazos	Adi	PUC-Rio	BR	356
Leles	Bruno	UNESP	BR	267
Leonhardt	Sara	University of Würzburg	DE	48
Leuschner	Christoph	University of Göttingen	DE	191, 252, 259
Lewis	Owen	University of Oxford	UK	54, 55
Ley	Alexandra	University Halle-Wittenberg	DE	64, 325
Ließ	Mareike	University of Bayreuth	DE	108, 324
Linares-Palomino	Reynaldo	Smithsonian Institution	PE	
Lopez Acosta	Juan Carlos	Ecologia y Restauración	MX	192
Lorenz	Stephanie	Georg-August-Universität Göttingen	DE	
Lucey	Jennifer	Department of Biology, University of York	UK	223
Luck	Marvin	University of Marburg	DE	114
Luke	Sarah	University of Cambridge	UK	212
Maas	Bea	University of Vienna	AT	230
Macario-Gonzalez	Laura	IGEO / TU Braunschweig	DE	167, 168
Macía	Manuel J.	Autonomous Univ. of Madrid	ES	251, 322
Majcher	Bartosz	Jagiellonian University in Kraków	PL	290
Malhi	Yadvinder	University of Oxford	UK	38, 147, 248, 257, 261, 262,
Manchego	Carlos	Technische Universität München	DE	281
Mantilla Contreras	Jasmin	University of Hildesheim, Institute of Biology & Chemistry, Ecology and Environmental Education Group	DE	116, 117, 119

Family name	First name	Organisation		Reference Page
Marian	Franca	Universität Göttingen	DE	99, 185
Marklewitz	Marco	Institute of Virology, Bonn	DE	79
Mathai	John	Leibniz Institute for Zoo and Wildlife Research	DE	229, 323
Matson	Amanda	University of Goettingen	DE	211, 219
Mattes	Julian	Philipps-University Marburg	DE	286
McMichael	Crystal	University of Amsterdam	NL	166
Mechik	Elena	Universität Hamburg	DE	146
Mehregan	Iraj	Department of Biology, Islamic Azad University, Science and Research branch, Tehran, Iran	IR	
Meza Flores	Liza Melina	Fondo de las Américas - Perú	PE	357
Migliore	Jérémy	Université Libre de Bruxelles	BE	66
Mohamed	Mohamed	Zagazig Uni./ Vet. College	EG	328
Mohd Nadzir	Mohd shahrul	National University of Malaysia	MY	126
Monemian	Seyedmahmoud	University of Göttingen	DE	274, 339
Montoya	Encarni	The Open University	UK	165, 253, 305
Morales	Lucia	Bangor University	UK	351
Morel	Alexandra	University of Oxford	UK	
Moreno	Monica	University of Freiburg	DE	
Morgan	Emma	ETH Zuerich	CH	63
Morris	Rebecca	University of Oxford	UK	123
Moses	Jimmy	Faculty of Science, University of South Bohemia	CZ	174, 175, 176
Mottl	Ondřej	Institute of Entomology, Biological Center, Academy of Science, ČR	CZ	177
Mukungu	Joëlle	University of Freiburg, Chair for Landscape management	DE	144
Mumme	Steffen	ITAW Büsum	DE	127
Murodova	Sayyora	national university of Uzbekistan	UZ	
Murori	Rosemary	International Rice Research Institute (IRRI)	KE	358
Nath	Arun Jyoti	Assam University, Silchar	IN	147
Neugebauer	Elenora	University Frankfurt	DE	
Neuschulz	Eike Lena	Senckenberg Biodiversity and Climate Reserach Centre Frankfurt	DE	45, 101, 287

Family name	First name	Organisation		Reference Page
Ngeve	Magdalene N.	Plant Biology and Nature Management / Vrije Universiteit Brussels	BE	67
Ngo	The Long	Hung Vuong Uni., Vietnam	VN	359
Niedballa	Jürgen	Leibniz Institute for Zoo and Wildlife Research	DE	65, 232, 323
Niessner	Armin	Universität Hohenheim	DE	240
Niether	Wiebke	Universität Göttingen, Physische Geographie	DE	148, 294
Niu	Furong	Georg-August-Universität Göttingen	DE	210
Nkengla	Lilian	International Institute of Tropical Agriculture (IITA), Cameroon	CM	360
Novotny	Vojtech	Biology Centre, Czech Academy of Sciences	CZ	53, 130, 171, 172, 173, 175, 175, 314
Nunoo	Francisca	Rural Education and Agriculture Development International	GH	
Nunoo	Isaac	Rural Education and Agriculture Development International	GH	334
Nunto	Nattapoom	University of Southampton	UK	330
Ofner	Elisabeth	University of Bayreuth	DE	272
Oliveras	Imma	OUCE/U.Oxford	UK	261
Orozco ter Wengel	Pablo	Cardiff University	UK	72
Owusu	Samuel	Kumasi Polytechnic	GH	
Page	Susan	Dept Geography, University of Leicester	UK	40
Pandey	Anu	jawaharlal nehru university	IN	
Parolin	Pia	INRA / University of Nice Sophia Antipolis	FR	84
Parr	Kate	University of Liverpool	UK	125
Pathak	Karabi	Assam University Silchar	IN	147
Paul	Carola	Technische Universität München	DE	90, 91
Pena Claros	Marielos	Wageningen University	NL	258, 260
Peters	Thorsten	FAU Erlangen-Nuremberg, Institute of Geography	DE	93, 94

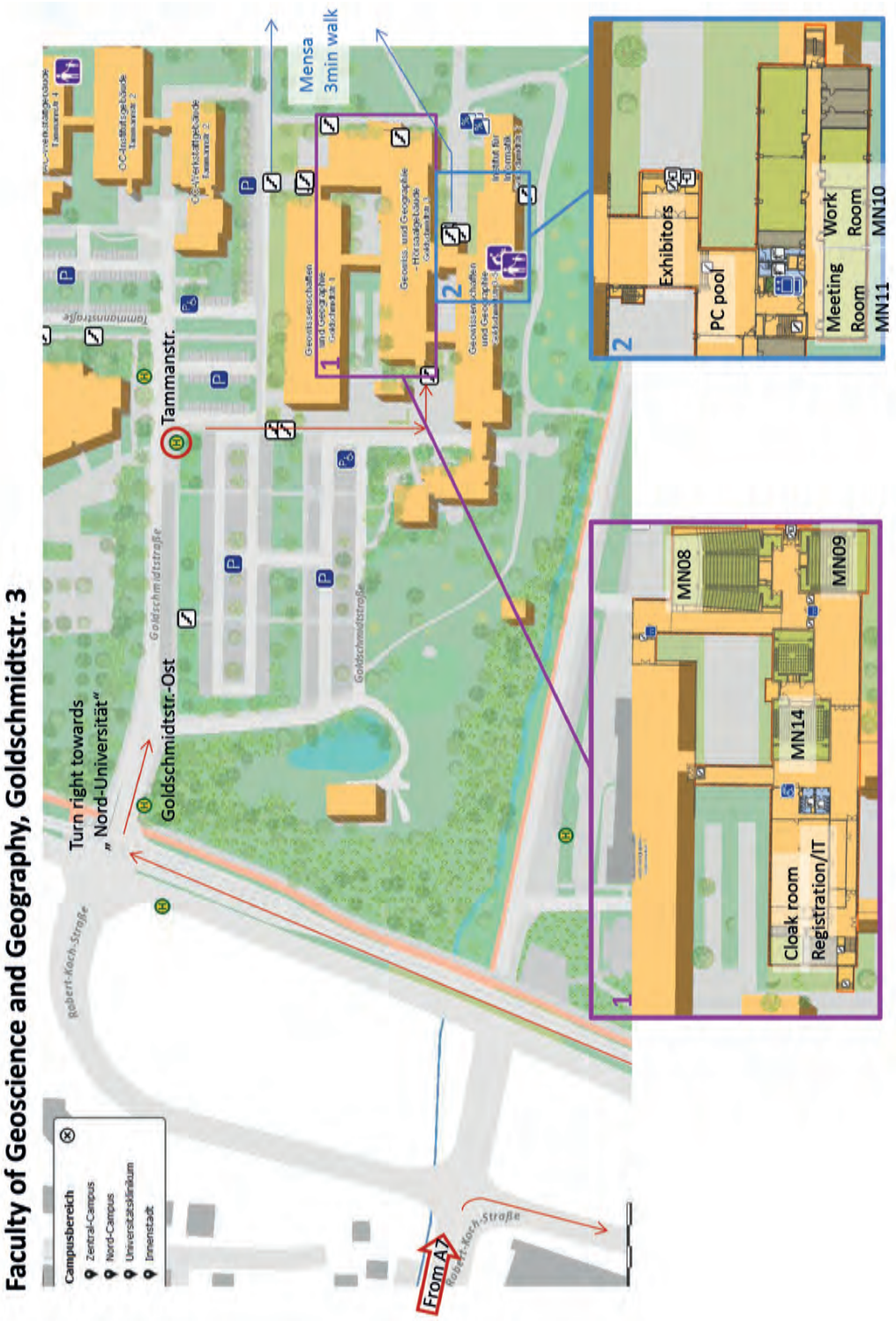
Family name	First name	Organisation		Reference Page
Peters	Marcell	University of Würzburg	DE	170, 178, 182, 184
Pfeifer	Marion	Imperial College London/ Newcastle University	UK	213
Pfeiffer	Simone	University of Göttingen, CBL-SeTSAF	DE	
Plowman	Nichola	Biology centre CAS	CZ	176, 177
Poliakova	Anastasia	University of Göttingen	DE	306, 308
Poorter	Lourens	Forest Ecology and Forest Management Group - Wageningen University	NL	39, 258
Prabhu	Ravi	ICRAF	KE	41
Prescott	Graham	University of Cambridge	UK	222
Prinz	Kathleen	FSU Jena	DE	61
Quiroz Dahik	Carlos	Universidad de Cuenca / Technical University of Munich	EC	195
Quitián	Marta	Senckenberg Biodiversity and Climate Research Centre (BiK-F) Frankfurt	DE	45, 101, 287
Radchuk	Viktoriia	Leibniz Institute for Zoo and Wildlife Research	DE	158
Radespiel	Ute	Institute of Zoology, TiHo Hannover	DE	58
Rakotoarisoa	Tsiry Fanilonirina	University of Hildesheim	DE	117
Ramadhani	Jambo Hamisi	Mozambique-Tanzania Centre for Foreign Relations	TZ	
Ramanan-kirahina	Rindrahatsarana	Mikajy Natiora Association	MG	361
Rasamimanana	Hantanirina	Ecole Normale Superieure Tana	MG	120
Ravalohari-manitra	Maholy	The Aspinall Foundation	MG	111
Razafimeva	Florette	World Bank	MG	
Reibelt	Lena	University of Hildesheim	DE	119
Revermann	Rasmus	University of Hamburg	DE	81, 228, 336
Richter	Torsten	University of Hildesheim	DE	116, 117, 118, 119
Rivera Coria	Walter Benjamin	Central University of Ecuador - School of Law	EC	362
Rocha	Maria	Julius-Maximilians-Universität Würzburg	DE	301
Rodriguez	Lily	CIMA Cordillera Azul	PE	244, 338

Family name	First name	Organisation		Reference Page
Rodriguez	Rodolfo	Universidad de Piura (UDEP)	PE	
Rodríguez	Jeronimo	Instituto Humboldt	CO	363
Rodríguez-Vargas	Ariel R.	Univ. Autónoma de Chiriquí	PA	364
Rodríguez-Zorro	Paula A.	University of Göttingen	DE	156, 162, 310
Rodtassana	Chadtip	Plant Sciences-University of Cambridge	UK	
Roman-Cuesta	Rosa Maria	Univ. Wageningen-CIFOR	NL	
Roth	Nicolas	AG Ökologie, Department Biologie, Universität Erlangen-Nürnberg	DE	318
Roucoux	Katy	University of St Andrews	UK	151, 159, 160, 161, 242, 304
Sahner	Josephine	Georg-August-University	DE	129
Salazar	Laura	Universidad Estatal Amazónica	EC	340
Salazar	Monica	University of Puerto Rico, Rio Piedras Campus	PR	300
Salgado	Jhenny	University of Goettingen	DE	96, 284
Sam	Legi	Environmental Futures Research Institute & Griffith School of Environment, Griffith University	AU	53, 172, 173
Sam	Katerina	Biology Centre CAS, Institute of Entomology	CZ	174, 181, 314
Sanchez-Galindo	Laura Margarita	University of Göttingen	DE	99
Santillan	Vinicio	Senckenberg Biodiversity and Climate Research Center	DE	45, 101, 287
Sarmiento	Victoria	Humboldt Research Institute-Colombia	CO	
Scharmann	Mathias	ETH Zürich	CH	71
Schellenberger Costa	David	University of Oldenburg	DE	188
Schleuning	Matthias	Senckenberg BiK-F	DE	45, 46, 47, 101, 183, 287
Schmid	Julian	Institute of Evolutionary Ecology and Conservation Genomics	DE	78
Schmidt Yáñez	Paul Luis	Göttingen University	AT	128
Schneider	Nicole	Universität zu Köln	DE	

Family name	First name	Organisation		Reference Page
Schneidewind	Ulf	Georg-August Universität Göttingen Abteilung PhysischeGeographie	DE	148
Schnetter	Marie-Luise	Institut für Botanik, guest	DE	307
Schüler-Goldbach	Lisa	Department of Palynology and Climate Dynamics, Göttingen University	DE	155
Schwarzkopf	Teresa	ICAE, Universidad de Los Andes	VE	254, 317
Sedlacek	Ondrej	Charles University in Prague	CZ	179, 180
Segar	Simon	Czech Academy of Sciences	CZ	53, 172
Setyaningsih	Christina Ani	University of Goettingen	DE	154
Shenkin	Alexander	University of Oxford	UK	262
Shumo	Marwa	Center for Development Research(ZEF) and icipe	KE	365
Siddons	David	Universidad del Azuay	EC	102, 277, 278
Sierra Cornejo	Natalia	University of Goettingen	DE	291
Silva	Brenner	University of Marburg	DE	105, 106, 280, 288
Silva de Oliveira	Déborah	Universitat Hamburg	DE	
Skiba	Ute	Centre for Ecology and Hydrology	UK	124
Slade	Eleanor	University of Oxford	UK	289, 332
Smith	James	ETH Zurich	CH	59, 293
Snaddon	Jake	University of Southampton	UK	214, 216, 330, 332
Soares	Eduardo	Universidade de São Paulo	BR	
Sommer	Simone	University of Ulm	DE	78
Spannl	Susanne	Institute of Geography, FAU Erlangen-Nuremberg	DE	97
Spear	Dakota	University of Cambridge	UK	331
Staab	Michael	University of Freiburg	DE	51, 52
Strobl	Simone	University of Bayreuth	DE	105, 106
Sulemana	Mohammed	University for Development Studies	GH	
Szefer	Piotr	Biology Centre, Czech Academy of Science	CZ	130
Szejner	Paul	Laboratory of Tree-ring research	US	366
Tao	Hsiao-Hang	University of Oxford	UK	216, 332

Family name	First name	Organisation		Reference Page
Thieme	Mercedes	FSU Jena	DE	61
Thu	Zin Myo	IUCN	MM	367
Tiede	Yvonne	Philipps-Universität Marburg, Conservation Ecology	DE	100, 103, 286
Tilch	Sebastian	Netzwerk-Forum zur Biodiversitätsforschung (NeFo)	DE	
Tito de Morais	Claire	ETH Zurich	CH	
Toivonen	Johanna	Department of Biology, University of Turku	FI	131
Tomasek	Oldrich	Charles University in Prague	CZ	
Torezan-Silingardi	Helena Maura	Universidade Federal de Uberlandia	BR	49
Tosso	Felicien	Gembloux Agro-Bio Tech/ University of Liege	BE	
Trachte	Katja	Philipps-University Marburg	DE	92, 94
Tran	Hoa	Center for Biodiversity and Biosafety, Institute of Agricultural Genetics	VN	207
Triest	Ludwig	Vrije Universiteit Brussel	BE	62, 67, 82
Turner	Edgar	Department of Zoology, University of Cambridge	UK	212, 213, 214, 216
van der Sande	Masha	Wageningen University	NL	258, 260
van Schingen	Mona	University of Cologne	DE	200
Vega	Luisa F.	University of Kiel	DE	299
Velescu	Andre	Karlsruher Institut für Technologie	DE	94, 283, 285
Vihotogbé	Romaric	Rhine-Waal University of Applied Sciences, Kleve, Germany / Laboratory of Applied Ecology, University of Abomey-Calavi, Benin	DE	149
Vilela Nogueira Abdo	Maria Teresa	APTA- Polo Centro Norte	BR	85, 337
Viquez-R	Luis	Institute of Ecology, UNAM	DE	75
Volf	Martin	Institute of Entomology, Biology Centre AS CR, v.v.i.	CZ	53, 172
Vollstädt	Maximilian	Senckenberg Biodiversity and Climate Research Centre (BiK-F)	DE	183
Wallis	Christine	Geography/Biology, University of Marburg	DE	100, 286, 287

Family name	First name	Organisation		Reference Page
Weigand	Anna	University of Zurich	CH	312
Weigend	Maximilian	Universität Bonn	DE	239
Weißflog	Anita	Bayreuth University	DE	55
Wheeler	Charlotte	University College London	UK	
Whitaker	Jeanette	Centre for Ecology & Hydrology	UK	186
Wilting	Andreas	Leibniz Institute for Zoo and Wildlife Research	DE	65, 158, 229, 232, 323
Wittmann	Florian	Max Planck Institute for Chemistry	DE	249
Zanetti	Ederson Augusto	Green Farm	BR	368
Zárate	Edwin	Universidad del Azuay	EC	101, 278
Zemp	Delphine	Potsdam Institute for Climate Impact Research	DE	198
Zigelski	Paulina	Universität Hamburg	DE	57, 273
Zinner	Dietmar	Deutsches Primatenzentrum	DE	271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