

gtö 2012

# ISLANDS IN LAND- AND SEASCAPE: THE CHALLENGES OF FRAGMENTATION

Conference of the Society for Tropical Ecology  
Erlangen, February 22 – 25, 2012



Islands in land- and seascape: The Challenges of Fragmentation

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## PROGRAMME & ABSTRACTS



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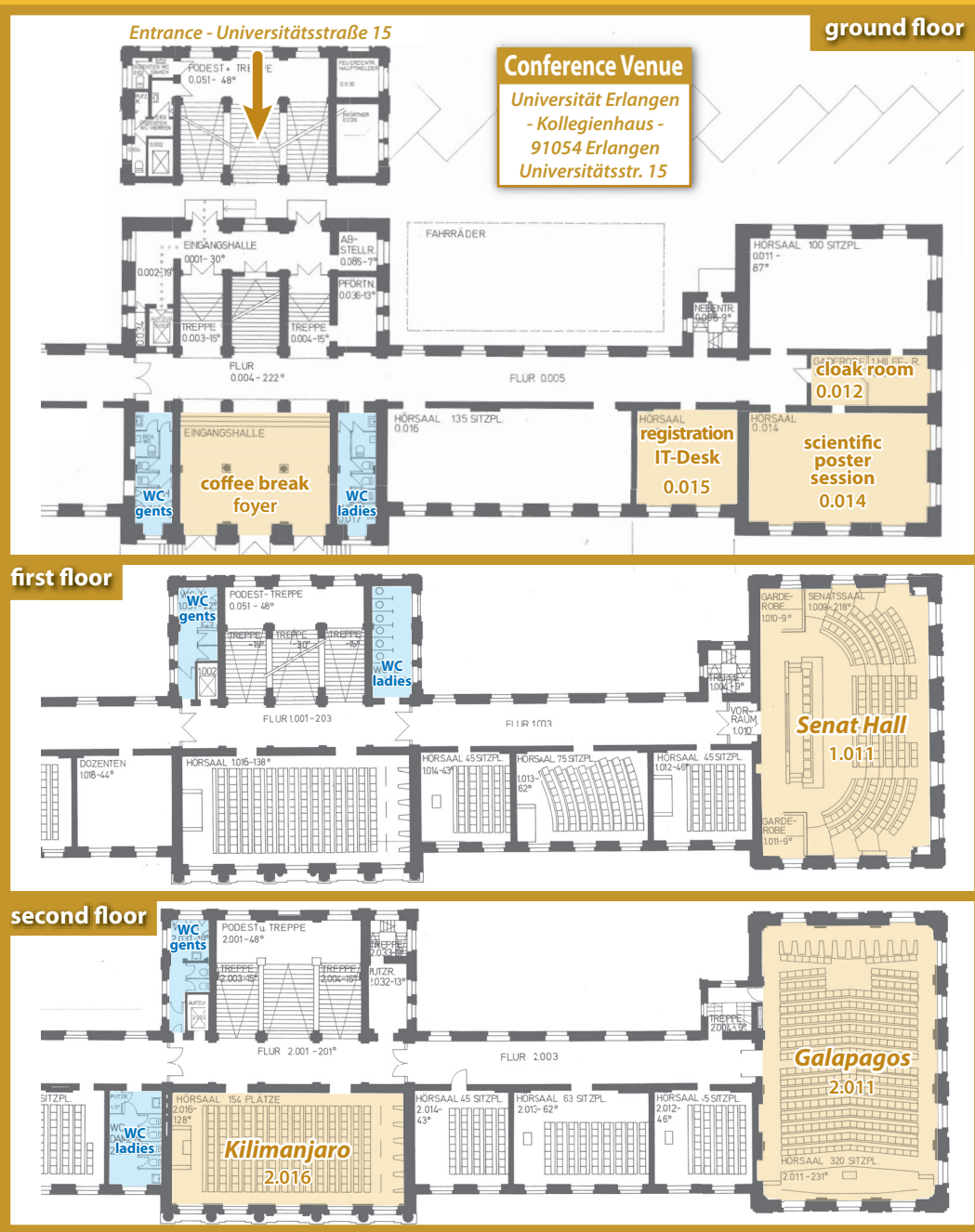
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gtö Gesellschaft für Tropenökologie e.V.  
Society for Tropical Ecology



Wednesday, 22 February	Thursday, 23 February	Friday, 24 February	Saturday, 25 February
Registration from 10:00, University Building Kollegienhaus, ground floor	8:30 Plenary: Keynote Room 2.011	8:30 Plenary: Keynote Room 2.011	8:30 Plenary: Keynote Room 2.011
	9:15 Parallel Session Room 2.011 "Galapagos" Room 2.016 "Kilimanjaro"	9:15 Parallel Session Room 2.011 "Galapagos" Room 2.016 "Kilimanjaro"	9:15 Parallel Session Room 2.011 "Galapagos" Room 2.016 "Kilimanjaro"
	10:30 Coffee break	10:30 Coffee break	10:30 Coffee break
	11:00 Parallel Session Room 2.011 "Galapagos" Room 2.016 "Kilimanjaro"	11:00 Parallel Session Room 2.011 "Galapagos" Room 2.016 "Kilimanjaro"	11:00 Parallel Session Room 2.011 "Galapagos" Room 2.016 "Kilimanjaro"
12:15-13:45 Opening Ceremony, Room 2.011 "Galapagos"	12:15 Lunchbreak	12:15 Lunchbreak	12:15 Closing Ceremony, Room 2.011
13:45 Plenary: Keynote Room 2.011	13:45 Plenary: Keynote Room 2.011	13:45 Plenary: Keynote Room 2.011	
14:30 Parallel Session Room 2.011 "Galapagos" Room 2.016 "Kilimanjaro"	14:30 Parallel Session Room 2.011 "Galapagos" Room 2.016 "Kilimanjaro"	14:30 Parallel Session Room 2.011 "Galapagos" Room 2.016 "Kilimanjaro"	
15:45 Coffee break	15:45 Coffee break	15:45 Coffee break	
16:15 Plenary: Keynote Room 2.011	16:15 Parallel Session Room 2.011 "Galapagos" Room 2.016 "Kilimanjaro"	16:15 Scientific poster session, Room 0.014	
17:00 Parallel Session Room 2.011 "Galapagos" Room 2.016 "Kilimanjaro"	17:00 For gto members only: GTÖ 35th Assembly, Senatssaal, Room 1.011		
18:30 Ice Breaker, Schloss	19:00 Public talk (in German), Room 2.011 "Galapagos"	19:00 Conference Dinner Hotel Bayerischer Hof	



# ISLANDS IN LAND- AND SEASCAPE: THE CHALLENGES OF FRAGMENTATION

Conference of the Society for Tropical Ecology  
Gesellschaft für Tropenökologie e.V. - gtö

Friedrich-Alexander-University  
22<sup>nd</sup> - 25<sup>th</sup> February 2012  
Erlangen

## IMPRESSUM

### Editors

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## WELCOME AND FOREWORD

**Dear participants, dear colleagues,**

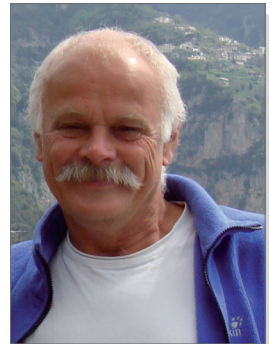
it is a great pleasure to welcome you to the Annual Conference of the Society for Tropical Ecology (gtö) at Friedrich-Alexander University (FAU) Erlangen-Nürnberg. Erlangen with its approximately 105,000 inhabitants is located about 15 kilometers north of Nuremberg in the foreland of picturesque Franconian Switzerland in Northern Bavaria. It is one of the best preserved baroque plan cities in Germany and guests as well as new arrivals always are welcome here. Erlangen got its reputation as an open minded city in the 17<sup>th</sup> century, when the French Huguenots made it their second home. The city still has an international feel, thanks to its position as a medical center, Siemens AG, and to the Friedrich-Alexander University being the second largest University in Bavaria and attracts 33.000 students.

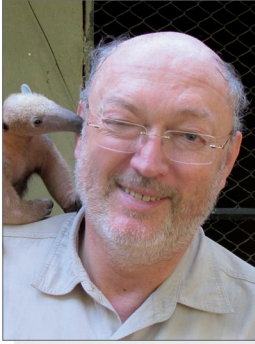
Following the International years of biodiversity (2010) and forests (2011), this conference highlights the importance of the problem of fragmentation of tropical ecosystems and habitats. Probably even more relevant than the ongoing climate change, this must be regarded a major threat of maintaining biodiversity and ecosystem functions for the future, challenging not only biological sciences but also land use management and politics on local, regional and global scales. Con currently with fragmentation goes an increasing isolation of remaining habitat fragments, initiating changes in the dynamics of populations and evolutionary processes. Insular areas such as mountains in tropical surroundings or true islands in tropical oceans provide natural laboratories where effects of isolation can be studied.

The effort of organizing such an event could not have been successfully surmounted without the engagement of our supporting local organizing team, including the students of the MSc Physical Geography course in Tropical Ecology. Furthermore, we appreciate the sponsorship of our donors and thank all participants for their contributions.

We hope that this year's gtö conference will stimulate the scientific debate about effects and possible counter measurements against ecosystem fragmentation and related detrimental processes. Besides, we are confident that you will enjoy your stay at Erlangen - not least to take the opportunity to explore the hidden treasures and the rich gastronomic culture of our town.

On behalf of the organizing team,  
Achim Bräuning,  
Michael Richter,  
Thorsten Peters





### Dear friends and colleagues,

the economic crisis especially in Europe makes headlines every day. Discussion goes around quite a number of possible solutions – or rather emergency matters. States, banks, companies, and private people have suffered serious financial losses and a few went even bankrupt or are close to it. This crisis is not the first one in history - and, allow me to predict it, it will not be the last. Some serious structural adjustments and (lots of) money may be necessary to overcome this crisis, but – as always in the past – a way out and forward will be found.

Unfortunately, contrary to the economic crisis, the ecological crisis we are living in is not that easy to solve and thousands of species and habitats have been lost already – many of them before being known to science. Extinct species cannot be recovered, and what is lost will be forgotten soon. Compared to the economic/financial crisis, this is a real and big disaster. But whom am I telling this. We, the participants of the 2012 Conference of the Society for Tropical Ecology - gtö, are aware of the downward trends of biological diversity worldwide and especially in the tropics. For most of us, the conservation of our study objects has become an issue as much as their study and investigation.

Fragmentation of habitats is posing a serious threat even to those ecosystems which are “internally” intact, traffic infrastructure such as roads and railways, shipping routes, power lines, human settlements and industrial agriculture are just a few of the causes for the formation of artificial islands of natural systems. What can we learn from the (true) island ecology? What can we do to preserve islands of nature in increasingly altered land and sea scapes? What are the real effects of fragmentation and which are the ways to re-connect fragmented habitats? These are the issues we want to discuss here in Erlangen under our conference title “Islands in Land and Sea Scapes – the Challenges of Fragmentation”. But as always we will not limit ourselves to sessions on these aspects but deal with a range of other, “free” matters. Tropical ecology is a wide and fascinating field.



We are very sad that at this conference we will miss our dear friend and colleague Elisabeth Kalko, an outstanding scientist and wonderful person. She passed away completely unexpectedly in September 2011. To her memory the traditional public evening speech at the gtö conference will from this year on be held as the "Elisabeth Kalko Memorial Speech". Elisabeth's special interest was the formation of and support to students and young scientists. And she was an enthusiastic member and Vice President of the gtö. In our work and hearts she will always be remembered.

I would like to thank our hosts at the University of Erlangen, our sponsors, my colleagues in the board and advisory council of the gtö, our speakers and you all who will make this conference a success.

Please do not forget to tell all your friends and colleagues who are not yet a member of gtö to join us. I'm not getting tired to repeat that the "weight" of gtö, the chance to really make a difference, does not depend only on scientific excellence but also on the number of our members.

I do wish us all a very successful gtö-conference 2012.

Prof. Dr. Manfred Niekisch  
President of the  
Society for Tropical Ecology - gtö



**WEDNESDAY, FEBRUARY 22<sup>ND</sup>****REGISTRATION**

Registration can be done

from **10:00 to 12:00**

in **Room 0.015**

at “Kollegienhaus”, Friedrich-Alexander-University, Erlangen

See „Map of Conference Venue“ on page 228

12:15 Opening Ceremony

## 13:45 Plenary: Keynote

Prof. Dr. Olivier Hardy

Phylogeographic patterns and gene flow in Central African rain forest plants

## 14:30 Parallel Sessions

## TROPIC SIMPLIFICATIONS AND FUNCTIONAL DOWNGRADING OF FRAGMENTED/HUMAN-MODIFIED TROPICAL FORESTS, p.30

Chairs: Rainer Wirth, Inara Leal

- 14:30 Proliferation of disturbance-adapted species and the persistence of tropical biodiversity in human-modified landscapes
- 14:45 How does forest biomass vary depending on succession stage and disturbance history in the Atlantic forest of Rio de Janeiro?
- 15:00 Forest regeneration dynamics in differently modified South African scarp forests
- 15:15 Impact of human disturbance on fruit dispersal by frugivores in a tropical rain forest
- 15:30 Trophic simplification in Neotropical bat assemblages following habitat fragmentation: lessons learned from bats on land-bridge islands in Panama

## BIOGEOGRAPHIC PATTERNS OF TROPICAL MOUNTAIN ECOSYSTEMS, p.40

Chair: Michael Richter

- 14:30 Are adaptation abilities linked to phylogentic and /or biological similarities? - An amphibian study on a volcanic mountain in Cameroon
- 14:45 Trophic niche differentiation and microhabitat utilization in a species-rich montane forest small mammal community of eastern Madagascar
- 15:00 Genetic differentiations within island endemics: A biogeographical evolution assay in selected *Aeonium* species
- 15:15 Vegetation structures and ecological features of the upper timberline ecotone along the Neotropical Andes
- 15:30 The long-term ecology of Lore Lindu National Park mountain rainforest (Sulawesi - Indonesia)

## 15:45 Coffee break

## 16:15 Plenary: Keynote

Dr. Marife D. Corre

Impact of elevated N input on net primary production and soil trace gas fluxes in tropical forests



## SESSION CONTINUED

- 17:00 Frugivorous bats suffer from hunting of larger mammals in Western Amazonia: an unexpected connection via mineral licks
- 17:15 How do forest fragmentation and matrix quality influence diversity of a hyper-diverse Malagasy amphibian assemblage?
- 17:30 Dominance vs. Diversity: massive impacts of ant community structure on ecosystem services in Indonesian agroforests
- 17:45 Trophic simplifications and functional downgrading of fragmented forests ? the case of leaf-cutting ants

## SESSION CONTINUED

- 17:00 Late Quaternary vegetation, climate and fire-dynamics in East Africa inferred from the pollen record from Maundi Crater, Kilimanjaro
- 17:15 The modern pollenrain/vegetation relationship in a tropical mountain rainforest - a guideline for past vegetation and plant diversity research
- 17:30 Importance of regional climates for species distribution patterns in the Ethiopian moist montane forests
- 17:45 Spatial patterns of tree species in mountain rain forests of South Ecuador
- 18:00 Predictive mapping of plant diversity and plant belts along an altitudinal gradient on a Loma mountain in the Peruvian desert
- 18:15 SPERICH: an open-source tool for the identification of spatial species richness patterns at large scales and in sparse data situations

18:30 Ice Breaker





THURSDAY, FEBRUARY 23<sup>RD</sup>

08:30 Plenary: Keynote

Dr. Meine van Noordwijk

Trees and watershed services in tropical landscapes in transition

09:15 Parallel Sessions

THURSDAY

FRAGMENTATION GENETICS IN THE TROPICS, p.55

Chairs: Chris J Kettle, Aline Finger

09:15 GENETIC FRAGMENTATION EFFECTS IN THE TROPICS: WHAT ANIMAL POPULATIONS CAN TELL US

09:30 Effects of habitat fragmentation on the genetic population structure of the frugivorous bat *Dermanura watsoni* (Phyllostomidae)

09:45 Do islands suffer from lower genetic diversity and inbreeding? The case of orchid bees in São Paulo, Brazil

10:00 Evolution on East African mountain archipelagos: Phylogeography and conservation biology of the Montane White-eye

10:15 Fragmentation genetics and reproductive success in *Dysoxylum malabaricum* (Meliaceae)

THE ROLES OF AGROFORESTRY IN MANAGING FRAGMENTED MULTIFUNCTIONAL LANDSCAPE, p.65

Chairs: Aster Gebrekirstos, Sonya Dewi

09:15 Connecting Krokosue Hills Forest Reserves and Bia Conservation Area of Ghana through the use of Cocoa Agroforestry Systems

09:30 Initial tree growth in different Taungya Systems in Panama

09:45 Diversity and Use of Woody Plant Species under Different Property Regimes in rural landscapes of northwest Ethiopia

10:00 Quantifying ecosystem services tradeoffs in rubber agroforests in Jambi Province, Indonesia: application of Agent-Based Modeling (ABM)

10:15 Productivity, conservation of tree diversity and carbon sequestration in agroforestry systems. A case study from the Gran Sumaco, Ecuador

10:30 Coffee break

#### SESSION CONTINUED

- 11:00 Seeing the trees for the Forest of Borneo
- 11:15 Genetic variation of teak (*Tectona grandis* Linn. f.) in selectively-logged and unlogged natural populations in Myanmar
- 11:30 How does heterozygosity and inbreeding influence germination, growth and survival in tropical trees
- 11:45 Effects of forest fragmentation on genetic variation patterns in African tree species

#### SESSION CONTINUED

- 11:00 Land Use Planning for Rural Development with Multiple Environmental Services in the tropical landscapes
- 11:15 Market mechanisms to avoid biodiversity loss in agroforestry systems
- 11:30 Does age matters: comparison of species diversity and traditional management practices in coffee based agroforestry in Sidama and Bench-Maji, Ethiopia
- 11:45 Site and Soil Ameliorative Potentials of Agroforestry Tree Species in Arsi Negelle District, Oromia, Ethiopia

THURSDAY

12:15 Lunch break



13:45 Plenary: Keynote

Prof. Dr. Beth Kaplin

The importance of buffer zones in mediating edge effects on ecological processes in forest islands surrounded by a sea of agriculture

14:30 Parallel Sessions

FRAGMENTATION, MOVEMENTS AND DISEASES, p.75

Chairs: Fred de Boer, Heribert Hofer

14:30 Fragmentation, movementst and implications for diseases expansion: a review

14:45 Eco-immunology of tropical mammals

15:00 Diversity within: changes in bat trypanosome prevalence and distribution in fragmented habitats

15:15 Reservoir competence, life history traits and fragmentation: why does the dilution effect occur?

15:30 Spatial habitat distribution, fragmentation and search effectiveness

TROPICAL DENDROECOLOGY, p.81

Chair: Achim Bräuning, Ute Sass-Klaassen

14:30 Variability of tree-ring structure and wood anatomical variables in tropical trees

14:45 Seasonal variability of stem growth and water use in a neotropical dry forest

15:00 Climatic reconstruction with dendrochronological methods in a dry forest in southern Ecuador

15:15 Combining ring width and stable-carbon isotopes of trees in a tropical lower montane forest of Southern Ecuador

15:30 Exception among exceptions: the mangrove *Avicennia*

15:45 Coffee break



DEFORESTATION IN AMAZONIA  
AND ITS CONSEQUENCES FOR  
ECOSYSTEMS AND BIODIVERSITY,  
p.90

Chairs: Erlei Cassiano Keppeler and  
Beatriz Machado Gomes

16:15 Amazonian ecosystem  
degradation from  
deforestation, fire and climate  
change

16:30 Long-term dynamics of  
Amazonian ecosystems and  
the effects of disturbance  
driven by climate, sea-level,  
fire and human impact

SESSION CONTINUED

16:15 Accelerated tropical forest  
dynamics: A pan-tropical tree  
ring study

16:30 Pervasive change in the  
nitrogen cycle of tropical  
forests

16:45 Past and current forest  
fragmentation in the  
Democratic Republic of  
Congo: exploring ancient  
charcoal as a natural archive

THURSDAY

17:00 GTÖ 35<sup>th</sup> Assembly  
For gtö Members Only, p.26

19:00 Public talk (in German)  
Christian Ziegler  
Von Fledermäusen, Wickelbären und verführerischen Orchideen - eine Reise  
durch die Regenwälder der Welt



## FRIDAY, FEBRUARY 24<sup>TH</sup>

08:30 Plenary: Keynote

Prof. Dr. Matthias Wolff

Galapagos- Herausforderungen für den Schutz dieses Naturerbes

09:15 Parallel Sessions

FRIDAY

TROPICAL ANIMAL ECOLOGY,  
p.96

Chair: Simone Sommer

09:15 Euglossine diversity patterns  
along a latitudinal gradient

09:30 How nectar-feeding bats find  
food: role of echolocation of  
*Leptonycteris yerbabuenae*  
during foraging at cactus  
flowers

09:45 Sex-biased dispersal and  
paternity patterns in the  
Neotropical proboscis  
bat, *Rhynchonycteris naso*  
(Emballonuridae)

10:00 Diversity and Distribution of  
Bats in Bolivia under climatic  
and biogeographic aspects

10:15 Selective Eavesdropping  
Behaviour in three  
Neotropical Bat Species

EFFECTS OF FRAGMENTATION  
ON ECOSYSTEM FUNCTIONING  
AND SERVICES OF BIODIVERSITY  
HOTSPOT ISLANDS IN TROPICAL  
HIGH MOUNTAINS, p.102

Chairs: Jörg Bendix, Erwin Beck

09:15 Fragmentation of a  
megadiverse mountain  
forest ecosystem in southern  
Ecuador and its consequences

09:30 The riddle of the seasons

09:45 Uncertainty in soil  
regionalisation and its  
influence on slope stability  
estimation

10:00 Biogeochemical responses to  
increasing N deposition in a  
tropical mountain forest in  
southern Ecuador

10:15 Refugia for cold-adapted  
species in the highly  
fragmented subnival-nival  
habitats of Iran

10:30 Coffee break

**PLANT-ANIMAL INTERACTIONS IN  
DISTURBED AND FRAGMENTED  
LANDSCAPES, p.118**

Chairs: Eckhard W. Heymann, Nina Farwig

- 11:00 Seed dispersal and recruitment patterns of fleshy fruited trees in fragmented landscapes
- 11:15 Fragmentation affects rodent-seed mutualisms in an Afromontane forest
- 11:30 Consequences of forest modification on structure and robustness of plant-frugivore networks
- 11:45 Consequences of invasive plants and human land-use on plant-pollinator networks
- 12:00 Seed dispersal of rattan palms (Calamoideae) by mammals in a lowland rain forest of Peninsular Malaysia

**SESSION CONTINUED**

- 11:00 Relationship between landslides, landscape evolution and vegetation under human pressure in the tropical Andes
- 11:15 What enables coexistence in forest communities? - The role of species traits and buffer mechanisms
- 11:30 Arbuscular mycorrhizae in a tropical montane rain forest in South Ecuador
- 11:45 Effect of topography and altitude on decomposition and microarthropod colonization of leaf litter in a tropical montane rain forest
- 12:00 Types of anthropogenic disturbances and their impact on plant species richness within a hotspot of biodiversity in South Ecuador

12:15 Lunch break

FRIDAY



13:45 Plenary: Keynote

Dr. Ingrid Parmentier

Organization of plant diversity in tropical Africa: spatial patterns and causality

14:30 Parallel Sessions

IMPORTANCE OF MICROHABITATS FOR TROPICAL BIODIVERSITY AND FUNCTIONAL ECOLOGY, p.124  
Chair: Lakatos, Michael

14:30 Microhabitat selection in Neotropical tadpole communities

14:45 Intraspecific morphological and behavioral variability of tropical fish from different habitats (Central and South Vietnam)

15:00 Soil properties affect the small-scale distribution of subterranean ants in a montane tropical forest

15:15 Microhabitats and desiccation tolerance: Implications for bryophytes in the tropical lowland forest

15:30 Geographical variation in the elevational distribution of montane Neotropical fern communities

SESSION CONTINUED

14:30 Ecological aspects of repasturisation of abandoned mountain pastures in South Ecuador

14:45 Species composition and genetic diversity of tropical bracken invading montane pastures in southern Ecuador

15:00 Use of environmental impact assessment tools to optimize conservation strategies of the threatened endemic flora of Pantepui (SE Venezuela)

15:15 The economics of rehabilitating the degraded forest resources: the case of Sekella Mariam Forest Priority Area, North Western Ethiopia

15:30 „New forests for Ecuador“: The first Knowledge Transfer Project for sustainable land use financed by DFG

15:45 Coffee break

FRIDAY



## 16:15 Scientific poster session

## BIOGEOGRAPHIC PATTERNS OF TROPICAL MOUNTAIN ECOSYSTEMS

Long-term vegetational dynamics of an Andean biodiversity hotspot . . . p.151

Molecular characterization of morphological taxa in the genus *Lophosoria* (*Dicksoniaceae*) . . . p.152

Linking ecosystem productivity and species richness using terrestrial ferns in tropical forests of northeastern Ecuador . . . p.153

## FRAGMENTATION GENETICS IN THE TROPICS

Biogeography and infraspecific relationships of riverine tree species in the West African Savanna region . . . p.154

Genetic survey of the woolly-mouse opossum *Micoureus paraguayanus* brings new insights over its population structure in fragmented landscapes . . p.155

Genetic diversity and population structure of *Didelphis albiventris* in Morro do Diabo State Park and surrounding Atlantic Forest Fragments . . . p.157

Genetic diversity of *Macaranga* pioneer trees (*Euphorbiaceae*) in Sarawak (Northwest Borneo) . . . p.158

Genetic differences between natural and planted populations of two rainforest tree species in the Philippines. . . . . p.159

Genetic processes underlying species coexistence in tropical rainforests of Borneo . . . . . p.160

## THE ROLES OF AGROFORESTRY IN MANAGING FRAGMENTED MULTIFUNCTIONAL LANDSCAPE

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Biodiversity co-benefit of REDD+: how to make it works? . . . . . p.162

## TROPICAL DENDROECOLOGY

Growth dynamics of native woody species along an elevational gradient in the Central Marañon Valley, Northern Peru . . . . . p.163

Growth dynamics of *Tabebuia chrysantha*, and their relationship with climatic factors in a dry and humid forest in southern Ecuador . . . . . p.164

How do tropical tree species respond to nitrogen fertilisation? Tree growth along elevational and nutritional gradients in Southern Ecuador. . . . . p.165

Water use and stem growth in a montane Pine Plantation in S-Ecuador . . p.166

Comparison of climax and pioneer tree species in Munessa Forest (Ethiopia): Intra-annual isotope measurements ( $^{13}\text{C}$ ) after in situ  $^{13}\text{CO}_2$  labelling . . p.167

Tracing climatic signals and responses to climate variability from stable isotopes in tree rings . . . . . p.168



## SCIENTIFIC POSTER SESSION CONTINUED

## EFFECTS OF FRAGMENTATION ON ECOSYSTEM FUNCTIONING AND SERVICES OF BIODIVERSITY HOTSPOT ISLANDS IN TROPICAL HIGH MOUNTAINS

Secondary growth in the Bolivian Andes: Dispersal limitation, habitat limitation and competition with ferns . . . . .p.169

Montane forest remnants in the bolivian Andes: How does elevation, edge & topography effect stand structure. . . . .p.170

Effects of fragmentation on tree species composition and diversity in the Atlantic Rainforest of Rio de Janeiro, Brazil. . . . .p.171

Fern and Lycophyte diversity in submontane forest fragments of the Atlantic Forest of Rio de Janeiro, Brazil . . . . .p.172

How to detect the tropical bracken cover in a fire-disturbed ecosystem in South Ecuador using a QuickBird scene and field-derived spectra? . . . . .p.173

Modeling and monitoring southern bracken in the San Francisco valley in the Ecuadorian Andes . . . . .p.174

Climate change effects on tropical mountain rain forests in southern Ecuador after IPCC SRES-AR4 scenarios A1B and B1 . . . . .p.175

Floristic Composition, Diversity and Structure of Uluguru Forests in Morogoro, Tanzania . . . . .p.176

## PLANT-ANIMAL INTERACTIONS IN DISTURBED AND FRAGMENTED LANDSCAPES

Modelling the distribution of tree species used by lion tamarins in the Brazilian Atlantic forest in a future scenario of climate change . . . . .p.177

Dispersal and Regeneration Capacity of a Large-Seeded Tree Species in a Forest-Savanna Mosaic in Western DR Congo . . . . .p.178

Seed dispersal by bats and birds in differently modified scarp forests of South Africa . . . . .p.179

Spatial genetic structure of *Symphonia globulifera* populations from different continents . . . . .p.180

The effect of seed predation, seed size and habitat on seedling recruitment in an Afromontane forest. . . . .p.181

## IMPORTANCE OF MICROHABITATS FOR TROPICAL BIODIVERSITY AND FUNCTIONAL ECOLOGY

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## SCIENTIFIC POSTER SESSION CONTINUED

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- Diversity and bioacoustics of orthopterans of the Chiquitania (San Sebastián, Bolivia) . . . . . p.185
- Abundance, richness and composition of butterfly assemblages in creek, slope and ridge rainforest in the Pacific Lowlands of Costa Rica . . . . . p.186
- Morphological specialization influences nectar extraction efficiency of sympatric nectar-feeding bats . . . . . p.187
- Sweet tooth with good teeth - low percentage of dental caries in the Neotropical frugivorous bat *A. jamaicensis* and probable causes . . . . . p.188
- Jamming Avoidance in free-ranging Greater Bulldog Bats (*Noctilio leporinus*) . . . . . p.189
- Rain increases the energy cost of bat flight . . . . . p.190
- Tackling the challenge of monitoring a cryptic predator's role in current dramatic tropical mammal declines . . . . . p.191
- Estimating forest duiker (*Cephalophinae*) density in Korup National Park: a case study on the performance of three line transect methods . . . . . p.192
- Symmeria paniculata* is the world's best diving tree . . . . . p.193
- Fern and Lycophyte diversity along an altitudinal gradient in the Serra dos Órgãos, Southeastern Brazil . . . . . p.195
- The influence of topography on tree regeneration in canopy gaps in a tropical montane forest in southern Ecuador . . . . . p.194
- Effects of experimental nutrient addition on the establishment and growth of tropical montane forest tree seedlings in southern Ecuador . . . . . p.196
- Effects of dispersal limitation of soil seed banks in tropical montane forest secondary growth in the Southern Yungas of Bolivia . . . . . p.197
- Genetic variation of teak (*Tectona grandis* Linn. f.) and dahat (*Tectona hamiltoniana* Wall.) in Myanmar . . . . . p.198
- Land use change and soil carbon stocks in the Peruvian Amazon region . p.199
- Geostatistical simulations of atmospheric nitrogen depositions in an Ecuadorian hotspot of biodiversity . . . . . p.200
- Validation of Multi-resolution Satellite Image Based Land-Use/Land-Cover Classification in the Modjo Watershed of Ethiopia: A Methodological Discourse . . . . . p.201
- Dammed rivers and vegetation changes in Amazonia . . . . . p.202



SCIENTIFIC POSTER SESSION CONTINUED

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HUMAN DIMENSIONS OF TROPICAL DEFORESTATION, FOREST FRAGMENTATION AND FOREST MANAGEMENT

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FRIDAY

19:00 Conference Dinner





## SATURDAY, FEBRUARY 25<sup>TH</sup>

### 08:30 Plenary: Keynote

Dr. Ivette Perfecto

Agricultural production and ecosystem services in fragmented landscapes: a theoretical framework and accumulated evidence

### 09:15 Parallel Sessions

#### FREE TOPICS

Chair: Thorsten Peters, Pia Parolin

09:15 Determinism in tropical forest biomass distribution due to forest spatial structure, highlighted by the study of the edge effect.

09:30 Patterns of functional traits in the biogeography of West African savannas

09:45 Do woodland patches in a grassland matrix act as potential refuge for small vertebrates in arid Australia?

10:00 Mating systems in Bohor Reedbuck are linked to habitat nutrient quality in a mesic tall-grass savanna

10:15 Patchily distributed in a "homogenous" environment: The case of the live-bearing Nimba toad

#### HUMAN DIMENSIONS OF TROPICAL DEFORESTATION, FOREST FRAGMENTATION AND FOREST MANAGEMENT, p.142

Chair: Perdita Pohle, María Fernanda López

09:15 Spatial Analysis of Forest Fragmentation for Buffer Zone Management in the Atlantic Forest of Rio de Janeiro, Brazil

09:30 Carbon sequestration and ecosystem services potential in a fragmented landscape in the Atlantic Forest, Rio de Janeiro.

09:45 Spatial Strategy for biodiversity conservation and habitat restoration of the Brazilian Atlantic Forest

10:00 Impacts of drought and logging on tropical rainforests in Africa: Modeling the dynamics of rainforests

10:15 Long-term gallery forest dynamic in the Venezuelan Guayana: implications to forest conservation and fire management in a protected area

10:30 Coffee break

#### SESSION CONTINUED

- 11:00 Siberut island under threat:  
First ecological insights on  
the endemic Siberut macaque  
(*Macaca siberu*)
- 11:15 Bonobos, *Pan paniscus*, in the  
forest-savannah mosaics of  
West DR Congo: does spatial  
structure influence the forest  
use dynamics?
- 11:30 Negative effects of  
conspecific density on  
fruit set of two neotropical  
understorey plants
- 11:45 Maximum glucocorticoid  
levels vary with feeding habit  
and habitat seasonality in two  
phyllostomid species
- 12:00 Multi-level social-ecological  
dynamics in Penghu  
archipelago, Taiwan

#### SESSION CONTINUED

- 11:00 Exploring the relationship  
between Farming Practices  
and Vegetation Change in  
Benue State, Nigeria
- 11:15 Predicting and Mapping  
of Forest Cover Spatio-  
Temporal Variability Using  
Geoinformation Techniques:  
The Case Study of Dendi  
District, Ethiopia

12:15 Closing Ceremony

SATURDAY



## FOR GTÖ MEMBERS ONLY

### Invitation to the 25<sup>th</sup> annual general assembly of the gtö in Erlangen 2012

The Executive Board of the *gtö* invites its members to the 25<sup>th</sup> annual general assembly on **Thursday 23.2. from 17-19 h** in the “Senatssaal” of the University of Erlangen

The assembly will be held in German.

#### The following items are scheduled:

1. Eröffnung der MV and Annahme der Tagesordnung
2. Genehmigung des Protokolls der 24. MV
3. Bericht des Präsidiums über das Geschäftsjahr 2011
4. Bericht des Sprechers des Wissenschaftlichen Beirats
5. Bericht des Schatzmeisters
6. Bericht der Kassenprüfer
7. Entlastung des Präsidiums
8. Neuwahlen: Vorstellung der Kandidaten und Wahl
9. Ecotropica
10. Vorbereitung der Tagung 2013 und 2014
11. Verschiedenes

THU 17:00 SENATSSAAL

## PRESENTATIONS OF THE ABSTRACTS



Keynote speaker: Prof. Dr. Olivier Hardy

## PHYLOGEOGRAPHIC PATTERNS AND GENE FLOW IN CENTRAL AFRICAN RAIN FOREST PLANTS

Olivier Hardy<sup>1</sup>, Katharina Budde<sup>2</sup>, Kasso Daïnou<sup>3</sup>, Gilles Dauby<sup>1</sup>, Jérôme Duminil<sup>1</sup>, Eben-Ezer Ewedje<sup>1</sup>, Myriam Heuertz<sup>1,2</sup>, Guillaume Kouamé Koffi<sup>1</sup>, Alexandra Ley<sup>1,4</sup>, Claire Micheneau<sup>1</sup>

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<sup>2</sup>*Centre of Forest Research CIFOR-INIA, Madrid, ES*

<sup>3</sup>*Université de Liège, Gembloux, BE*

<sup>4</sup>*University Halle-Wittenberg, Halle, DE*

Analyses of the geographic patterns of genetic variation are very valuable to test biogeographic hypotheses and to study evolutionary and ecological processes acting at the population level. However, until recently, few such studies had been conducted on plant species from African rain forests. This is now changing as new data on different species of trees and lianas are rapidly accumulating. Here we will illustrate how spatial patterns of genetic variation of plastid and nuclear genetic markers (DNA sequences and microsatellites) can help answering two types of questions: (1) Are Pleistocene forest refuge hypotheses consistent with the observed phylogeographic patterns? (2) What is the scale of seed and pollen dispersal distances in canopy tree species? Phylogeographic patterns indicate that most of the widespread species showing nowadays a near continuous spatial distribution have been fragmented in the past. However, patterns vary substantially among species and they provide only partial support for current hypotheses on the location of Pleistocene forest refuges. In addition, some patterns shared between species are not predicted by these hypotheses, suggesting that scenarios of past forest changes must be revisited. In canopy trees, while estimates of seed dispersal distances range from a few tens of meters to a few kilometers depending on dispersal vectors, pollen dispersal often seem to reach a few kilometers, and it may become particularly extensive in low density populations. Accurate estimates are needed to parameterize models of the dynamics of populations, the dynamics of colonization fronts as well as the dynamics of introgression between differentiated populations in secondary contact zones. Such models would be very valuable to interpret phylogeographic patterns and predict the fate of populations under current human pressures.

Keynote speaker: Dr. Marife D. Corre

## IMPACT OF ELEVATED N INPUT ON NET PRIMARY PRODUCTION AND SOIL TRACE GAS FLUXES IN TROPICAL FORESTS

Marife D. Corre<sup>1</sup>

<sup>1</sup>*Soil Science of Tropical and Subtropical Ecosystems, Goettingen University, Goettingen, DE, mcorre@gwdg.de*

Tropical rain forests contain more than 40% of global terrestrial biomass C, account for about one third of the global soil organic C storage, cycle more than 10% per year of the atmospheric CO<sub>2</sub>, and play a dominant role in global biosphere-atmosphere exchange of other trace gases (NO, N<sub>2</sub>O and CH<sub>4</sub>) (IPCC 2006, 2007; Jobbágy and Jackson 2000; Malhi 2005). One of the most important human-driven global change processes occurring in the last 30 years is increased in deposition of reactive N, and the fastest rates of increase are in tropical regions (Galloway et al. 2008). Added N is likely to alter the C balance of tropical forest ecosystems as well as their soils' trace gas dynamics. Presently, we still know very little about how increased N input will affect net primary production (NPP) and trace gas fluxes, two of the most important ecosystem processes with direct impact on climate change and C sequestration, in tropical forests. So far, there are only few studies providing direct evidence, i.e. experimental N addition, on NPP responses and most of these studies are conducted in tropical montane forests. Only one long-term experiment on N addition is presently on-going in old-growth lowland forest. Even fewer studies address responses of trace gas dynamics to chronic N addition. I will present a review of above- and belowground NPP responses to N addition in tropical forests, including recent studies published after the review of Tanner et al. 1998. Studies on responses of NO, N<sub>2</sub>O, CO<sub>2</sub> and CH<sub>4</sub> to chronic N addition, conducted in Hawaii, Puerto Rico, Costa Rica, China, and Panama will be presented and reasons for contrasting findings will be discussed. Analyses will be presented on 1) whether NPP and trace gas flux responses are (de)coupled, and 2) whether the nutrient limitation theory of Walker and Syers (1976) (i.e. N-rich and P-poor lowland forests on old, lowland soils and the converse for young, upland soils) that mainly considers the 'time' factor is may be too simplistic for the tropical sites studied so far.





## TROPHIC SIMPLIFICATIONS AND FUNCTIONAL DOWNGRADING OF FRAGMENTED/HUMAN-MODIFIED TROPICAL FORESTS

Chairs: Rainer Wirth, Inara Leal

Contact: [wirth@rhrk.uni-kl.de](mailto:wirth@rhrk.uni-kl.de)

Tropical forest landscapes are facing unprecedented levels of habitat fragmentation and biodiversity loss with cascading impacts on organisms and ecological processes in the remaining ecosystems, including the re-assemblage of biotic communities, the alteration of forest dynamics (e.g. retrogressive successional pathways), and habitat homogenization via structural and biomass collapse. Among the key issues to emerge from recent research into the processes driving these changes, is the disruption/simplification of trophic interactions (such as pollination, parasitism, predation, seed dispersal, interspecific competition, herbivory, or even multitrophic level interactions) as a prime source of functional downgrading of fragmented ecosystems. In a nutshell key questions address (i) the processes driving the nature and magnitude of biological disruptions, (ii) the principal functional services they are involved into, how such disruptions impact (iii) ecological organization at multiple levels and spatial scales (iv) the emergence of winner species and the mechanisms of their self-perpetuation, and (v) threats versus opportunities for native biodiversity persistence in human-modified landscapes. The symposium is offered as a cross section of researchers addressing these questions from various perspectives to develop new theoretical and applied insights required for a better understanding of biotic homogenization and functional simplification in human-modified landscapes all across the tropics.

## PROLIFERATION OF DISTURBANCE-ADAPTED SPECIES AND THE PERSISTENCE OF TROPICAL BIODIVERSITY IN HUMAN-MODIFIED LANDSCAPES

Marcelo Tabarelli<sup>1</sup>

<sup>1</sup>*Universidade Federal de Pernambuco, Recife, BR, mtrelli@ufpe.br*

Despite its relevance, the mechanisms controlling species replacements and biotic homogenization of native biotas remain poorly understood. Here we advocate for the occurrence of a particular loser\winner replacement experienced by tropical forests: the replacement of the old-growth tree flora by small sets of pioneer or successional tree species across edge-affected habitats and hyper-fragmented landscapes. Overall, patterns of tree assemblage structure documented at multiple spatial scales in human-disturbed biotas suggest that loser/winner replacements can be promoted by native rather exotic species, leading to a cross-scale taxonomic homogenization; i.e., it does not depend on biological invasion or even shifts of species range. Species loss is not limited to restricted-range species but potentially to any species of particular ecological groups (i.e. non-random species loss), which are effectively unable to deal with highly modified habitats such as desiccated/illuminated forest edges and fire-degraded fragments. Finally, environmental filtering, disruptions of species interactions and over-exploitation (instead of competitive exclusion by invasive winner species) appear to command such rearrangement of the native tree flora and the nature of remaining tree assemblages. Such perception stresses the proliferation of disturbance-adapted native organisms as a key issue in conservation biology, regardless of the spatial scale, at which we intend to examine the responses of species assemblages to human disturbances and the future of tropical biodiversity.



## HOW DOES FOREST BIOMASS VARY DEPENDING ON SUCCESSION STAGE AND DISTURBANCE HISTORY IN THE ATLANTIC FOREST OF RIO DE JANEIRO?

Dietmar Sattler<sup>1</sup>, André Lindner<sup>2</sup>, Oliver Thier<sup>1</sup>

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<sup>2</sup>TU Dresden, Dresden, DE

Tropical forests are large reservoirs of biomass and there is a need for information on existing carbon stocks in these ecosystems. Reliable estimates of aboveground biomass stocks within the Atlantic Forest are still rarely available. Past human disturbance is one important factor affecting forest structure variation and biomass accumulation among these forests. To support the efforts of improving the quality of estimations of the current and future biomass carbon storage capacity of this disturbed forest region, we tested a non-experimental small scale approach to compare the aboveground tree biomass (AGB) of forest sites with known disturbance history and of different succession stage. The woody plant community ( $\text{dbh} \geq 10\text{cm}$ ) was censused and estimates of above ground tree biomass have been carried out using an allometric equation for moist tropical forests already applied for the study area. A very early stage of woody plant succession has been sampled destructively and dry AGB was measured directly. We identified significant differences in recent AGB of the compared forest sites. With  $313 (\pm 48 \text{ Mgha}^{-1})$  the highest AGB-values have been found in a preserved forest area within a National Park, followed by  $297 (\pm 83) \text{ Mgha}^{-1}$  at a former clearcut site. Lowest forest AGB has been calculated for the area with past selective logging:  $204 (\pm 38) \text{ Mgha}^{-1}$ . Woody vegetation of the very early succession contributes to AGB with up to  $86 (\pm 77) \text{ Mgha}^{-1}$ . Our results suggest that biomass productivity can recover in a forest which was completely cleared 60 years ago to reach AGB values up to a level that almost represents the situation in a preserved forest. Furthermore, even shrubby vegetation of early successions, which mostly remains unconsidered, can contribute remarkably to the aboveground biomass stocks of the investigated landscape.

## FOREST REGENERATION DYNAMICS IN DIFFERENTLY MODIFIED SOUTH AFRICAN SCARP FORESTS

Nina Farwig<sup>1</sup>

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Human disturbance imperils biodiversity and ecological processes involved in forest regeneration ranging from pollination over seed fate to seedling recruitment. In a heterogeneous South African landscape we investigated the effects of forest modification on community assemblages of insects, birds, small mammals and trees and studied pollination and seed removal of the native tree species *Celtis africana* as well as seed fate and natural recruitment. We worked in all representative types of modified scarp forest at the landscape scale. Species' abundance and the composition of insect, bird, small mammal and tree communities differed significantly among the different forest types. Specialized species strongly declined with increasing habitat modification, whereas generalist species increased in the more modified forest types. We found enhanced pollination and seed removal of *Celtis africana* in modified forests compared to the two natural forest types. Seed predation rates were highest in highly modified forest types. Correspondingly, recruitment was lowest in highly modified forest types. These findings indicate that even though the mobility of insects and birds seems to maintain pollination and seed removal in isolated modified forest types, high predation rates reduce their regeneration potential. This suggests that only by studying the entire regeneration loop we are able to develop sound management recommendations for forests in modified landscapes.

WED 15:00 GALAPAGOS



## IMPACT OF HUMAN DISTURBANCE ON FRUIT DISPERSAL BY FRUGIVORES IN A TROPICAL RAIN FOREST

Olivier Boissier<sup>1</sup>, François Feer<sup>1</sup>, Pierre-Michel Forget<sup>1</sup>

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Tropical rainforests worldwide are coming under increasing pressure from human activities, which are altering key ecosystem processes such as plant-animal interactions. However, while the direct impact of human disturbance on communities such as game species has been well studied, the consequences of impoverished animal communities on mutualistic interactions such as seed dispersal remains chiefly understood at the plant species level. We asked whether communities of endozoochorous tree species had altered seed dispersal in forests where frugivore communities have been modified by hunting and logging. We indirectly evaluated the effect of the frugivore community on 4 families of animal-dispersed plants (Sapotaceae, Myristicaceae, Burseraceae and Fabaceae) at two forest sites in French Guiana. The human-impacted site, Montagne de Kaw, is located close to urban areas and sees both hunting and logging, while the remote control site, Nouragues Research Station, is virtually untouched. On both sites, we estimated consumption and seed dispersal rates from fruit and seed counts conducted in one square meter quadrats placed under fruiting trees, while the diversity and abundance of the frugivore communities was evaluated during daytime censuses conducted along line transects. A general trend towards lower consumption and dispersal rates was found in Kaw, especially in the genus *Manilkara* (Sapotaceae) for which a markedly lower seed dispersal was associated with a hunting depleted community of large-bodied primates, and a greater abundance of small-bodied primates, the latter being unable to swallow and disperse large-seeded species such as *Manilkara* spp.

**Merian award applicant**

## TROPHIC SIMPLIFICATION IN NEOTROPICAL BAT ASSEMBLAGES FOLLOWING HABITAT FRAGMENTATION: LESSONS LEARNED FROM BATS ON LAND-BRIDGE ISLANDS IN PANAMA

Christoph F.J. Meyer<sup>1</sup>, Elisabeth K.V. Kalko<sup>2,3</sup>

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<sup>3</sup>*Smithsonian Tropical Research Institute, Balboa, PA*

In the Neotropics, bats represent important components of biodiversity from taxonomic and functional perspectives, and provide key ecosystem services including arthropod predation, seed dispersal, and pollination. Because of their local abundance, richness, and ecological diversity, bats are a promising indicator group for studying responses to landscape fragmentation. In my talk I will provide an overview of the insights into bat responses to forest fragmentation gained as part of a comprehensive project conducted within a fragmented system with high fragment-matrix contrast, land-bridge islands in Gatún Lake, an artificial reservoir in central Panama. We evaluated population-, ensemble-, and community-level responses of bats to fragmentation (islands vs. mainland control sites), and possible edge-related gradients in these attributes between interior and edge sites in continuous forest. We further tried to elucidate the mechanisms underlying the observed patterns and possible scale-dependence in species' responses. Compared to continuous forest, islands were characterized by a less diverse and structurally simplified bat fauna, strongly dominated by a few large frugivorous species with good dispersal abilities and an increased abundance of nectarivores. Gleaning animalivorous species were almost exclusively restricted to continuous forest and nearly absent from islands distant from the mainland. An analysis of trait-based differences in species responses suggested that high sensitivity towards habitat edges and limited mobility may underlie this vulnerability to fragmentation. Although there was no significant effect on overall species composition, species richness was significantly lower at continuous forest edges compared to interior sites. Distance from the mainland and percent forest cover were the best predictors of species richness and assemblage composition, whereby responses were found to be scale-dependent. Patterns of nestedness further confirmed that bat assemblages on Gatún Lake islands are most strongly shaped by isolation effects and differential colonization reflecting species-specific differences in mobility. The observed trophic simplifications highlight the potential for forest fragmentation to considerably alter patterns of seed dispersal, pollination, and biological control. The negative effects observed in gleaning insectivorous bats, for instance, may contribute to the functional downgrading of forest fragments if their functional role - herbivory control through arthropod predation - is not replaced in these forest remnants.



## FRUGIVOROUS BATS SUFFER FROM HUNTING OF LARGER MAMMALS IN WESTERN AMAZONIA: AN UNEXPECTED CONNECTION VIA MINERAL LICKS

Simon Ghanem<sup>1,2</sup>, Christian Voigt<sup>1,2</sup>

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Hunting reduces the overall abundance of mammals with often direct negative effects for associated ecosystem services such as seed-dispersal. In our study site in eastern Ecuador, both oil companies and local tribe communities have a substantial negative impact on medium-sized and large mammals, either via road construction and deforestation, or via hunting, respectively. We asked whether the loss of larger mammals affects ecologically important mineral licks, as licks may deteriorate over time when not kept open by large mammals. Mineral licks are nutrient-rich muddy depressions that are used by larger mammals for soil consumption. These mineral licks are also of pivotal importance for frugivorous bat species, because reproducing bats supplement their nutrient-poor diet with clay from mineral licks. In our study, we tested whether defaunation of large mammals leads to deterioration of mineral licks and thereby influences the abundance of frugivorous bats at such licks. We expected mineral licks in areas with a higher level of disturbance to show signs of deterioration such as increased leaf litter or plant cover. In addition, we expected to capture fewer bats at mineral licks in disturbed forests than in forests without hunting or habitat loss. Indeed, mineral licks in forests with pronounced disturbance were covered by more young seedlings and leaf litter than mineral licks in pristine forests. Also, we encountered fewer bats at disturbed mineral licks than at pristine mineral licks. We conclude that defaunation of Amazon forests affects not only large mammals directly but most likely also frugivorous bat assemblages, because reproducing female bats have less access to the nutrient-rich soils of mineral licks. Thus, hunting puts the ecosystem services of mammals at risk in two ways, by eliminating seed-dispersing large mammals and by reducing habitat quality for populations of seed-dispersing bats.

**Merian award applicant**



## HOW DO FOREST FRAGMENTATION AND MATRIX QUALITY INFLUENCE DIVERSITY OF A HYPER-DIVERSE MALAGASY AMPHIBIAN ASSEMBLAGE?

Jana Carina Riemann<sup>1</sup>, Serge Herilala Ndriantsoa<sup>2</sup>, Mark-Oliver Rödel<sup>3</sup>, Julian Glos<sup>1</sup>

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Habitat fragmentation is a process that may lead to the loss of biodiversity, i.e. to species-depleted communities in fragments. There are various phenomena associated with habitat fragmentation. The most prominent are the reduction in the total habitat area, an increasing ratio of edge to interior habitat, and the isolation of one forest fragment from others. Matrix habitat, i.e. the non-forested area in between patches of natural forest habitat, might have a key influence on the diversity of these forest patches as it might or might not act as a corridor for dispersal. Moreover, higher quality matrix reduces the isolation of forest patches by allowing species to expand their activities (e.g. feeding) outside of fragments, or it might be even suitable habitat *per se* for some species.

Our study was conducted in the Ranomafana National Park and its surroundings, a mid-altitude rainforest ecosystem in Eastern Madagascar that is exceptional in its amphibian diversity (> 100 species). The surrounding area is, mainly due to human slash and burn agriculture, a highly fragmented landscape. We aim to identify important drivers of amphibian community structure in this system, and hypothesize that fragment quality and size, and the quality of matrix habitats are important drivers. We analyze how patterns of amphibian diversity depend on fragmentation related properties of amphibian habitat such as forest fragment size and isolation. We further investigate the suitability of different types of matrix habitat (i.e., rice fields, banana plantations, secondary vegetation) for migration of frogs between fragments and as valuable habitat for some species.

**Merian award applicant**



## DOMINANCE VS. DIVERSITY: MASSIVE IMPACTS OF ANT COMMUNITY STRUCTURE ON ECOSYSTEM SERVICES IN INDONESIAN AGROFORESTS

Arno Wielgoss<sup>1,2</sup>, Teja Tscharntke<sup>1</sup>, Brigitte Fiala<sup>2</sup>, Shahabuddin<sup>3</sup>, Yann Clough<sup>1</sup>

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<sup>3</sup>*Dep. of Agriculture; Klabat University, Palu, ID*

In agricultural landscapes arthropod predators are providing crucial ecosystem services. Predator community structure but also presence, abundance and identity of ecologically dominant species may influence the predatory pressure on single pest species. But pest control is just one of many direct and indirect linkages between predators and crop plants. Therefore marketable yield should be an essential response variable for assessing the impact of predators on final ecosystem services.

Here, we analyse pest, disease and crop productivity data of a large scale ant exclusion and ant fauna manipulation experiment in smallholder cacao in Indonesia to quantify the ecosystem services of ants depending on ant community structure.

Cocoa yields of unmanipulated control trees with mixed ant species communities and moderate abundances were 32% higher than those of trees with ant exclusion. In Dolichoderinae-dominated communities with high abundances the effect strongly depended on the identity of the dominant species, causing yield losses of 35% in the case of one species and no significant losses in the case of another species.

Our data suggests that single species dominated predator communities may have higher predatory pressure on certain prey species, but mixed species communities balance possible ecosystem disservices like plant pathogen dissemination keeping the overall yield losses on a relatively low levels, providing overall ecosystem services of high economic relevance.

**Merian award applicant**

## TROPHIC SIMPLIFICATIONS AND FUNCTIONAL DOWNGRADING OF FRAGMENTED FORESTS? THE CASE OF LEAF-CUTTING ANTS

Rainer Wirth<sup>2</sup>, Inara Leal<sup>1\*</sup>

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<sup>2</sup>*University of Kaiserslautern, Kaiserslautern, DE*

*\*Presenting author*

Leaf-cutting ants (*Atta* spp.) became a topical issue in neotropical ecology, particularly because they reach hyper-abundance due to escalating levels of fragmentation in recent years. Here, we compile quantitative results on the manifold impacts leaf-cutting ants exert on Brazilian Atlantic Forest plant assemblage via direct (i.e. the trophic impact of herbivory and seed dispersion) and indirect (i.e. ecosystem engineering promoted by changes in microclimate and edaphic conditions) effects. We show that both types of impacts negatively influence plant performance of (1) plant species bearing ant-targeted seedlings; (2) small-seeded tree species without resprouting abilities, (3) light-sensitive, shade-tolerant species; and (4) plant species whose seeds require undisturbed habitats for better germination and establishment. These results indicate that the increased abundance of leaf-cutting ants in human-modified landscapes is sufficient to influence, in a highly variable way, plant populations and assemblages, and ultimately, the successional trajectories of forest vegetation at multiple-spatial scales, via differential effects on various plant functional types. Our findings greatly extend knowledge on the role played by leaf-cutting ants as a disturbance agent by demonstrating that they might help to retain some biodiversity within a reduced set of secondary and intermediate tree species dominating hyper-fragmented landscapes.



## BIOGEOGRAPHIC PATTERNS OF TROPICAL MOUNTAIN ECOSYSTEMS

Chair: Michael Richter

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Tropical mountain regions are global hotspots of Biodiversity. Besides a great number of microhabitats and ecological niches, a high rate of genetic differentiation plays a big role in speciation processes. Besides, the historical migration process and climate change determine biogeographic patterns of biodiversity and speciation processes. However, due to the lack of historical information, environmental changes are often scarce. The session addresses the analysis of spatial patterns of individuals, species and ecosystems and the underlying mechanisms and processes that are relevant to be understood in order to develop adequate and successful conservation strategies.

## ARE ADAPTATION ABILITIES LINKED TO PHYLOGENTIC AND /OR BIOLOGICAL SIMILARITIES? - AN AMPHIBIAN STUDY ON A VOLCANIC MOUNTAIN IN CAMEROON

Mareike Hirschfeld<sup>1</sup>, Mark-Oliver Rödel<sup>1</sup>

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Various among the threaten amphibian species; especially those in forested tropical highlands, have to cope with dramatic climate alterations and man-made habitat degradation. However, distinct properties which could predict the capability of species to survive in already altered habitats, as well as in environments that are likely to change in the future are unknown. The presented project aims to detect links between survival probability, species specific habitat requirements and life-history traits. The study is carried out on the Mount Manengouba in south-western Cameroon. This area comprises a variety of degradation types (pristine forest to farmbush) from around 1000 to 2400 m asl. There, we focus on the anuran genera *Cardioglossa*, *Arthroleptis* and *Phrynobatrachus*, chosen on basis of their biological and phylogenetic characteristics. *Cardioglossa* and *Arthroleptis* are closely related (family Arthroleptidae) but differ in their biology; e.g. *Arthroleptis* are direct developers; in contrast *Phrynobatrachus* (Phrynobatrachidae) and *Cardioglossa* have free swimming and feeding tadpoles. All three genera comprise several species along the altitudinal and habitat gradients in this particular area. Hence, allowing searching for correlations between the range of occupied habitats and particular life-history traits. Finally we hope to identify phylogenetic independent life-history traits which facilitate and / or constrain species' adaptation capacity to current or future habitat and climate alterations. Preliminary results will be given in the talk.



## TROPHIC NICHE DIFFERENTIATION AND MICROHABITAT UTILIZATION IN A SPECIES-RICH MONTANE FOREST SMALL MAMMAL COMMUNITY OF EASTERN MADAGASCAR

Melanie Dammhahn<sup>1</sup>, Voahangy Soarimalala<sup>2</sup>, Steven M. Goodman<sup>2,3</sup>

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Unraveling the mechanisms facilitating species coexistence in communities is a central theme in ecology. Species-rich tropical mammal communities provide excellent settings to explore these mechanisms as they often harbor numerous congeneric species. However, explicit tests for the mechanisms that allow strict sympatry in these assemblages is often hampered because of the difficulty in obtaining detailed ecological data on the organisms making up the community. Using stable nitrogen and carbon ratios of hair samples, we examine whether trophic niche differentiation and microhabitat segregation explain the co-existence of 21 small mammal species at a montane humid forest site in eastern Madagascar. Overall, the community was trophically diverse and covered a wide isotopic space. This diversity was based on: (1) a multi-layered trophic community structure with frugivorous-granivorous rodents (subfamily Nesomyinae) as primary consumers and insectivorous tenrecs (family Tenrecidae) as secondary and tertiary consumers, (2) trophic segregation and even distribution of functional and microhabitat groups, and (3) a dense and regular species packing in the community and (4) within functional and microhabitat groups. The 12 locally occurring *Microgale* shrew tenrecs (family Tenrecidae) showed high trophic redundancy, but were maximally spaced from each other within the trophic space covered by the genus. Thus, a combination of differentiation of microhabitats and trophic niches explains the coexistence of small mammals in this community. Congeneric species appeared to be under more intense competition compared to non-congeneric species and the co-existence of congeneric species can only partly be explained by trophic and microhabitat niche segregation.

## GENETIC DIFFERENTIATIONS WITHIN ISLAND ENDEMICS: A BIOGEOGRAPHICAL EVOLUTION ASSAY IN SELECTED AEONIUM SPECIES

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The genus *Aeonium* Webb & Berthel. serves as popular example for adaptive radiation on islands within the plant kingdom. In a relatively short evolutionary period various ecological niches have been realized and a great variety of morphological forms and ecophysiological characteristics have developed. The Canary Islands are the distinct centre of species diversity within that genus and recent research results imply a phylogenetic origin on that volcanic archipelago, stating *Aeonium* as neoendemic. Most of the species occur only on single islands and clear intrageneric lineages with vicariant island distributions can be seen, which, with respect to the young geological age of some of the Canary Islands and further hints, indicates recent speciation and ongoing evolutionary processes.

Considering phylogenetic and biogeographical relationships we selected three ecologically different single island endemic *Aeonium* species of La Palma, Tenerife and El Hierro and one variety distributed across two of these islands to identify and compare population structures, potential evolutionary relevant differentiations and gene flow barriers. By taking into account the strong topographical and ecological heterogeneity as well as the steep elevational and environmental gradients of these geologically young and highly structured islands we hypothesize distinct intraspecific genetic patterns according to these structures over different geographical scales and differences among our study species.

From each taxon DNA-samples comprehensively were taken throughout the respective entire distribution range and DNA fingerprinting data were collected by analysing 10 ISSR (Inter Simple Sequence Repeats) markers, respectively. Population genetic analyses combined with GIS studies are being carried out to detect geographically and ecologically conditioned population differentiations in order to investigate biogeographical structures and evolutionary processes within these island endemics.





## VEGETATION STRUCTURES AND ECOLOGICAL FEATURES OF THE UPPER TIMBERLINE ECOTONE ALONG THE NEOTROPICAL ANDES

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The position of the upper timberline varies considerably along the Neotropical cordilleras. *Polylepis*, sometimes joined by *Gynoxis* trees, is the most prominent member of tropical South American treelines above 4.200 m a.s.l. between 3°S and 7°S, within the so called Amotape-Huancabamba Floristic Zone, a much lower upper timberline at around 3.200 – 3.400 m a.s.l. interrupts the high one of *Polylepis*-stands in the northern (Venezuela, Columbia, northern-central Ecuador) and central Andes (central-southern Perú, Bolivia, northern Chile, north-western Argentina). This timberline depression results from the absence of the usually superposing *Polylepis*-belt, and so far no reason for this phenomenon was discovered. Within this transition zone, 239 tree species of 39 different plant families were identified within 80 timberline transects on a total area of only 8.000 m<sup>2</sup> (!). Here, Melastomataceae (42 spp.), Asteraceae (29 spp.), Araliaceae (15 spp.), and Cunoniaceae (14 spp.) were the most species-rich families, while Melastomataceae and Cunoniaceae were the most common, with 20 % and 14 % of all tree individuals, respectively. Monotypic *Polylepis* forests containing much less species do not exist within the Andean Depression. The different species combinations are mainly due to variations in temperature, the number of humid months and precipitation. The remarkably high tree species diversity within the upper treeline ecotone in the centre of the Andes Depression partly results from a considerable lack of nutrients (strongly competitive species are locked out, cf. soil nutrient hypothesis) on the one hand. On the other hand, high precipitation amounts and high wind speeds are also responsible for the lowering of the treeline.

**Merian award applicant**

## THE LONG-TERM ECOLOGY OF LORE LINDU NATIONAL PARK MOUNTAIN RAINFOREST (SULAWESI - INDONESIA)

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In order to obtain a deep understanding of future environment/ecosystem interactions in tropical ecosystems a long-term perspective of the interaction between climate changes, human impact and vegetation dynamics is needed. Despite this the majority of research projects dealing with conservation and rehabilitation of tropical biodiversity and ecosystems are based on short-term datasets rarely spanning more than the century timescale. We present the results of pollen and microcharcoal analyses of a sediment core carried out from Lake Kalimpaa (1°19'34.8"S, 120°18'31.9"E), located close to the north-eastern border of the protected area of the Lore Lindu National Park in Central Sulawesi a "Man and Biosphere Reserve" by the UNESCO since 1978. Lake Kalimpaa is situated approximately at 1600 m a.s.l., within the lower-mid montane vegetation belt. The first 160 cm of the core represent the last 1400 years and the sampling resolution averages around 50 years. Thus provide the unique opportunity to investigate the long-term ecology of what is now consider an undisturbed mountain rainforest.

The palaeoecological approach allows important questions to be added:

- How old is the the natural untouched mountain rainforest in the Lore Lindu National Park?
- What was the response of the mountain rainforest to ENSO events and climate changes?
- Is there evidence of a precolonial exploitation of the landscape in the highlands and to what extent is that different from the post colonial time?

The main contribution of Lake Kalimpaa record is to provide information on vegetation response to climate variability and human impact and therefore is particularly important to corroborate the development of nature conservation strategies in the Lore Lindu area.



## LATE QUATERNARY VEGETATION, CLIMATE AND FIRE-DYNAMICS IN EAST AFRICA INFERRED FROM THE POLLEN RECORD FROM MAUNDI CRATER, KILIMANJARO

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In our project, we study pollen found in peat and sediment cores from different key areas at Kilimanjaro to reconstruct former and to predict future landscape dynamics. We would like to better understand local and regional ecosystems, climate and fire dynamics in a larger context, ecosystem dynamics and their reaction on environmental changes, connections and disjunctions of different ecosystems and their role for the development of the biodiversity hot spots in East Africa.

Our first study site, the Maundi Crater at 2780m asl, is located on the SE slope of Kilimanjaro within ericaceous vegetation. We have analyzed 72 pollen samples of a ~ 6m long sediment core. The pollen and charcoal record from the Maundi Crater on Kilimanjaro is one of the longest terrestrial records in equatorial East Africa giving an exceptional insight into the vegetation and climate dynamics back to the early Glacial period. The results allow comparison of palaeo-environmental changes and patterns with other archives from mountain areas in East Africa. During the past ~ 90 000 cal yr BP the distribution of the vegetation belts classified as colline savanna, submontane woodland, montane forest, ericaceous belt, and alpine vegetation as well as their composition changed; especially during the transition between the late Pleistocene to the Holocene this becomes very evident. The taxa diversity increases steadily during the recorded time span. This remarkable archive of vegetation and climate history of East Africa reveals major shifts in the upper vegetation zones of at least 1100m but on the other hand underlines the role of Kilimanjaro as a glacial refuge for montane forest species similar to that of the Eastern Arc Mountains. Therefore this pollen record adds another milestone to east African vegetation and climate reconstructions.

**Merian award applicant**

## THE MODERN POLLENRAIN/VEGETATION RELATIONSHIP IN A TROPICAL MOUNTAIN RAINFOREST - A GUIDELINE FOR PAST VEGETATION AND PLANT DIVERSITY RESEARCH

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Especially in the tropics, information about representation, reproduction and biodiversity of pollen taxa is still scarce, even though it is urgently needed to provide a guideline for palaeoecological research and nature conservation strategies, as well as for the better understanding of past diversity patterns. We investigated modern pollen rain in the northern Andean biodiversity hotspot of South Ecuador by the means of pollen traps. Our analysis is based on an extent sampling design which covers 54 plots (20x20 m) on three different altitudinal levels from the premon-tane to the upper mountain rainforest (1000, 2000, 3000 m) for which detailed tree vegetation analyses (DBH > 5 cm) were carried out. To make a direct comparison between plant and pollen taxa possible, we applied taxonomic surrogacy on the raw data. The overall pattern of pollen versus vegetation data revealed a good correlation between pollen and plant diversity and representation, but more on a regional than on a local level. A downward drift of pollen to lower elevations was evident.

**Merian award applicant**



## IMPORTANCE OF REGIONAL CLIMATES FOR SPECIES DISTRIBUTION PATTERNS IN THE ETHIOPIAN MOIST MONTANE FORESTS

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Tropical mountain regions harbour high biodiversity that is likely to be affected by climate change. This is also the case for the Ethiopian montane forests, which form part of the Eastern Afromontane Biodiversity Hotspot due to high species richness and threat levels. The objective of this study was (i) to assess the variation in floristic diversity of the five remaining moist montane forest areas in Ethiopia (altitude: 970 - 2,280 m), (ii) to evaluate the climatic differences between these areas based on nineteen bioclimatic variables derived from the WorldClim global climate data set (time period 1950-2000), and to (iii) analyse the importance of these bioclimatic factors, altitude and geographic location in explaining species distribution patterns. The results are based on 180 study plots and multivariate statistical analyses. Each of the sampled forest areas showed a distinct species composition and was governed by a particular regional temperature and rainfall pattern related to the diverse topography of the Ethiopian highlands. Altitude proved to be an important factor in explaining species distribution patterns, but its effect was modified by regional differences in rainfall and temperature regimes. The most important bioclimatic variables in determining species distribution patterns were amounts of precipitation of the warmest quarter, mean temperature of the driest quarter (December - February in all study areas), and minimum temperature of the coldest month. Generally, the number of Afromontane species was greatest, and the number of Guineo-Congolian species smallest, in areas with high precipitation during the warmest quarter and low minimum temperature of the coldest month. The study shows the importance of regional differences in precipitation and temperature regimes for species distribution patterns in tropical montane forests with a diverse topography. Seasonal variations also need to be considered, especially for precipitation. Finally, the study highlights the need for systematic on-the-ground measurements of climatic variables in tropical montane areas in order to understand the current climate regime and as a basis for modelling future changes.

## SPATIAL PATTERNS OF TREE SPECIES IN MOUNTAIN RAIN FORESTS OF SOUTH ECUADOR

Daniel Kübler<sup>1</sup>, Patrick Hildebrand<sup>1</sup>, Bernd Stimm<sup>1</sup>, Reinhard Mosandl<sup>1</sup>, Michael Weber<sup>1\*</sup>

<sup>1</sup>*Institute of Silviculture, Freising, DE*

*\*Presenting author*

Tropical forests are known to be highly diverse in terms of microhabitats, ecological niches, and species richness. However, spatial explicit analyses of species distribution are still rare. We analysed spatial patterns of tree species (>20 cm DBH) in three microcatchments with a total area of 13 ha in a tropical mountain rain forest in South Ecuador. First-order properties were described and compared for the most abundant and dominant species in the area using kernel smoothing. The relationship between spatial distribution of the species and topographic variables (elevation, curvature and slope) was analysed. First results indicate that most of the examined species can be clearly categorised as either belonging to a ridge or valley forest type. Second-order properties were analysed to answer the questions if the species show a clumped or random spatial pattern and if this can be linked to topographic or biological factors (e.g. dispersal mechanisms). Implications of the results for forest management options are briefly discussed



## PREDICTIVE MAPPING OF PLANT DIVERSITY AND PLANT BELTS ALONG AN ALTITUDINAL GRADIENT ON A LOMA MOUNTAIN IN THE PERUVIAN DESERT

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The hyperarid Peruvian desert stretches for more than 2000 km along the coast. Plant life is sparse. Only fog-favored mountains represent islands of vegetation harboring disjunct species as well as numerous endemic descendant species. The mountain Mongón (9°S, 38°W), where our study area is located (3.3 km<sup>2</sup>), is one of these fog oases. The objectives of this study were 1) to spatially predict the plant diversity, and 2) to differentiate altitudinal plant belts. For this purpose, we sampled 100 randomly chosen plots (4 × 4 m) on the fog-influenced southern slope. Subsequently, we chose a generalized linear model (GLM) combined with a conditional auto-regressive correlation (CAR) structure for predicting the plant diversity. We used altitude and plan curvature as predictors. The altitudinal zones could be extracted by applying a model-based clustering. We found 70 vascular plant species (32 families). Species number varied between 0 and 24 per relevé (mean: 9.4). The GLM-CAR model clearly reflects different fog moisture levels. The model-based clustering revealed five altitudinal zones. The lowermost and uppermost zones showed a very low alpha diversity (< 6). In the foot region ephemeral herbs were present whereas in the hardly vegetated summit region cacti prevailed. Both zones are followed by a transition zone according to species number (≈10). In both transition zones ephemeral herbs occurred with great frequency. In addition, potentially perennial plants revealed a high recurrence in the lower transition zone. In the middle vegetation belt highest species numbers were recorded. Here again ephemeral herbs dominated but also potentially perennial plants were found. Woody species occurred seldomly. In comparison with other South American Loma mountains, mountains closer to our study area showed a greater similarity in terms of species composition than mountains farther apart (Southern Peru). This has to be interpreted in the light of differences in the available species pool, topography and geologic history. Our study revealed the high relevance of modeling plant diversity within these ecosystems, which are of global relevance due to their high rate of endemism. The high diversity contrasts the surrounding barren land, and our study is one step towards a spatial understanding of these ecosystems on a larger scale.

**Merian award applicant**

## SPERICH: AN OPEN-SOURCE TOOL FOR THE IDENTIFICATION OF SPATIAL SPECIES RICHNESS PATTERNS AT LARGE SCALES AND IN SPARSE DATA SITUATIONS

Claudia Raedig<sup>2</sup>, Sven Lautenbach<sup>1</sup>, Maximilian Lange<sup>1</sup>

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At large scale, most species distribution datasets rely on distribution data obtained from herbarium and museum specimens. Such 'presence-only data' are getting more and more into focus due to the increasing interest in continental and global maps of distribution patterns. However, working with specimen data generally implies a number of potential problems such as the incompleteness of distribution data caused by heterogeneous sampling effort, the inaccuracy of distribution data, in particular of unrevised data, the difficulty of handling the large numbers of species considered. Revised distribution data covering large areas are hardly available, and if, occurrences per species are often scarce. In species distribution modelling, typically species with few records are excluded due to statistical requirements.

Under such conditions, an alternative to statistical species distribution modelling is the use of geometric approaches to construct species ranges. These species ranges can subsequently be overlaid to produce maps of species richness. As a part of LUCI project (<http://www.lucci-vietnam.info>) the R package SPERICH was developed which uses an extended alpha-hull approach to construct species richness maps at large scale in sparse data situations. The interpolation of species ranges can be limited according to the altitudinal distribution of species if such information is available. The interpolated species ranges are combined in an inverse-distance weighted approach which can be adjusted for spatial heterogeneous sampling effort. Resulting maps can be further processed with any GIS environment.

In addition, an evaluation of the robustness of the estimated species distribution patterns based on a cross validation is included in SPERICH. Moreover, SPERICH allows the handling of large datasets. Since it is built as R package, it can be further developed according to the requirements of various research questions. The opportunities of SPERICH are demonstrated for a large Neotropical angiosperm dataset containing more than 4,000 species.

**Merian award applicant**





**Keynote speaker: Dr. Meine van Noordwijk**

## **TREES AND WATERSHED SERVICES IN TROPICAL LANDSCAPES IN TRANSITION**

Meine van Noordwijk<sup>1</sup>

<sup>1</sup>*World Agroforestry Centre (ICRAF)*

Tropical landscapes are changing rapidly, generally losing natural forest cover and gaining planted trees, in various spatial configurations. Broad patterns of 'forest transition' are now recognized as replicable storylines, but the balance between push and pull factors differs between political, economic and social contexts. The hydrological consequences of changes in tree cover are a primary reason for public concern over changes in tree cover, but science-based understanding of the key processes does not align smoothly with public perceptions and the policies based on that. The paper will review seven domains of hydrological influence of trees and forests: 1) short cycle rainfall in ocean-land gradients, 2) local triggering of precipitation, 3) partitioning of precipitation over river flow and evapotranspiration, plus a soil storage component, 4) use of the soil buffer for various types of evapotranspiration plus groundwater flows, 5) dynamics of river flow influenced by river bed and riparian zone vegetation, 6) water use in irrigated systems and 7) water use and re-use in urban and industrialized landscapes. Salient research questions and credible research methods and models are discussed.

**Keynote speaker: Prof. Dr. Beth Kaplin**

## **THE IMPORTANCE OF BUFFER ZONES IN MEDIATING EDGE EFFECTS ON ECOLOGICAL PROCESSES IN FOREST ISLANDS SURROUNDED BY A SEA OF AGRICULTURE**

Beth Kaplin<sup>1</sup>

<sup>1</sup>*Center for Tropical Ecology & Conservation, Antioch University New England, Keene, USA*

Tropical forests host at least two-thirds of Earth's terrestrial biodiversity, provisioning goods and services for human well-being at local to global scales. However, the future of tropical forests has never been more uncertain. Typically isolated and surrounded by human-dominated landscapes, a host of issues face tropical forests, including negative effects from fragmentation, isolation, edges, and human-wildlife conflict. Protected areas are a key approach in tropical forest conservation, but land use around protected areas, even large areas, may disrupt ecosystem functioning along edges. These disruptions can lead to a cascade of alterations, potentially penetrating far into forest interior and ultimately reducing effective size. Recent research shows quality of surrounding matrix can significantly mediate extent and magnitude of edge disruptions. Thus matrix matters greatly to protected area effectiveness, inviting us to revisit role of buffer zones. Crucial parameters to consider include permeability, hospitability, effectiveness at mediating interactions, range of effective quality, appropriate widths, and permissible human activities in the buffer. These are critical questions today as the need to maintain resilience in the face of climate change and food security concerns increases. Interactions between tropical forest protected areas and surrounding matrix cannot be overlooked, emphasizing the need to consider buffer zones.

THU 13:45 GALAPAGOS



**Public talk in German: Christian Ziegler (Nature - and Wildlife Photographer)**

## **VON FLEDERMÄUSEN, WICKELBÄREN UND VERFÜHRENDEN ORCHIDEEN - EINE REISE DURCH DIE REGENWÄLDER DER WELT**

Christian Ziegler<sup>1</sup>

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Tropische Regenwälder beherbergen mehr als 50 % aller bekannten Tier – und Pflanzenarten, trotzdem wissen wir nur sehr wenig über diese diversen Gemeinschaften, und die Arten aus denen sie zusammengesetzt sind. Tropenbiologen rund um die Welt erforschen diese Lebensräume und helfen uns zu verstehen wie Artenvielfalt 'funktioniert', und wie wir diese Ökosysteme unserer schützen können. In meiner Arbeit als Photojournalist bin ich von den Erkenntnissen und der Hilfsbereitschaft eben dieser Biologen abhängig, um meine Geschichten zu visuell erzählen zu können.

Mein Vortrag ist eine visuelle Reise durch Regenwälder in Mittelamerika, Afrika und Asien. Zu Beginn werde ich von den Bestäubern und anderen Besuchern des Balsabaumes berichten, von Kolibris zu Wickelbären, von Blattschneiderameisen und Gottesanbeterinnen. Der nächste Teil des Vortrags wird uns nach Äquatorial Guinea führen, wo ich Teil eines Photographenteams war, das die vom Aussterben bedrohten Primaten der Insel Bioko dokumentierte, um sie besser schützen zu können. Darauf folgt ein Exkurs in die Welt der Orchideen, mit ihren oft zauberhaften, manchmal seltsam anmutenden Blütenformen, und wie diese ihre Bestäuber anlocken und oftmals betrogen. Der letzte Teil des Abends ist den Fledermausen Panamas, und der Arbeit von Elisabeth Kalko gewidmet, die fast 20 Jahre in Panama gearbeitet hat. Den zahllosen Feldtagen von Dr. Kalko und ihren Studenten verdanken wir eine intime Kenntnis einer hochdiversen tropischen Fledermausgemeinschaft, und den Mechanismen, die diese erhalten.

## FRAGMENTATION GENETICS IN THE TROPICS

Chairs: Chris J Kettle, Aline Finger

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The aim of this session is to present the most up-to-date and novel research applying molecular methods (Landscape genetics, conservation genetics and phylogeography) to advance our understanding of fragmentation in the tropics. Particularly, in the context of how population size and isolation influences population and species extinction. Habitat fragmentation affects different organisms in a myriad of complex ways, at different temporal and spatial scales. Molecular methods provide a very powerful tool for investigating contemporary dispersal, colonization and connectivity, key ecological processes which are notoriously difficult to study using classical field ecological studies. We propose a one-day session on fragmentation genetics which will include two keynote speakers (of 30 mins) by world renowned scientists in the field of animal and plant conservation genetics. This will be complemented by a collection of papers which provide a broad perspective on the implications of fragmentation for plants (from a range of life forms from epiphytic plants to large tropical trees), invertebrates, terrestrial vertebrates and marine organisms. We aim to avoid technical papers, but focus on papers which have broad interest to tropical conservation biologists, ecologists, zoologists and behavioral ecologist. Combining talks from a wide range of tropical taxa, we will focus on studies where molecular methods provide important insights into the implications of fragmentation for conservation, habitat restoration and sustainable resource management. This will have broad appeal to all delegates of the GTÖ meeting. Our aim will be to co-ordinate the contributing papers from this session in to a special issue of one of the following leading Journal, Molecular Ecology, Biological Conservation, or Conservation Genetics.

THU 09:15 GALAPAGOS



## GENETIC FRAGMENTATION EFFECTS IN THE TROPICS: WHAT ANIMAL POPULATIONS CAN TELL US

Ute Radespiel<sup>1</sup>

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THU 09:15 GALAPAGOS

Habitat fragmentation has long been recognized as a very consequential type of human intervention in natural habitats. Fragmentation may reduce or even eliminate gene flow between previously connected populations and may thereby lead to an increase of genetic structure beyond the level of pure isolation by distance. Although natural factors such as selective landscape permeability may cause similar effects, habitat fragmentation can be particularly harmful, since it usually coincides with a dramatic decrease in habitat size, leading to a reduction of the effective population size, which may result in a loss of genetic diversity or even severe genetic bottlenecks. Habitat fragmentation, however, probably also occurred naturally at various time points in the evolutionary history of extant species, e.g., as a consequence of Pleistocene climate and vegetation changes. Although these effects have been studied in some depth in temperate regions but not so much in tropical biota, recent studies demonstrate that tropical species underwent quite similar dynamics. It is a major challenge for molecular ecologists to disentangle these various drivers of genetic structure, i.e., to understand the origins of the present day genetic structure in time and space. However, this analytical step is necessary to evaluate possible implications of habitat fragmentation for the long-term survival of a population. I will review the present-day knowledge on these processes by referring to various tropical animal models including our own main study models, the Malagasy lemurs.

## EFFECTS OF HABITAT FRAGMENTATION ON THE GENETIC POPULATION STRUCTURE OF THE FRUGIVOROUS BAT *DERMANURA WATSONI* (PHYLLOSTOMIDAE)

Simon Ripperger<sup>1,2</sup>, Marco Tschapka<sup>1</sup>, Elisabeth Kalko<sup>1</sup>, Frieder Mayer<sup>2</sup>

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During the last decades habitat degradation and fragmentation caused by changes in land use reached critical levels, with devastating consequences on diversity and functionality of ecosystems, particularly in the species-rich tropics. Such anthropogenic influences may directly affect diversity and/or abundance of local organisms (e.g. by poaching, logging or removal of whole habitats). Encroachments leading to habitat disruption (e.g. streets, farmland etc.) may cause discontinuities in gene flow that may easily remain undetected over decades and gradually endanger populations' fitness and long-term survival due to inbreeding and genetic drift. An increasing number of studies reveals genetic erosion of animal and plant populations as a consequence of habitat fragmentation. However, most small-scale studies focus on rather small, immobile organisms, whereas research on mobile animals is mainly conducted in a larger geographic context. Very few studies examined small-scale population genetic structure of highly mobile, flying vertebrates in anthropogenic influenced, omnipresent landscapes, that are composed of suitable habitat remnants embedded into a matrix of anthropogenically modified areas. Especially Neotropical frugivorous bats play a crucial role in degraded areas as they are capable of maintaining seed dispersal between fragments and promote forest regeneration processes. In our study we examined the genetic population structure of a small frugivorous tent-making bat, *Dermanura watsoni* (Phyllostomidae), inhabiting forest fragments in the Caribbean lowlands of Costa Rica, a region that is dominated by crop lands and cattle pastures. We chose a set of forest fragments of different quality (size, connectivity) to evaluate continuity of gene flow and in consequence possible population differentiation on a small spatial scale. We used a dual molecular marker system (nuclear microsatellites & mitochondrial D-loop) to address the influence of habitat parameters on genetic diversity and to identify barrier-effects of landscape elements towards gene flow.

**Merian award applicant**

THU 09:30 GALAPAGOS



## DO ISLANDS SUFFER FROM LOWER GENETIC DIVERSITY AND INBREEDING? THE CASE OF ORCHID BEES IN SÃO PAULO, BRAZIL

Samuel Boff<sup>1</sup>, Isabel Alves-dos-Santos<sup>1</sup>, Maria Cristina Arias<sup>1</sup>, Antonella Soro<sup>3</sup>, Robert Paxton<sup>3</sup>

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THU 09:45 GALAPAGOS

Bees are crucial insects in terrestrial ecosystem, essential for the conservation of natural habitat and economically important for their pollination services. Because the Hymenoptera (ants, bees and wasps) are haplodiploid, sterile or inviable so-called 'diploid males' are produced through inbreeding when an individual is homozygous at the Complementary Sex Determination locus. Inbreeding, a consequence of low genetic diversity in small population, can increase the production of diploid males, making haplodiploids more prone to extinction. Previous studies have suggested that orchid bees suffer high levels of 'diploid male production' (DMP) whereas more recent studies suggest they do not. Our aim was to resolve this discrepancy by determining whether island populations of orchid bees suffered lower genetic diversity and high DMP, as identified using 7 high variable microsatellite genetic loci. We studied one orchid bee species from the continent and from adjacent islands off the coast of São Paulo, Brazil. Our hypothesis, based on the assumptions that inbreeding increases in smaller areas, is that populations on islands have a higher frequency of diploid males than populations on the continent. We sampled orchid bee males from the continent (São Sebastião) and from three islands of differing sizes (Ilhabela, Buzios and Vitoria) at different distances from São Sebastião. Five percent of 1319 genotyped males for all areas were diploid. A higher frequency of diploid males (10%) was found on the smallest and most isolated island studied (Vitoria), although its allelic richness and heterozygosity were not significantly lower than in other studied areas. This is the first reported comparison of DMP in orchid bees between a continental land mass and islands. The absence of genetic differentiation between islands and the continent suggests that the distances between the studied areas are not barriers to dispersal of orchid bees, even though island populations suffered more than the mainland from inbreeding (higher DMP). Moreover, DMP was higher compared to values reported in previous studies with microsatellites, and the higher frequency of diploid males in Vitoria Island is in agreement with our expectations that mating between relatives can be more common in small areas, possibly due to small population sizes.

**Merian award applicant**

## EVOLUTION ON EAST AFRICAN MOUNTAIN ARCHIPELAGOS: PHYLOGEOGRAPHY AND CONSERVATION BIOLOGY OF THE MONTANE WHITE-EYE

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Mountain areas of East Africa show contradicting climate compared with the surrounded dry savannas and semi-deserts. This led to long-term isolation of islands-like retreats harbouring cool and moist climatic conditions. Cloud forests with unique biodiversity including a high number of endemic species can be found on top of these mountain archipelagos due to strong isolation combined with constant environmental conditions. The bird Mountain White-eye *Zosterops poliogaster* occurs exclusively in such higher elevation mountain forests. To analyse recent isolation effects we measured morphologic and genetic (based on 19 micro-satellites) features of 650 individuals covering the major range of the species' distribution from Ethiopia to Tanzania. The obtained genetic structure coincides with the populations forming distinct clusters for each mountain population. Thus, dry savannah acts as effective barrier for local populations as revealed by Circuit Scape Models. Morphologic and genetic variability is highest over the interconnected Central Kenya Highlands, creating a pool of intraspecific variability. In contrast, populations on isolated mountains in the south and north (e.g. Mt. Kulal, Chyulu Hills, Taita Hills and Mt. Kasigau) show low diversities and significant higher levels of fluctuating asymmetries (which can be interpreted as an index for environmental stress). In a conservationists' view, these results show that the sedentariness and specific habitat demands lead to strong matrix events, so that even adjoining areas (e.g. Mbololo and Dawida within the Taita Hills) are differentiated from each other, and thus habitat fragmentation within mountain forests might have negative effects on the vitality of *Z. poliogaster* populations.

THU 10:00 GALAPAGOS





## FRAGMENTATION GENETICS AND REPRODUCTIVE SUCCESS IN *DYSOXYLUM MALABARICUM* (MELIACEAE)

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We investigate the effects of habitat fragmentation on gene flow and reproductive success in *Dysoxylum malabaricum* (Meliaceae), a rare timber tree endemic to the biodiversity hot spot Western Ghats, in India.

The research area is situated in a very patchy agro-forest landscape containing a high density of small 'sacred grove' forests within a matrix of rice paddy and coffee plantations. Along with the expansion of coffee these forest patches were reduced in extent by more than 50%.

We sampled all 235 adult trees within this landscape (289 km<sup>2</sup>) and genotyped them at eleven nuclear microsatellite loci. We applied a paternity and parentage analysis of 566 seed and 488 seedlings to assess contemporary gene flow by pollen and seed dispersal and evaluated spatial genetic structure and historic gene flow. Together with field observations on recruitment success and a nursery experiment we record seedling performance to evaluate the genetic and reproductive consequences of fragmentation.

Our results demonstrate that *D. malabaricum*, clearly has the capacity for long distance pollen dispersal exceeding distances greater than 5 km. Isolated trees receive heterogeneous pollen from distant trees, whereas trees occurring in clumps receive pollen predominantly from conspecifics at short distances. Reproductive output measured as seedling densities within a 10 m radius of surveyed fruiting trees are highly variable and seem to be site specific. Still there is a trend of higher reproductive output in isolated trees with an average of 76 seedlings per survey tree compared to less isolated trees which have an average of only 27 seedlings per tree.

This study contributes to a better understanding of the complex effects of fragmentation on the reproductive ecology of trees, where spatial isolation not necessarily results in genetic isolation. We discuss the implications of our findings in the context of predicted future agricultural intensification in this agro-forest landscape mosaic.

**Merian award applicant**

## SEEING THE TREES FOR THE FOREST OF BORNEO

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Forest fragmentation is a principal driver of biodiversity loss. The forests of SE Asia and especially the Island of Borneo experience some of the most acute and rapid forest degradation and fragmentation in the world. This has major implications for climate change mitigation, biodiversity conservation and rural livelihoods. Understanding the implications of fragmentation for constituent tree species is especially important for developing scientifically informed conservation management and ecological restoration strategies. The lowland forests of Borneo are among the most species rich forests in the world. They are also unique in that they are dominated by a single family of trees the Dipterocarpaceae, which dominate the canopy and an important timber tree family. I provide a synthesis of our recent research on the population and conservation genetics of a range of species within this important family. I present results on fine-scale spatial genetic structure, pollen and seed dispersal and mating system, from dipterocarp studies in Borneo, India and the Seychelles. I discuss the implications for forest management and restoration and argue that the dipterocarps may be especially vulnerable to habitat fragmentation. Finally, I highlight the current gaps in our knowledge and propose a set of management priorities to ensure that species within this family can effectively contribute to the establishment of resilient future forest landscapes in the region.

THU 11:00 GALAPAGOS



## GENETIC VARIATION OF TEAK (*TECTONA GRANDIS* LINN. F.) IN SELECTIVELY-LOGGED AND UNLOGGED NATURAL POPULATIONS IN MYANMAR

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Teak (*Tectona grandis*) is a tropical forest tree species that naturally occurs in India, Laos, Thailand and Myanmar which possesses the largest area of teak forests. Ten polymorphic nuclear microsatellite markers were used to investigate the genetic variation of teak in selectively logged and unlogged natural populations in Myanmar. A total of 1600 samples from adult (N=50) and young regeneration (N=50) in selectively logged and unlogged populations in four regions each in the northern and southern parts of Myanmar as well as 80 samples from two Benin populations were used for the study. Genetic diversity within teak populations in Myanmar was relatively high but lower compared to the Benin populations. No significant differences were found among the adults and the regeneration as well as between selectively logged and unlogged teak populations. However, inbreeding was significantly higher in the regeneration in unlogged than in selectively logged populations. In addition, the allelic richness was significantly higher in southern than in northern populations. An Unweighted Pair Group Method with Arithmetic Mean (UPGMA) revealed two major clusters in Myanmar: one with the northern populations and one with the southern populations. The Benin populations were clustered with the populations of South Myanmar. Mantel tests revealed significant positive correlations between the genetic and geographical distance among populations. An Analysis of Molecular Variance (AMOVA) detected the highest genetic variation within populations. The *F*<sub>st</sub> values were significantly different among all teak populations and higher between than within the regions in Myanmar. The impact of selective logging on genetic structures of teak, and the consequences for sustainable utilization and conservation of the species in Myanmar were discussed.

**Merian award applicant**

## HOW DOES HETEROZYGOSITY AND INBREEDING INFLUENCE GERMINATION, GROWTH AND SURVIVAL IN TROPICAL TREES

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Bornean rainforests are among the most species-rich in the world, but are threatened by deforestation, fragmentation and degradation. They are particularly vulnerable because reproduction of the dominant trees, Dipterocarpaceae, relies on sporadic "general flowering" events which recur only every 7 to 10 years. As forests become increasingly disturbed it is vital to understand how this influences reproduction and the ability of forests to regenerate.

Regeneration is strongly linked to the success of pollination during these flowering events. Dipterocarp trees are pollinated by insects which range from tiny poorly-dispersed thrips to highly-mobile large bees. Seed dispersal is inherently limited and secondary dispersal is rare. Therefore, population genetic structure is strongly influenced by pollination. Because many pollinators travel short distances, the pollen they transfer may result in mating between closely related neighbouring trees, reducing genetic variability in seedlings with consequences for regeneration. However, it remains unknown exactly how genetic factors influence seedling growth and survival.

Seeds were collected from 18 mother trees (which varied in neighbour distance and degree of spatial isolation), of a critically endangered canopy species; *Parashorea tomentella*, during a minor flowering event in 2009 and germination tests conducted. A mean of 87.5% (range 38-100%, SE  $\pm$  3.6%) of seeds germinated successfully. Seedlings were grown under treatments that manipulate light conditions, nutrient supply and the biotic environment. Mother tree effects on germination and growth parameters were investigated. All seedlings and non-germinants were genotyped at a set of eight nuclear microsatellite loci and the subsequent data analysed to determine how heterozygosity affected the probability of seed germination, growth and survival. I discuss the implication of these results in the context of limited pollen dispersal associated with habitat fragmentation and minor flowering events.

**Merian award applicant**

THU 11:30 GALAPAGOS



## EFFECTS OF FOREST FRAGMENTATION ON GENETIC VARIATION PATTERNS IN AFRICAN TREE SPECIES

Reiner Finkeldey<sup>1</sup>, Oliver Gailing<sup>1,2</sup>, Kathleen Prinz<sup>1\*</sup>, Akindele Akinagbe<sup>1,4</sup>, Taye Bekele<sup>1</sup>, Abayneh Derero<sup>1,3</sup>

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\*Presenting author

THU 11:45 GALAPAGOS

Human activities, in particular land use changes, reduce the habitat of numerous tropical forest tree species. Population decline and the survival of remnant populations only in widely isolated forest fragments potentially endanger the genetic resources of trees throughout the tropics. Losses of genetic diversity due to genetic drift and inbreeding are imminent threats to the persistence of small tree populations and eventually even species in this situation. However, the life history characteristics of most tropical trees, in particular their efficient means of gene dispersal and their long generation times, suggest that high levels of genetic variation might be maintained even in severely disturbed landscapes and small forest fragments.

Many densely populated regions in Africa have been severely affected by deforestation and forest fragmentation. We studied extant genetic diversity patterns in four tree species from East and West Africa in order to assess levels of genetic diversity in highly fragmented populations and to test the hypothesis of low genetic variation in small and isolated forest fragments.

Genetic variation patterns at Amplified Fragment Length Polymorphisms (AFLPs) and chloroplast haplotypes of *Hagenia abyssinica* and *Cordia africana* in Ethiopian populations suggest the maintenance of considerable intraspecific diversity even in small and isolated populations. While genetic diversity levels of the 'pioneer' tree species *Triplochiton scleroxylon* are largely unaffected by forest fragmentation and disturbance in the Akure Forest Reserve in Nigeria, a decrease of genetic diversity in disturbed populations was observed for the climax tree *Mansonia altissima*.

We conclude that even small and widely separated forest fragments often contain ample genetic diversity within forest tree populations and discuss the significance of this finding for the development of *in situ* and *ex situ* conservation strategies for forest genetic resources in the tropics.

## THE ROLES OF AGROFORESTRY IN MANAGING FRAGMENTED MULTIFUNCTIONAL LANDSCAPE

Chairs: Aster Gebrekirstos, Sonya Dewi  
Contact: A.Gebrekirstos@cgjar.org

Up to ninety percent of the biodiversity in the tropics are located in human-dominated landscapes. Protected natural areas are essential but insufficient to maintain biodiversity especially that protected areas tend to be isolated. It requires both a combination of sites and conservation action in the wider landscape. The long-lasting conservation of indigenous plant and animal diversity will depend on our ability to design and manage agricultural landscapes so that they conserve the original biodiversity as much as possible, while still sustaining agricultural production goals, indigenous cultures and local livelihoods. The multiple roles of agroforestry in contributing to the conservation of biodiversity and local livelihoods in fragmented landscapes are increasingly being recognized but not yet translated into standard practices in landscape planning and management. This session will bring together experts from the field of agroforestry and related areas, and present innovative work on designing multifunctional landscapes as a means to attain conservation and production simultaneously. The technical, institutional, and market frameworks that motivate and reward communities for maintaining and restoring fragmented landscapes will be explored. Particularly, the use of agroforestry to promote ecosystem services, increase production and reduce forest conversion, their roles as buffer zones, corridors and matrix to support ecological functions within the landscape will be discussed. The results of the presentations will be synthesized to alert decision makers and managers to the importance of considering trees on agricultural landscapes in biodiversity conservation plans and a way forward in managing fragmented landscapes.

THU 09:15 KILIMANJARO



## CONNECTING KROKOSUE HILLS FOREST RESERVES AND BIA CONSERVATION AREA OF GHANA THROUGH THE USE OF COCOA AGROFORESTRY SYSTEMS

Richard Asare<sup>1</sup>, Victor Afari-Sefa<sup>2</sup>, Opoku Pabi<sup>3</sup>, Yaw Osei-Owusu<sup>3</sup>, Isaac Gyamfi<sup>1</sup>

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THU 09:15 KILIMANJARO

The Upper Guinean forest extends across six West African countries from southern Guinea to Ghana. It originally covered as much as 420,000 km<sup>2</sup> harbouring more than half of all mammalian species in Africa. However, centuries of human activities have resulted in the loss of nearly 70% of this original forest cover. Two protected areas in the Western region of Ghana (Bia National Park and Krokosue Hills Forest Reserve), which form part of the Guinea forests have been encroached through lumbering for timber and extensification of no-shade cocoa and other crop production systems. The purpose of the study is to develop a multi-disciplinary strategy for forest corridor connectivity in the two protected areas so as to address the environmental and social impact of cocoa production. Biophysical assessments i.e., satellite images, vegetation pattern maps, and expert data in a decision support system were used to select suitable candidate's sites for the corridor within a GIS framework. Socio-economic assessments involved secondary data and expert knowledge augmented with primary data sets in a static cost-benefit analysis framework to assess the opportunity costs of alternative farming systems to cocoa agroforestry in the delineated corridors. Results from baseline scenario analysis confirm that cocoa yield increases in production is dependent on expansion into existing forested areas. While timber trees planted within cocoa agroforests settings would help offset the yield losses in cocoa shade-yield relationships compared to full sun-production systems, the on-farm benefits of cocoa agroforestry practices alone are insufficient to justify the adoption by farmers. Paying land users who adopt these practices premium prices for the cocoa produced and substantial off-farm environmental and ecosystem services under agro-forestry systems can tip the balance towards adoption.

**Keywords:** cocoa agroforestry, corridor creation, biodiversity hotspots, biodiversity conservation, Ghana

## INITIAL TREE GROWTH IN DIFFERENT TAUNGYA SYSTEMS IN PANAMA

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The accelerating deforestation in the tropics calls for an extensive scientific research on sustainable land-use systems, that reduces deforestation, supports the regeneration of ecosystems and provides income for the people as well as for the national economy. Tropical timber plantations are considered as a sustainable and economically feasible way to foster reforestation of degraded lands. However, the greatest obstacle to the implementation of timber plantations for small and large-scale reforestation is the long term investment of land, labor and other farm resources in trees. This research project aims at developing methods to provide earlier returns out of wood plantations and reforestations to make them more attractive as a land use concept for large and also small scale farmers. The research approach is to integrate understory crops in timber plantations to provide earlier returns, diversify farm products and allow more efficient use of land and labor. In the course of the present project different understory crops were tested under six different valuable exotic and native tree species on three hectares in Eastern Panama. Initial tree growth and mortality has been evaluated in comparison to tree monocultures as well as optimal tree planting distances and light regimes. The results indicate no significant differences in tree growth and mortality between agroforestry treatments and plots without association with arable crops, which leads to the conclusion that enrichment planting is possible without causing damage to the high quality timber trees. Our results show that the enrichment of the six tree species with pigeon pea (*Cajanus Cajan*) even improved tree growth. Economic analyses of the different systems and interviews with local farmers have been carried out to complete the assessment of suitability of the agroforestry approach as a sustainable land use concept and a method to improve traditional plantation forestry.

THU 09:30 KILIMANJARO





## DIVERSITY AND USE OF WOODY PLANT SPECIES UNDER DIFFERENT PROPERTY REGIMES IN RURAL LANDSCAPES OF NORTHWEST ETHIOPIA

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THU 09:45 KILIMANJARO

The high diversity of woody plant species (WPS) in the Ethiopian Highlands suggests an important role in the livelihoods of the rural poor. However, different property regimes create differences in access and in the biophysical condition of the resources. Our study aims at understanding the biological diversity, ownership regimes, and use patterns of WPS. The study carried out in two villages of North-West Ethiopia. We did exhaustive enumeration and inventory with sample plots to assess biological diversity; and PRA and RRA tools to identify ownership regime, use patterns and desired management. 70 WPS were recorded with decreasing diversity statistics from homestead to church and to communal woodlands. Regarding trees on homesteads under private property regimes, household members define a variety of products, including products with high market value. WPS are therefore managed according to the respective needs of the household. WPS under church property are protected by the strong religious values of the community. Whilst the benefits of protecting these woodlands are non-tangible, they remain vital to the society. As the protection is a result of guardianship by both priests and members of the parish, it is a hybrid form of private-public property regime. A variety of different and complex arrangements is in place for the management of WPS on communal woodlands. These are related to proximity of settlement to the area, social institutions in the villages as well as outside interventions by government authorities and development organisations. Benefits for the community thus vary, and range from grazing land to the fulfilment of immediate cash needs in terms of charcoal or timber sale. There is evidence that villagers develop strategies for conservation of communal woodlands dependent on land use history, migration as well their different social realities. We suggest that different property regimes may have substantial impacts on sustainable use of woody plant species. However for successful management both the bio-physical and the social complexities need serious consideration, in particular regarding common pool resource management.

**Merian award applicant**

## QUANTIFYING ECOSYSTEM SERVICES TRADEOFFS IN RUBBER AGROFORESTS IN JAMBI PROVINCE, INDONESIA: APPLICATION OF AGENT-BASED MODELING (ABM)

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Ecosystem services (ES) trade-offs occur when the provision of the ES is reduced as a consequence of increased use of another ES. The growing demand to meet the human needs particularly for food causes the decline in other ecosystem services such as (agro)biodiversity which are both crucial to human wellbeing. In the recent years, payments or rewards for ecosystem services (PES) as a market based instrument has widely recognised as a management approach to address both the environment conservation and human welfare while serves as a policy instrument to deal with the ES tradeoffs. However, there is no solid understanding how PES could affect the synergies and tradeoffs among ES. The challenge of ES trade-offs assessment lies on the complexity of ecosystem dynamics in which human and natural processes are coupled. The general problem of all ecological analyses and all environmental decision process is the enormous complexity of the investigated ecosystems and landscape patterns (Müller et al., 2000). Since complex system violates the assumptions of reductionist techniques, the need to work across all manner of human boundaries at different geographic scales (including downstream and upstream relations) is required. It involves an interdisciplinary work and cross-sectional approach of disciplinary boundaries (social and ecological sciences) to understand these complexities. To address this complexity, this research applies a multi-agent system modelling approach (MAS) to simulate and visualise the temporal and spatial scale effects on the tradeoffs between goods and services. This research study aims to develop a tool-based approach using MAS model to assess ES tradeoffs and to support the design of PES schemes.

**Merian award applicant**

THU 10:00 KILIMANJARO



## PRODUCTIVITY, CONSERVATION OF TREE DIVERSITY AND CARBON SEQUESTRATION IN AGROFORESTRY SYSTEMS. A CASE STUDY FROM THE GRAN SUMACO, ECUADOR

A. Oswaldo Jadan<sup>1</sup>, Sven Günter<sup>1\*</sup>

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THU 10:15 KILIMANJARO

The Biosphere Reserve Gran Sumaco, Ecuador is in process of developing strategies for the establishment of biological corridors. In this study we are analyzing the potential of agroforestry systems for providing environmental services and the possible effects for productivity. Traditional chakra systems of the Kichwa people with main focus on providing food for subsistence are compared with market oriented systems using grafted cacao and cacao propagated by seeds. The second factor for the study is the influence of tree cover on productivity, tree diversity and carbon sequestration. Closed-by primary forests were analyzed as reference system. The research is oriented towards the question if potential losses of income due to higher tree cover could be compensated by carbon markets or payments for environmental services.

While agroforestry systems with tree cover stored between 26 (chakra) to 42 % (cacao by seeds) of total carbon in comparison to primary forests, those without tree cover only 18 to 25 %. Consequently, systems with tree cover stored between 29-56 t C more than those without tree cover. However, lower tree cover provided a significant higher productivity, equivalent to a 420-820 \$ higher net income per hectare in relation to systems with higher tree cover.

Our preliminary analysis indicate that local PES regimes would not be able to compensate potential economic losses due to increased tree cover; however voluntary carbon markets would be an attractive alternative for prices of approx. 15 \$ per ton. It may be surprising, that the chakra systems did not show higher environmental services than market oriented cacao systems.

## LAND USE PLANNING FOR RURAL DEVELOPMENT WITH MULTIPLE ENVIRONMENTAL SERVICES IN THE TROPICAL LANDSCAPES

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Land use planning can potentially minimize conflicts between multiple objectives, such as rural development and maintenance of environmental services. However, a plan without implementation does not make much difference. Implementation requires a combination of 'buy in' by multiple stakeholders and effective authority of government agencies. Both of these may be lacking in many developing countries, as truly participatory planning processes are rare and multiple government agencies compete for influence rather than acting in coordination. Development targets are generally framed in terms of economic growth rather than equity, and tend to follow a sectoral approach. Changes in forest, agroforest, agriculture and other land uses are intertwined in rural livelihoods, through driver interactions at multiple levels, such that addressing the land use and land use change issues need a holistic and system rather than sectoral approach.

The District of Merangin in Jambi province, Sumatra, Indonesia was selected as a case study for the first application of a new tool called LUMENS (Land Use planning for rural development with Multiple Environmental Services). LUMENS will include spatially explicit representations of three environmental services, i.e., climate change mitigation, biodiversity maintenance and watershed protection, alongside rural development. The services will be quantified and predicted under several scenarios. Future land use changes are projected through spatially explicit driver modelling in combination with the scenarios developed from multistakeholder processes.

LUMENS will allow ex-ante exploration of the consequences of ranges of scenarios of land use/land use changes on multiple environmental services. We draw on a hybrid of pattern-process based rapid appraisals of C-stock, biodiversity and water flow persistence in the catchment to predict performances of a particular landscape in terms of climate change mitigation, biodiversity maintenance and watershed protections under several scenarios. Quantification of foregone opportunities caused by avoiding some land use/land use changes in order to maintain/improve some quantifiable environmental services is used to advise the process of negotiating a common and agreed scenario to be adopted and implemented.

THU 11:00 KILIMANJARO



## MARKET MECHANISMS TO AVOID BIODIVERSITY LOSS IN AGROFORESTRY SYSTEMS

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THU 11:15 KILIMANJARO

In areas where primary forests have been highly intervened or cleared, agroforestry systems play an important role delivering agricultural and forest products. These lands are acknowledged for supplying ecosystem services to society and also performing as corridors connecting isolated patches providing shelter for the local flora and fauna. In spite of the benefits associated to agroforestry, the adoption has been lower than expected due to lack of economic evidence supporting the already existing successful biological background; at the same time intensive agriculture is gaining room among farmers. Payments for ecosystem services are an alternative to internalize the benefits of agroforestry and compensate landowners for the forgone income that maintaining a biodiversity friendly land-use may cause. We estimated the financial compensations needed to persuade farmers to maintain their traditional shade coffee lands instead of replacing them with maize applying Mean-Variance decision rules in southwest Ecuador. We apply the decision making under uncertainty approach for the calculation of the compensations, incorporating factors like price volatility to model risk. Our results showed that farmers would demand a compensation of US\$ 86 ha<sup>-1</sup>year<sup>-1</sup> to avoid future land conversion. In a second step, we applied the Modern Portfolio Theory to calculate a land-use portfolio combining both productive options to maximize farmer's expected utilities while reducing risks. The optimum portfolio turned out to be a share of 73% maize and 27% shade coffee. A raise in the share of coffee to 75% would require a payment of US\$ 40 ha<sup>-1</sup>year<sup>-1</sup>; this means that we may achieve already beneficial shifts in the land-use distribution from maize towards shade coffee for comparatively small compensation payments, if we accept some maize areas.

## DOES AGE MATTERS: COMPARISON OF SPECIES DIVERSITY AND TRADITIONAL MANAGEMENT PRACTICES IN COFFEE BASED AGROFORESTRY IN SIDAMA AND BENCH-MAJI, ETHIOPIA

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The coffee based agroforestry systems of South and Southwestern Ethiopia which evolved from wild coffee forest possess diversity of tree species purposefully maintained for coffee shade and other benefits. This research is done to understand the traditional shade-tree management practices and species diversity in the coffee based agroforestry system. The major data collection techniques used in this study were semi structured questionnaire based on stratified random sample of households, inventory of shade tree diversity in the same household's plot, observation and review of secondary data. The collected data was analyzed using descriptive statistics and qualitative content analysis. The result shows that in Sidama, five tree species are most frequently used as shade and similar number of other tree species entirely excluded from the farm because of inferior qualities with respect to several parameters in Sidama, while in Bench-Maji there are three species selected as promising and no undesirable tree species according the interview. The main criteria to select and use a tree in Sidama are soil improving quality, moisture discharging capacity, availability of seed, wood quality, shade level, moisture retention, cash generation, cultural value and non-negative effects while in Bench-Maji for wood quality, natural presence of the species, shade level and cultural values. On the bases of wood species inventory, seventy-one and forty-eight perennial species were registered in Sidama and Bench-Maji respectively. In the latter system, the agroforest tree species are much similar but less diverse from the adjacent natural forest. In Sidama, trees severely threatened and scarce in natural forest are found growing in better abundance in domesticated landscape. The management intensity is also higher in Sidama than in Bench-Maji probably attributed to smaller size of landholding where the average is one-third of that of Bench-Maji. Shade trees are either planted, deliberately retained or wildlings. It can be concluded that traditional coffee-shade management is contributing to the preservation of species diversity in both regions. However, the species diversity and management intensity of agroforest varies in the two regions.

**Keywords:** shade trees diversity, Sidama, Bench-Maji, Ethiopia, Traditional coffee-shade management

THU 11:30 KILIMANJARO



## SITE AND SOIL AMELIORATIVE POTENTIALS OF AGROFORESTRY TREE SPECIES IN ARSI NEGELLE DISTRICT, OROMIA, ETHIOPIA

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THU 11:45 KILIMANJARO

The contribution of scattered trees in the farmland on soil fertility and microclimatic moderation has not yet been studied and documented in Arsi Negelle district of Oromia regional state, Ethiopia. Therefore, experiment was conducted to study the effect of agroforestry tree species on site and soil amelioration under their canopy. The tree species considered for the study were *Balanites aegyptica*, *Acacia tortilis* and *Acacia seyal*. The surface and subsurface soil layer of 0-15cm and 15-30cm are considered for soil parameters and some of the microclimatic studies. The treatments were arranged in RCBD with three replications. Observations recorded were: BD, pH, EC, Av. N, Av. P, Av. K, OC, CEC and microclimatic parameters viz. soil moisture, relative illumination, soil temperature and beneath canopy temperature. Except pH and Av P all soil and microclimatic parameters under the canopy distances were significantly different from the open control at ( $p=0.05$ ). Soil bulk density increased as the distance increased from the tree base to open field for the surface and subsurface soil layers. Av N under canopy of *Acacia tortilis* was superior to that of *Balanite aegyptica* and *Acacia seyal*. Av K was significantly higher under *Balanites aegyptica* and *Acacia tortilis* at the nearest and middle distances from the trees' bole. Av N was found to be in deficient "low" range in the treatments studied; however, Av P and Av. K were from sufficient to deficient "medium to low" range. Similarly, CEC were significantly different ( $p = 0.05$ ) at both surface and subsurface soil layers under the tree canopies. CEC was higher under the canopy distances than in the open field and showed a declining trend from the tree base to the open control. Besides, soil temperature, under canopy temperature and relative illumination decreased from May up to July under all treatments whereas soil moisture showed an increasing trend from May up to July under all treatments.

**Keywords:** *Balanites aegyptica*, *Acacia tortilis*, *Acacia seyal*, site microclimate, soil amelioration

**Merian award applicant**

## FRAGMENTATION, MOVEMENTS AND DISEASES

Chairs: Fred de Boer, Heribert Hofer

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Scope: With an increase in fragmentation, the distribution and movement of many animal species are affected. Some species might benefit from habitat fragmentation, whilst others will restrict their movement, with potential negative effects for their distribution. It is therefore important to understand the relationships between movement and habitat fragmentation, and how fragmentation or the decrease in the size of suitable habitat influences animal movement and distribution. Not only do we need to understand how local extinction and differences in distributions are affected by changes in movement, but also ecological consequences of these impacts need to be understood. One of these consequences is a change in the expansion/restriction of diseases. The spread of diseases like Bovine Tuberculosis, Lyme, West Nile fever, avian influenza, or other zoonotic disease is influenced by the distribution of hosts and vectors. Hence, the analysis of the distribution of diseases and the expansion should also take into account the spread of hosts and vectors, in relation to the permeability of the landscape, so that our understanding of the spatio-temporal dynamics of these diseases is increased, and more effective control measures can be taken. On the other hand, by understanding the link between fragmentation and disease incidence we will improve our knowledge of the population impact of top-down processes as exemplified by interactions between pathogens and their hosts.

THU 14:30 GALAPAGOS





## FRAGMENTATION, MOVEMENTS AND IMPLICATIONS FOR DISEASES EXPANSION: A REVIEW

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THU 14:30 GALAPAGOS

Fragmented habitat patches can be mapped, with patches as dots and movement as arrows. These networks can be analysed by Graph Theory, where the areas are nodes and the movements edges, an upcoming field that is applied to a variety of network analysis. Typical of the most fragmentation networks is that they are fixed in space, and hence movement from one node to the other has a cost related to the length of the edge. Using Graph Theory we can test how a disease is spread over the continent, to what extent different networks are coupled or unconnected, and what the best disease control mechanisms are. Most networks are characterised by certain general laws on the basis of important topological features that link the network structure to the network efficiency and connectivity. Spatial networks are, due to their spatial characteristics and heterogeneity of nodes and edges, probably not scale-free networks, in which the disease expansion is superefficient. Fragmentation both leads to a reduction of total area, and the creation of new nodes. This leads to changing edge weights, node strength, and edge rewiring. Important questions are how do networks cope with these dynamics, and how are network efficiency, network connectivity, and network collapse influenced by these changes? What are the threshold distances at which sub-graphs become connected? The network properties of a network, the existence of clustering, its spatial characteristics and differences in node strength and edge weights, decrease the speed at which a disease is spread, and can potentially prevent pandemics. To what extent the network configuration and its spatio-temporal dynamics influence the chances of pandemics or disease expansion still needs to be analysed, although it is hypothesized that this is inversely proportional to the network connectivity. However, intermediate levels of network coupling might promote persistence of diseases in meta-populations. The existence of low mobility, small population sizes and a high degree of clustering, can even lead to the disease eradication. Understanding these relationship can lead to highly efficient vaccination schemes.

## ECO-IMMUNOLOGY OF TROPICAL MAMMALS

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Ecological and social factors are central in the emergence and transmission of infectious diseases, thus bearing the potential for shaping a species' immune competence. Although previous studies demonstrated a link between social factors and the cellular immune system for captive mammals, it is yet poorly understood how ecological factors correlate with immune parameters. Here, we tested if the cellular and humoral immune response of free ranging bats is influenced by two ecological factors: diet and shelter choice. We found that circulating white blood cell counts (WBC) of 24 co-existing Neotropical bat species varied with the species-specific diet. Bats that included at least partially vertebrates in their diet exhibited the highest WBC, followed by phytophagous and insectivorous species, which is consistent with the prediction that the immune system is linked to the pathogen transmission risk of a trophic level. The constitutive humoral immune response, assessed by an *in vitro* bacterial killing assay, tended to decrease with increasing roost permanence, suggesting a strong humoral immune system of bats roosting in more ephemeral structures, than those roosting in more permanent structures. Our results suggest that the ecology of mammals is an important factor in the evolution of their cellular and humoral immune system.

**Merian award applicant**

THU 14:45 GALAPAGOS



## DIVERSITY WITHIN: CHANGES IN BAT TRYPANOSOME PREVALENCE AND DISTRIBUTION IN FRAGMENTED HABITATS

Veronika Cottontail<sup>1,2</sup>, Nele Wellinghausen<sup>2,3</sup>, Iain Cottontail<sup>4</sup>, Elisabeth Kalko<sup>1,5</sup>

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Studying the effects of habitat fragmentation upon the prevalence of pathogens in two species of fruit bats, *Artibeus jamaicensis* and *A. lituratus* (Phyllostomidae), in Panama showed that 32.4% of all bats (n=256) were infected with trypanosomes. One third (38.9%) of all *A. jamaicensis* and 12.2% of all *A. lituratus* were trypanosome-positive. Molecular analysis revealed a surprising diversity in the trypanosome genetic lineages.

Sequencing of SSUrRNA gene fragments from these trypanosomes revealed 12 different genetic sequences, belonging to *T. cruzi cruzi*, *T. cruzi marinkellei*, *T. rangeli* and 3 hitherto unknown trypanosome haplotypes. Distribution and diversity of trypanosomes varied greatly in relation to the degree of habitat fragmentation. Alpha-diversity of haplotypes was highest in large continuous forest (Simpson index: 0.79). It decreased to 0.73 on islands with a low degree of isolation ("near islands") and was lowest (0.68) on small and isolated islands in Lake Gatun ("far islands"). We found a threefold increase in the prevalence of *T. cruzi cruzi* and a twofold increase of *T. cruzi marinkellei* in bats captured on the islands compared to the bats caught in continuous forest (mainland). The prevalence of other trypanosomes stayed the same or tended to decrease. On the far islands, one unknown trypanosome haplotype disappeared. The significant differences in the distribution of trypanosomes between islands and mainland strongly suggest that the degree of fragmentation (habitat size and isolation) not only increases infection rates, but also favors generalist parasites, in particular *T. cruzi cruzi* and *T. cruzi marinkellei*.

These shifts in haemoparasite prevalence might be linked to changes in the vegetation composition and structure. For instance, transmission of *T. cruzi* on the islands might be favored by the increased abundance of palm trees (*Attalea butyracea*), the preferred roosts of *A. jamaicensis*. An additional explanation might be the strong reduction of bat species richness on the islands, which supports the proposed "dilution effect", stating that a decrease in host diversity should lead to an increase in the transmission of generalist pathogens.

**Merian award applicant**

## RESERVOIR COMPETENCE, LIFE HISTORY TRAITS AND FRAGMENTATION: WHY DOES THE DILUTION EFFECT OCCUR?

Zheng Huang<sup>1</sup>, Fred de Boer<sup>1</sup>, Frank van Langevelde<sup>1</sup>, Valerie Olson<sup>2,3</sup>, Tim Blackburn<sup>3,4</sup>, Herbert Prins<sup>1</sup>

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Fragmentation, habitat loss, and global decline in biodiversity are of major concern since these human impacts have altered the dynamics of diseases caused by generalist parasites. Nowadays, increasing evidence suggests that biodiversity loss, partly under influence of fragmentation, tends to increase disease risk, the so-called the dilution effect. Some studies indicated that the dilution effect generally occurs when competent host species for a pathogen survive in disturbed low-diversity communities and increase their population. Yet, we do not know why these competent host species are more likely to have higher probabilities of surviving these biodiversity declines. Here, we studied the relationship between the species' reservoir competence and their life-history traits which are considered as predictors to species' local extinction risk. We tested these relationships in three vector-borne disease systems, namely Lyme disease, West Nile Encephalitis (WNE) and Eastern Equine Encephalitis (EEE). The results showed that species' reservoir competence and infectivity are usually negatively associated with body size (in all three disease systems), or positively correlated with clutch size (in EEE). Hence, our results suggest that the life-history traits which are correlated to the species' local extinction risk are also able to explain part of the variation in species' reservoir competence and infectivity. Our results explain why competent host species usually survive when biodiversity declines, such as under increasing fragmentation from human disturbance, and hence why disease prevalence is often higher in fragmented low-biodiversity landscapes.

**Merian award applicant**



## SPATIAL HABITAT DISTRIBUTION, FRAGMENTATION AND SEARCH EFFECTIVENESS

Tom Huismann<sup>1</sup>, Frank Van Langevelde<sup>1</sup>, Fred de Boer<sup>1</sup>, Herbert Prins<sup>1</sup>

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THU 15:30 GALAPAGOS

Habitat destruction constitutes a direct loss of habitat and resources. In the process, however, it also causes habitat fragmentation. This fragmentation of existing ecosystems changes the spatial distribution of habitat and resources. The distribution of forest remnants will, for instance, be more highly aggregated than the original distribution. Alternatively, if habitat is divided into smaller plots a more regular spatial distribution or pattern may result. Here we show that the effect of such changes in spatial distribution depends on the animal's movement behaviour. Furthermore we show that changes in overall density and changes in the degree of aggregation have an interactive effect on the efficiency of these movements. Consequently, animals inherently using a movement strategy optimal for a random distribution of resources, e.g. a correlated random walk, may be more adversely affected by fragmentation than would be expected based on simply considering density changes. Additionally, this effect would be more pronounced as overall density decreases. In such cases the animal may experience an area as unsuitable simply based on its search performance and will have to make longer moves. In this way fragmentation and the resulting spatial pattern can increase the rate of dispersal of potential vectors and consequently the potential of and velocity with which vector-borne diseases are likely to spread.

**Merian award applicant**

## TROPICAL DENDROECOLOGY

Chair: Achim Bräuning, Ute Sass-Klaassen

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Tree-ring analysis provides useful information about environmental changes on forest ecosystem, forest dynamics and regeneration, carbon budgets and growth-climate interactions. Besides growth rates, variations wood anatomy and stable isotope composition provide useful information for deciphering the environmental archive preserved in tropical trees. Dendroecology can be applied to generate relevant information from different tropical ecosystems, such as rain forests, dry forests, savannahs or mangroves, but also from anthropogenic ecosystems such as plantations or other economic plants. However, dendroecology is challenging in tropical climates due to the specific tree architecture and wood anatomy, sometimes preventing straightforward approaches that are successfully applied in temperate climate zones. The session will be dedicated to methodological progress in tropical dendroecology and to innovative case studies emphasizing the potential of new fields of application of tree-ring studies in tropical environments.

THU 14:30 KILIMANJARO



## VARIABILITY OF TREE-RING STRUCTURE AND WOOD ANATOMICAL VARIABLES IN TROPICAL TREES

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Trees react with cambial dormancy to unfavourable growth conditions, resulting in differing wood anatomical structures that appear as rings in the cross-section of the trees stem. The anatomical background of the visibility of tree rings will be explained and an overview over the wood anatomy and the variability of tree-ring structures of the stem will be given.

For a deeper understanding of the influence of external growth factors on the wood anatomical structure, samples of many tropical trees were analysed across plant families and a wide climatic gradient. For all samples a unique data set on climate, site and forest stand conditions is available. Different vessel variables as well as the relative cross-sectional area of vessel, parenchyma and fibre tissue were studied in individual tree rings of varying sizes. High within-species and within-site variation of wood anatomical variables was observed which was higher than inter-species and -site variation. In addition, between-ring variation within many individuals was higher than variation between individuals. The differences within individuals show how trees can adapt or adjust to environmental variability and can provide information about the plasticity of a species under changing environmental conditions.

The variable 'vessel diameter' showed the strongest and most significant correlations to other wood anatomical variables, but also to climate parameters and tree morphology. Thereby tree size (DBH & height) and crown exposure to light had the strongest impact on vessel size and consequently on hydraulic stem architecture. General climate conditions only showed a weak influence on vessel variables. The principal component analyses revealed a strong influence of tree morphology and a weaker influence of climate on the hydraulic stem architecture. In contrast the general climatic site conditions strongly influenced fibre and parenchyma tissue.

**Merian award applicant**

THU 14:30 KILIMANJARO

## SEASONAL VARIABILITY OF STEM GROWTH AND WATER USE IN A NEOTROPICAL DRY FOREST

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<sup>3</sup>*Botanical Institute, University of Hohenheim, Hohenheim, DE*

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The dry forests of the Northern Peruvian coastal region is strongly affected by a highly variable precipitation regime characterized by a dry season of up to eight months. At the Game Reserve of El Angolo in northern Peru, we conducted continuous measurements of stem growth and xylem flux density over a three year period on 30 trees of the most common tree species. Four evergreens and 6 deciduous species were included for comparison of contrasting functional plant types. Measurements of microclimate and soil humidity were conducted in parallel. Phenology was observed and general trends taken from literature reports.

Mean radiation load and air temperature were stable all year round and showed little annual variation. Mean vapor pressure difference (VPD) was around 1 kPa, maximum VPD was high and occasionally exceeded 3 kPa. Night VPD typically did not reach zero and fog or condensation were then absent. Night VPD at the end of the dry season may not drop below 0.5 kPa, enough to drive significant transpiration. Soil volumetric water content in 10cm depth saturated after significant rains within 24h, but soil water was depleted within few weeks. The soil within 20cm depth needed one month continuous rainfall to saturate but retained plant available water for several months thereafter.

Surprisingly, daily and seasonal patterns of tree stem growth and xylem flux varied widely and were often decoupled from the usual driving factors such as atmospheric vapor pressure deficit, solar radiation, tree phenology or flowering. Even though most species in the dry forest are deciduous, tree growth is not always reduced during the leafless period. Some species also seem to have extensive root systems for maintaining continuous water extraction. The tree species which dominate the dry forests of El Angolo obviously have a variety of adaptations and strategies to maintain stem growth during the dry season and to cope with the highly variable and seasonal water availability of their habitat.

THU 14:45 KILIMANJARO





## CLIMATIC RECONSTRUCTION WITH DENDROCHRONOLOGICAL METHODS IN A DRY FOREST IN SOUTHERN ECUADOR

Darwin Alexander Pucha Cofrep<sup>1</sup>

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Dendrochronological studies provide important paleoclimatic data in many parts of the world; however dendrochronology in the tropics is still a science in development. So far, little is known about how the climate affects the development of trees in different forest ecosystems. Especially, tree growth-climate relationships in tropical dry forests are hardly studied. Therefore, we combine measurements of individual annual growth rings with the variations of the stable carbon isotope content ( $\delta^{13}\text{C}$ ) to obtain information about how different climatic conditions influence the short-term and the long-term growth rates and the intrinsic water-use efficiency of trees. In this paper, we present the first chronology of *Bursera graveolens* from a dry forest in southern Ecuador and compare tree ecological time series with the El Niño-Southern Oscillation (ENSO) index. Finally, a reconstruction of the variations of humidity conditions during the past decades is carried out based on stable carbon isotope variations in the wood and ring width measurements.

**Merian award applicant**

THU 15:00 KILIMANJARO

## COMBINING RING WIDTH AND STABLE-CARBON ISOTOPES OF TREES IN A TROPICAL LOWER MONTANE FOREST OF SOUTHERN ECUADOR

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In dendrochronology the use of stable-carbon isotopes is established as a complementary tool to reconstruct paleoclimate. In this context studies on stable-carbon isotopes and tree ring width of trees from tropical montane zones are still understudied. Therefore, our study examined annual stable-carbon isotopic pattern, ring width and climate conditions in a neotropical forest. As trees are living organisms they respond to environmental changes, which are revealed in the isotopic composition of the  $\alpha$ -cellulose. Our first results from broadleaved deciduous trees (*Cedrela montana*) demonstrate the potential of  $\delta^{13}\text{C}$  values for climate reconstructions. We detected relations between climate, e. g. relative humidity, site conditions and tree growth. Tropical broadleaved deciduous tree species are able to achieve a stable-carbon isotopic signal in their annual rings under everwet conditions and show a good potential for paleoclimatic research. These results could help to identify and interpret extreme climate events (ENSO).

**Merian award applicant**

THU 15:15 KILIMANJARO



## EXCEPTION AMONG EXCEPTIONS: THE MANGROVE *AVICENNIA*

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THU 15:30 KILIMANJARO

The mangrove *Avicennia*, the only mangrove genus with successive cambia, has the broadest distribution of all mangroves genera. This pattern is repeated at local scale where *Avicennia* trees can grow more landinward and at places with more stressful environmental conditions if compared to other mangroves. This study wants to address the questions: “Why is *Avicennia* able to survive at locations where other mangrove genera are not able to grow?” and “What makes *Avicennia* so well adapted to highly stressful conditions?”. To address these questions, we (i) made a wood anatomical comparison between different mangrove genera and between mangrove genera and their respective closest relatives, and (ii) investigate the three-dimensional structure of *Avicennia*’s water transport system through (micro) CT-scanning. We furthermore analysed the link between successive cambia and stressful environmental conditions through a database analysis, studied *Avicennia*’s special growth using dendrometers and addressed the functionality of the internal phloem by MRI scanning. We can conclude that (i) the water transport system of *Avicennia* is, more than in other mangrove genera, adapted to extreme environmental conditions and that (ii) *Avicennia*’s highly complex three-dimensional structure of xylem and phloem tissue most probably offers advantages in stressful environments as was proven by a clear link between species with successive cambia and dry or salty habitats. Overall, the vessel characteristics, the structure of the transport tissues as well as the special way of radial growth seem to offer *Avicennia* the necessary characteristics to survive in extreme conditions. These insights are of special importance in the understanding of the mangrove ecosystem but also bring understanding in the survival strategies and mechanisms of radial growth of trees in general.

**Merian award applicant**

## ACCELERATED TROPICAL FOREST DYNAMICS: A PAN-TROPICAL TREE RING STUDY

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Permanent plot studies have shown remarkable increases in above ground biomass of intact rainforest stands in Amazonia and tropical Africa. Furthermore several permanent plot studies have found indications of accelerated forest turnover and increased tree recruitment and mortality. Both of these observations have been linked to the effect of climate change and a direct CO<sub>2</sub> fertilization effect. However, several potential biases regarding the permanent plot studies have been put forward, mainly concerning the small number of measurements and the relatively short time scale on which these studies have been carried out: i.e. no more than a few decades. These and other limitations to the study design have made conclusions on the long term trend of increased forest biomass and accelerated forest dynamics a point of dispute. These limitations urgently ask for more high resolution, long-term data on tropical tree growth. The use of tree rings has long been recognized as an adequate and reliable proxy for long term studies on patterns of tropical tree growth and tropical forest dynamics. In the TROFOCLIM project we will use the tree ring approach for our objective to reconstruct pan-tropical forest dynamics. Tree ring data is collected from forests within three different countries: Bolivia, Cameroon and Thailand. Our sampling design allows us to apply spatial modelling of the disturbance history of the forest and we have sampled trees over all size classes in order to compare relative growth and dynamics over time. With these methods we will evaluate the evidence for a long term trend of accelerated tropical forest dynamics over the past 200 years.

THU 16:15 KILIMANJARO



## PERVASIVE CHANGE IN THE NITROGEN CYCLE OF TROPICAL FORESTS

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The widespread changes in tropical forests recorded over the past decades have resulted in an intensive discussion of potential causes and consequences. Tree rings show the effect of increasing atmospheric CO<sub>2</sub> on tree physiology, but can be ambiguous tools when searching for growth trends. Apart from CO<sub>2</sub> it is unclear which other drivers might have had a persistent and large-scale effect on tropical forests. We found consistent changes in nitrogen isotopes in tree rings of forests in Brazil and Thailand and in leaf δ<sup>15</sup>N and nitrogen concentrations in Panama. The interpretation is supported by similar changes in leaf N after a decade of N fertilization in Panama. Pan-tropical nitrogen emissions more than tripled over the past 35 years, the effect of which is seen in high atmospheric NO<sub>2</sub> over many tropical forests, and must have resulted in substantial regional increases in anthropogenic N deposition. This lead to increased N availability and changes in the N cycle of tropical forests, the possible implications of which will be discussed.

THU 16:30 KILIMANJARO

## PAST AND CURRENT FOREST FRAGMENTATION IN THE DEMOCRATIC REPUBLIC OF CONGO: EXPLORING ANCIENT CHARCOAL AS A NATURAL ARCHIVE

Wannes Hubau<sup>1,2</sup>, Jan Van den Bulcke<sup>1</sup>, Joris Van Acker<sup>1</sup>, Hans Beeckman<sup>2</sup>

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Fossil pollen and charcoal fragments are preserved in lake sediments, under forest soils and in ancient human settlements where they can be accompanied by artifacts. As such, vegetation history is remarkably well archived and sometimes closely linked to cultural history. However, direct evidence for Central African vegetation history has been derived only from pollen analysis so far. Although charcoal analysis has proven worthwhile for palaeovegetation reconstructions in temperate regions and South America, the charcoal archive has hardly been consulted for Central Africa. Moreover, a transparent charcoal identification procedure using large databases and well defined characters has never been developed. Yet, charcoal analysis is often spatially and taxonomically more precise than palynology.

Therefore, we present a Central African charcoal identification protocol within an umbrella database of species names and metadata, compiled from an on-line database of wood-anatomical descriptions (InsideWood), the database of the world's largest reference collection of Central African wood specimens (RMCA, Tervuren, Belgium) and inventory and indicator species lists (Hubau et al., In Press).

We applied the protocol on charcoal fragments collected in systematically excavated profiles in the Mayumbe forest (DR Congo). The Mayumbe is a postulated Pleistocene forest refuge area. Indeed, identification results suggest a rather stable primary forest environment in the middle of the Mayumbe forest between 8000 and 200 cal yr BP. However, the charcoal record also seems to suggest the existence of a forest-savanna mosaic pattern closer to the Mayumbe forest boundary during the Holocene Cool period between 2500 and 2000 cal yr BP. Holocene forest regression and fragmentation is thought to be climate-driven. However, human disturbance became increasingly important throughout the Holocene, which might be the reason why the Mayumbe is currently still fragmented and characterized by large patches of savanna and secondary forest.

Reference: Hubau, W., Vandenbulcke, J., Kitin, P., Mees, F., Van Acker, J. & Beeckman, H. (In Press). Charcoal identification in species-rich biomes: a protocol for Central Africa optimised for the Mayumbe forest. Review of Palaeobotany and Palynology.

THU 16:45 KILIMANJARO



## DEFORESTATION IN AMAZONIA AND ITS CONSEQUENCES FOR ECOSYSTEMS AND BIODIVERSITY

Chairs: Erlei Cassiano Keppeler and Beatriz Machado Gomes

Contact: [erleikeppeler@gmail.com](mailto:erleikeppeler@gmail.com)

The Amazon in the wider sense is an area of freshwaters and forests, covering approximately 8 million km<sup>2</sup>. It involves various countries, including Brazil, Bolivia, Peru, Ecuador, Colombia, Venezuela, Surinam and Dutch and French Guyana, called equally Legal Amazonia. In contrast, the ecological region of the 'Real' Amazon corresponds to approximately 5 million km<sup>2</sup> in total. Revisions of the numbers of species for the latter area are estimate 1000 species of birds, 300 species of mammals, 550 species of reptiles, 200 species of amphibians, 250,000 species of insects, 20,000 of species of flora, 3,000 species of fishes, 300 species of zooplankton and 500 species of algae. These data underline that the biodiversity of the Amazon forest and freshwater region is the richest of the world. The deforestation and the expansion of agriculture are factors that determine the occupation and land use in the region in the recent decades. This represented, beyond of the degradation, more an opportunity to develop more species occupying new niches, such for example by forest clearing. Size, shape, insulation, type of neighborhood and history of disturbances have relationships with biological phenomena, and consequently affect the dynamics of forest fragments. The session will address aspects of species biodiversity of Amazonia and its relations with environmental factors and effects of the forest fragmentation on terrestrial and aquatic biodiversity.

## AMAZONIAN ECOSYSTEM DEGRADATION FROM DEFORESTATION, FIRE AND CLIMATE CHANGE

Anja Rammig<sup>1</sup>, Fanny Langerwisch<sup>1</sup>, Kirsten Thonicke<sup>1</sup>, Wolfgang Cramer<sup>1,2</sup>

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FR*

Ecosystems in Amazonia face a variety of threats ranging from immediate to more long-term pressures. At present, agricultural expansion through deforestation and the introduction of fire is the major cause of habitat loss for Amazonian plant and animal species. However, over longer timeframes, forest- and freshwater-ecosystems in Amazonia will be confronted with large-scale fragmentation from ongoing deforestation, fire and climate change. Here, we apply the dynamic vegetation model LPJmL-SPITFIRE in combination with climate projections from the IPCC Fourth Assessment Report (AR4) and deforestation projections from Sim Amazonia to estimate potential impacts on Amazonian ecosystems. We show that with business-as-usual deforestation rates, up to 70% of Amazon forests may be degraded already until 2050. Fires escaping from deforested areas into the neighbouring forests may add up to 12% of forest degradation. By the end of the 21<sup>st</sup> century, approximately 90% of original rainforest habitats may be lost due to more frequent fire incidence, increasing temperatures and drought stress. Changes in temperature and precipitation also lead to strong changes in inundation patterns of freshwater ecosystems. Longer inundation periods are likely to occur in the western basin, while a shortening of inundation length are projected for the eastern and south-eastern basin. This will have consequences on habitats for plant and animal species. In combination with changes in riverine carbon cycling many species might experience habitat loss or reduced food supply. While the northwest basin experiences mainly changes triggered only by climate change, the southeast basin experiences changes triggered by climate change combined with land use change. The increase (1.2 fold) in transported organic material caused by climate change is overcompensated by deforestation (0.8 fold) here. Such changes in Amazonian forest- and freshwater-ecosystems will have severe consequences for habitat and food supply of animal and plant species.

THU 16:15 GALAPAGOS





## LONG-TERM DYNAMICS OF AMAZONIAN ECOSYSTEMS AND THE EFFECTS OF DISTURBANCE DRIVEN BY CLIMATE, SEA-LEVEL, FIRE AND HUMAN IMPACT

Hermann Behling<sup>1</sup>

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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. Palaeo-ecological studies based on pollen analysis in different ecosystems of Amazonia and neighbouring regions provide insight on long-term vegetation and biodiversity dynamics and the response to environmental change.

THU 16:30 GALAPAGOS



**Keynote speaker: Prof. Dr. Matthias Wolff**

## **GALAPAGOS- HERAUSFORDERUNGEN FÜR DEN SCHUTZ DIESES NATURERBES**

Matthias Wolff<sup>1</sup>

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Das Galapagos Archipel, UNESCO Weltnaturerbe seit 1978, öffnet sich zunehmend dem globalen Markt und dem kontinentalen Ekuador, wodurch die Prozesse der Habitatzerstörung, Verschmutzung und Verlust an Biodiversität-im Wesentlichen durch eingeschleppte Arten, einschließlich Krankheiten wie Vogelmalaria oder Denguefieber- beschleunigt werden. Es scheint, dass technologische Lösungen zur Verringerung des ökologischen Fußabdruckes auf den Inseln (wie das Wegschiffen von Müll oder ein verbessertes Quarantänesystem) diesen Degradationsprozess verlangsamen aber nicht werden aufhalten werden können. Im Vortrag wird ein Überblick über das derzeitige Sozio-Ökosystem Galapagos gegeben, es wird die natürliche Einzigartigkeit des Archipels beschrieben, und es wird auf die wichtige Rolle der Wissenschaft für den Naturschutz von Galapagos eingegangen. Darüberhinaus werden Ansätze skizziert, die helfen können, die negativen Auswirkungen der Kontinentalisierung und des Tourismus auf das Archipel abzdämpfen.

Summary:

Galapagos, a UNESCO natural world heritage site since 1978, is increasingly opening to the global market and to mainland Ecuador, thereby accelerating the process of habitat degradation, contamination, and biodiversity loss mainly through the introduction of invasive species including diseases, such as Avian Malaria and Dengue Fever. It seems, however, that technological solutions for reducing the local ecological footprint (such as shipping wastes away and improving quarantine systems) will allow to slow down, but not to impede, the degradation process. This talk gives an overview of the present Galapagos Socio-ecosystem, describes the natural uniqueness of the archipelago, emphasizes the role of science during the past 50 years for the conservation of Galapagos and discusses possible approaches to mitigate the effect of increased continentalization and tourism for the archipelago.

**Keynote speaker: Dr. Ingrid Parmentier**

## **ORGANIZATION OF PLANT DIVERSITY IN TROPICAL AFRICA: SPATIAL PATTERNS AND CAUSALITY**

Ingrid Parmentier<sup>1</sup>, Olivier J. Hardy<sup>1</sup>

<sup>1</sup>*Université Libre de Bruxelles, Brussels, BE*

The origin of geographic patterns of plant diversity is much debated. Are these patterns mainly determined by ecological gradients (deterministic processes) or are they resulting from stochastic processes and the influence of historic events? We will present insights into this question using two models in African rain forests: rain forest trees and inselberg vegetation.

We assembled a large number of forest tree inventories from West and Central Africa to test the hypothesis that maximal tree alpha diversity is linearly limited by the dry season length, as previously hypothesized for Amazonia. We concluded that it does not apply to African rain forests. We did however observed tree alpha diversity patterns in African rain forest and we tested the hypothesis of climatic determinism with more sophisticated models. We demonstrated that it was not possible to establish causal relationships because of the strong spatial autocorrelation observed both in the climatic data and in the diversity data.

With the inselberg model, we developed an original method based on the analysis of the phylogenetic structure of plant communities to sort out the influence of stochastic and deterministic processes on plant assemblages. Inselbergs are rock outcrops that combine strong ecological gradients at the local scale, and insular properties at the regional scale. In a rain forest landscape, they can be considered "habitat islands". We showed that floristic similarity between inselberg vegetation plots depended on both microhabitat differentiation and on spatial distance, while phylogenetic clustering (i.e. excess of phylogenetic similarity between species from a same plot) only appeared between plots from differentiated microhabitats, and increased with ecological distance. Assuming that traits tend to be phylogenetically conserved (i. e. adaptations to ecological conditions), the absence of phylogenetic structure between inselbergs within the same micro-habitat indicates that species turnover is probably due to dispersal limitation (stochastic factor) rather than to regional-scale variations in environmental factors. Similar ecological niches are occupied by different species according to the geographical location, which has strong implications for biodiversity conservation.



**TROPICAL ANIMAL ECOLOGY**

Chair: Simone Sommer

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FRI 09:15 GALAPAGOS

## EUGLOSSINE DIVERSITY PATTERNS ALONG A LATITUDINAL GRADIENT

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Euglossine bees are an important pollinator group in the Neotropics. About 600 to 700 orchid species are exclusively dependent on the pollination of male orchid bees. We analysed 16 orchid bee assemblages along a latitudinal gradient of 18° from Amazonian Peru to subtropical Bolivia. Orchid bee diversity decreased towards the subtropics and was related to different climatic factors. Parallel to species diversity, phylogenetic diversity decreased towards the subtropics. Therefore, in the two most southern sites the species poor assemblages mainly consisted of generalistic, phylogenetically rather young species. This may indicate that these regions have been colonized rather recently.

**Merian award applicant**

FRI 09:15 GALAPAGOS



## HOW NECTAR-FEEDING BATS FIND FOOD: ROLE OF ECHOLOCATION OF LEPTONYCTERIS YERBABUENAE DURING FORAGING AT CACTUS FLOWERS

Tania P. Gonzalez-Terrazas<sup>1</sup>, Jens Koblitz<sup>2</sup>, Marco Tschapka<sup>1</sup>, Theodore H. Fleming<sup>3</sup>, Rodrigo A. Medellín<sup>4</sup>, Elisabeth K. V. Kalko<sup>1</sup>

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How nectar-feeding bats detect, recognize and localize flowers is still only poorly understood. As flowers are motionless and do not actively produce sound, bats are likely to use primarily olfactory (and sometimes visual) cues but they may potentially also use echolocation to find new sources of nectar. While diffuse scent cues allow no precise localization of a target, the spatial properties of echo-acoustic cues are very precise and could play a major role, particularly at close range. In order to better understand the role of echolocation for detection, identification and localization of flowers, we conducted behavioral experiments with the nectar-feeding bat *Leptonycteris yerbabuenae* (Phyllostomidae: Glossophaginae) while exposed to objects with different acoustic properties. We compared bat behaviour at the flower of a columnar cacti, *Pachycereus pringlei*, to that at an acrylic hollow hemisphere (10 cm diameter) that is acoustically conspicuous to bats, but, in contrast to the cactus flower, does not present any scent. For recording foraging behaviour we used two infrared video cameras under stroboscopic illumination synchronized with ultrasound recordings, which allowed us a spatial reconstruction of the flight path synchronized with the echolocation behaviour. Bats showed a stereotypic behavior when visiting the cactus flower and a more variable trajectory while approaching the hemisphere. All individuals approached both targets but visited only the cactus flower; none of the bats made the attempt to insert the snout inside the hemisphere. Bats emitted continuously single, short, multi-harmonic, and frequency-modulated (FM) echolocation calls during orientation flight. Upon closing in on the target bats changed to typical approach behaviour, characterized by the emission of call groups with a rising number of pulses of decreasing duration. The main behavioural difference between the targets consisted in the number of calls in the last group, emitted before the bat visited or flew away: While this group contained 10 - 20 calls at the cactus flower, bats broadcasted only 2-4 calls at the hemisphere. This difference depends most likely on the acoustic characteristics of the targets. Based on these results we argue that specific echo-acoustic characteristics of flowers are crucial for *L. yerbabuenae* for detection, localization and identification of flowers.

**Merian award applicant**

## SEX-BIASED DISPERSAL AND PATERNITY PATTERNS IN THE NEOTROPICAL PROBOSCIS BAT, *RHYNCHONYCTERIS NASO* (EMBALLONURIDAE)

Linus Günther<sup>1</sup>, Martina Nagy<sup>1</sup>, Mirjam Knörnschild<sup>2</sup>, Frieder Mayer<sup>1</sup>

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Although bats form the second largest mammalian order, the mating system of only 7% of all known bat species has been studied so far. Polygyny appears to dominate group-living bats, while female defence supposedly leads to male-biased dispersal. Several selective pressures favour natal dispersal: avoidance of inbreeding, local mate and resource competition. Philopatry is favoured because of the mortality risk caused by dispersal, the benefits of familiarity with the natal area, and kin cooperation. However, the way these forces shape dispersal patterns is still discussed controversially. Showing a high diversity in mating systems and social organisations the Emballonurids represent an excellent model system to study the evolutionary causes of different reproductive strategies.

In our study we focus on dispersal and mating behaviour of the Neotropical proboscis bat in a Caribbean lowland rainforest in Costa Rica. Proboscis bats form year-round stable colonies of 5 to 45 individuals with sex-ratios of nearly 1:1. By combining long-term observations with microsatellite analysis of 10 highly polymorphic loci, we examined dispersal behaviour and paternity patterns in three colonies: Contrary to former studies based on field observations we found that dispersal is female-biased. In several cases the tenure duration of male adults in a colony exceeds the period until the onset of sexual maturity of females. Thus, our results suggest that female natal dispersal has evolved to avoid father-daughter inbreeding. Although paternity of a number of offspring remained unsolved or was attributed to extra-colony males, most offspring were sired by colony males. From a male perspective our results suggest that advantages of male natal philopatry and a long tenure counterveil the pressure of local mate competition with their relatives.

**Merian award applicant**

FRI 09:45 GALAPAGOS





## DIVERSITY AND DISTRIBUTION OF BATS IN BOLIVIA UNDER CLIMATIC AND BIOGEOGRAPHIC ASPECTS

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<sup>2</sup>*Biodiversity and Climate Research Centre (BiK-F), Frankfurt am Main, DE*

Bats are the second-largest group of mammals in the world and have their widest range of distribution in tropical regions, but many aspects of these animals have not been well-studied, especially in the Neotropics. This study focuses on the diversity and distribution of bat species within the eastern lowlands of Bolivia. As a climatic transition zone between humid Amazon habitats and the dry Chaco, the studied region of the lowlands is a mosaic of different vegetation forms. Dominated by the endemic Chiquitano dry forest, other elements are Cerrado savannahs, forests influenced by Amazonian climate and anthropogenic areas like cattle farms. Three geographically different sites were selected, all characterized by comparable composition of habitats. For each site bat species assembly and abundance in different habitats were recorded and compared to reveal possible differences in the population structures within this transition zone. DNA-barcoding, morphological data and ultrasonic recordings provide a first assessment of different bat populations in this still much understudied region. In the course of this study widely distributed generalist species were registered, as well as some rare specialists. On this base, the Bolivian bats were then compared to other Neotropical bat populations genetically as well as ecologically.

## SELECTIVE EAVESDROPPING BEHAVIOUR IN THREE NEOTROPICAL BAT SPECIES

Kirstin Übernickel<sup>1</sup>, Marco Tschapka<sup>1</sup>, Elisabeth K.V. Kalko<sup>1,2</sup>

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Only little information is available for mammals on inter-species information transfer using public information. We asked whether eavesdropping on echolocation calls of bats may be advantageously used by sympatric bats with overlapping feeding ecology. Acoustic playback trials consisted of six sequences: search phase calls and terminal feeding buzzes emitted by conspecifics, a heterospecific of the same family, and a heterospecific of a different family.

Both *Noctilio leporinus* and *Noctilio albiventris* (Noctilionidae) reacted towards specific playbacks with repeated approaches towards the playback speaker. In contrast, *Saccopteryx bilineata* (Emballonuridae) did not react to any playback sequences presented.

We suggest that inter-individual information transfer via eavesdropping on public information may depend mainly on species-specific traits, including foraging and social behavior (territoriality, group foraging), and also on distribution and density of prey.

**Merian award applicant**



## EFFECTS OF FRAGMENTATION ON ECOSYSTEM FUNCTIONING AND SERVICES OF BIODIVERSITY HOTSPOT ISLANDS IN TROPICAL HIGH MOUNTAINS

Chairs: Jörg Bendix, Erwin Beck

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Spatial fragmentation is a major issue in tropical mountain ecosystems. Due to the complex topography and its influence on the environmental conditions (climate, soils etc.), the landscape is naturally fragmented into different ecological niches which may foster a high diversity of species, functional links and ecosystem services. At the same time, tropical mountain ecosystems are rapidly changed by anthropogenic fragmentation, mainly due to the conversion of natural vegetation (e.g. mountain forest) to inset islands of arable land and pastures, with hitherto unknown consequences. To develop sustainable management strategies on a scientific basis that adequately balance the effects of natural (mostly positive) and anthropogenic (mostly negative) fragmentation effects, sound knowledge on the relations between biodiversity and ecosystem functioning/services is needed. Particularly challenging in tropical mountain hotspots is to find suitable and sensitive indicator systems which can be used in comprehensive monitoring approaches as surveillance and/or alarm systems for critical effects of fragmentation on biodiversity and ecosystem services. For the proposed session we invite particularly papers dealing with all kinds of fragmentation effects on biodiversity and ecosystem functioning/services (past, present and future) which help to deepen our understanding on tropical mountain hotspot islands, the successful application of suitable indicator and monitoring systems, to unveil fragmentation effects on trophic networks and/or on interactions between the abiotic, biotic and anthropogenic spheres, particularly related to specific ecosystem services, experimental approaches to develop and calibrate suitable indicator systems, or to find representative indicator species for surveillance/alarm monitoring systems.

FRI 09:15 KILIMANJARO

## FRAGMENTATION OF A MEGADIVERSE MOUNTAIN FOREST ECOSYSTEM IN SOUTHERN ECUADOR AND ITS CONSEQUENCES

Joerg Bendix<sup>1</sup>

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Spatial fragmentation e.g. due to the complex topography or dynamic processes as natural landslides is a disposition of tropical high mountain areas. Among other factors, the resulting diversity of niche conditions can contribute to a high biodiversity in these areas. It is recently under discussion if this high diversity of niche conditions in the natural system even could mitigate the expected impacts of global climate change e.g. on species composition and related ecosystem functions/services. However, at the same time, biodiversity as well as ecosystem functioning and services of most tropical mountain ecosystems are threatened by anthropogenic fragmentation. In the absence of protection and conservation measures, human activity mainly generates islands of forest remnants, embedded in patches of arable land and pasture areas, with hitherto unknown consequences for biodiversity and ecosystem services. The presentation will give an overview about natural and anthropogenic fragmentation and fragmentation processes in an Andean hot-spot area of southern Ecuador around the San Francisco Valley in the provinces of Loja and Zamora-Chinchiipe. Selected impacts of fragmentation on biodiversity and ecosystem functioning/services will be discussed.

FRI 09:15 KILIMANJARO



## THE RIDDLE OF THE SEASONS

Rütger Rollenbeck<sup>1</sup>

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Precipitation in the South of Ecuador is a very complex phenomenon. At the same time it is the most heterogeneous climate factor influencing ecology, geodynamics, biodiversity and human impact on these systems. Precipitation shows a unique seasonal behaviour for the eastern and western escarpment of the Andes and its amount, intensity and daily cycle varies even from valley to valley.

A sophisticated instrumental setup was implemented, consisting of a horizontal scanning weather radar, a vertical rain profiler, a network of rainfall- and fog-collectors and Present weather sensors, to register microphysical characteristics of precipitation. This ground based setup was complemented by satellite cloud observations and regional climate models.

The main results are high-resolution maps of precipitation distribution on a small time step (1 hour). Synthesising these data with satellite observations and the modeling approach enabled the identification of the most important precipitation generation mechanisms in the region. A much more realistic map of the annual totals of precipitation could be produced.

This seasonal behaviour is coupled to specific precipitation types. While the long-time assumption was, that the higher mountain regions receive advective rain and convective showers are restricted to mountain basins and the lowlands, the patterns observed in this study reveal a much more complex interaction of climatological and topographical features:

- During the rainy season of the eastern escarpment the whole region is dominated by advective events driven by the strong tropical easterlies blowing with great uniformity from NE to SE.

- In the shorter dry season from September to December, the whole region shows a much more „tropical“ behaviour.

Precipitation formation is apparently governed by two main features of the region. The topographic pattern of the mountain ridges induce a strong east-west gradient. The temporal patterns are modified by the annual displacement of the intertropical convergence zone, perpendicular to the east-west gradient. Hence, the region of Loja represents an important mixing zone between amazonian and pacific ecosystem influences. This climatological patterns induce a heterogeneous spatial structure, which contribute to the high geo- and biodiversity of the region.

## UNCERTAINTY IN SOIL REGIONALISATION AND ITS INFLUENCE ON SLOPE STABILITY ESTIMATION

Mareike Ließ<sup>1</sup>, Bernd Huwe<sup>1</sup>

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Soil slides are a common phenomenon on the steep slopes of the investigation area in the Andes of southern Ecuador. Regionalised soil information is used to predict slope failure risk by calculating the soil shear ratio on a potential sliding surface. A sensitivity analysis was performed to investigate whether the uncertainty of these digital soil maps causes an uncertainty in the factor of safety (FS) prediction. However, soil map uncertainty can be overcome by hundredfold Random Forest prediction based on Jackknife data subsets in order to identify failure sites with high prediction accuracy ( $\geq 99\%$ ). Small erosion caused depressions which lead to a high soil wetness, probably induce a positive feedback mechanism in causing landslides which again lead to further water accumulation in their gullies and consecutive high landslide risk in these slope positions.

**Merian award applicant**



## BIOGEOCHEMICAL RESPONSES TO INCREASING N DEPOSITION IN A TROPICAL MOUNTAIN FOREST IN SOUTHERN ECUADOR

Andre Velescu<sup>1</sup>, Carlos Valarezo<sup>2</sup>, Wolfgang Wilcke<sup>1</sup>

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The Andean tropical mountain forest is affected by climate-driven acid and base depositions (Da Rocha et al., 2005; Boy and Wilcke, 2008; Boy et al. 2008) and will experience an increasing N input in the future (Galloway et al. 2004).

To explore the response of the forest to low-level nutrient input, an interdisciplinary nutrient manipulation experiment (NUMEX) was established on the eastern cordillera of the Andes at 2000 m a.s.l. in the area of the Reserva Biológica San Francisco. Since 2008 we have continuously applied 50 kg ha<sup>-1</sup> a<sup>-1</sup> of N, 10 kg ha<sup>-1</sup> a<sup>-1</sup> of P, 50 kg + 10 kg ha<sup>-1</sup> a<sup>-1</sup> of N and P and 10 kg ha<sup>-1</sup> a<sup>-1</sup> of Ca in a randomized block design to simulate increased deposition. All study plots are equipped with litterfall and throughfall collectors, litter lysimeters, suction cups at 0.15 and 0.3 m soil depth and FDR sensors.

We observed a rapid response of the ecosystem to these low-level nutrient additions, such as decreased retention of nutrients deposited from the atmosphere in the canopy, increased nutrient fluxes with litterfall and an almost quantitative retention of the applied nutrients in soil. Furthermore, our data indicate decreasing TOC and DON concentrations in soil solution and increasing TOC/DON-ratios in response to the N additions. These responses are similar to those in an adjacent undisturbed forest site, where the same trend of decreasing TOC and increasing TOC/DON ratios were observed in response to increasing N deposition in the last decade. We hypothesize that the N addition accelerates the degradation, particularly of the polar fraction of dissolved organic matter in soil solution, resulting in enhanced C release to the atmosphere.

An opportunity to detect the fate of added N and further elucidate the processes behind our observations is the joint 15N pulse-chasing experiment, which is planned in 2012. Because the applied isotope label will be incorporated into the N cycle, budgeting all main N fluxes and pools is a promising approach to elucidate the fate of the label (Lehmann et al. 2004). Such a comprehensive approach will also overcome problems associated with experiments focusing on selected ecosystem compartments where frequently unaccounted losses of the label occur (Dinkelmeier et al. 2003, Silver et al. 2005). NUMEX will furthermore serve to validate simulations of the impact of changed deposition rates on nutrient cycles in the mountain forest ecosystem.

## REFUGIA FOR COLD-ADAPTED SPECIES IN THE HIGHLY FRAGMENTED SUBNIVAL-NIVAL HABITATS OF IRAN

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Iran is a mountainous country in Southwest Asia. The subnival to nival vegetation zones are found at elevations above 3600-3900 m in a highly fragmented distribution across Alborz, Zagros and NW-Iran. These cold habitats are isolated islands of highly limited area size, surrounded by extensive lower-elevation mountain areas. From 152 vascular plant species which are living within the subnival and nival zones, 52 species are restricted to these elevations and known as true subnival-nival species. The rate of the endemism is very high for this flora, where c. 70% of species are restricted to Iran, and most of them are narrowly distributed endemics. In contrast, the degree of endemism of subnival-alpine and of subnival-subalpine species, with 53% and 20%, respectively, is considerably smaller.

The outstanding rate of high-altitude endemism appears to result mainly from orographic isolation of the country's highly scattered cold areas and by the absence of extensive Pleistocene glaciations. Most of the widespread species of Iran's subnival-nival flora now have highly disjunct distribution over the Iran to Himalaya-Central Asia and/or Europe, where the high elevation patches of Iran remained since the Pleistocene as refugia for cold-adapted taxa.

The distribution ranges of all 152 species show 10 different distribution patterns: 1) Holarctic, 2) Irano-Turanian to Euro-Siberian, 3) Hindu Kush-Himalaya and Central Asian elements with disjunct distribution in Iran, 4) Iran to Caucasus and/or Anatolia, 5) Iran to Caucasus and E Anatolia, 6) distribution across the Atropatenean region, 7) Alborz and Zagros, 8) Alborz endemics, 9) Zagros endemics, 10) NW-Iran endemics.

Only three highest mountain peaks of Iran currently exceed the elevational limits of vascular plant life, and the predicted climate warming may seriously threaten the survival of the unique subnival-nival flora of Iran, due to the very low potential of alternative low-temperature habitats at higher elevations.

**Merian award applicant**

FRI 10:15 KILIMANJARO





## RELATIONSHIP BETWEEN LANDSLIDES, LANDSCAPE EVOLUTION AND VEGETATION UNDER HUMAN PRESSURE IN THE TROPICAL ANDES

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Landslides contribute to species richness through the creation of microhabitats, i.e. spatial fragmentation. This holds true especially for the biodiversity hotspot island Reserva Biológica San Francisco (RBSF) located on the eastern slope of the Andes in Southern Ecuador. The objective of this study was 1) to spatially predict landslide susceptibility and thus areas of potential high biodiversity on the perhumid slope (study area RBSF) and additionally on the deforested, semi-arid slope (study area Masanamaca) of the South Ecuadorian Andes, 2) to quantify material eroded by landslides in both study areas and 3) to discern the relationship between vegetation and landslides under natural conditions and human pressure. Generalized Additive Models (GAM) with topographic variables as predictors were used to model landslide susceptibility. We measured material eroded by shallow landslides in the form of the landslide mobilization rate, i.e. the lowering rate vertical to the surface. Among the examined covariates, slope and local catchment area showed the closest relation to landslide initiation. LMRs ranged between 0.4 and 4 mm yr<sup>-1</sup> in the semi-arid study area. Along the road the LMR reached 5 mm yr<sup>-1</sup> in the RBSF area and 2 mm yr<sup>-1</sup> in its natural part. Here, vegetation overload might contribute to landslide initiation followed by vegetation succession. A fast „mosaic cycle“ of the mountain rainforest ecosystem begins on the bare landslide-affected ground. By contrast, succession in the semi-arid area remains in premature stages mainly due to human activity such as grazing and fire. Consequently, landslide activity supports badland development and decreasing species numbers in the semi-arid area, whereas it further boosts the outstanding biodiversity in the natural RBSF area. The results provide a basis for the spatially differentiated assessment of landscape evolution and degradation in an area with a close relation between landslide activity, natural vegetation succession and human land use.

## WHAT ENABLES COEXISTENCE IN FOREST COMMUNITIES? - THE ROLE OF SPECIES TRAITS AND BUFFER MECHANISMS

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Many tropical forest ecosystems display exceptional (tree) species diversity. The question of species coexistence has been challenging ecological research for decades. There exist numerous approaches to explain coexistence of species, e.g. niche theory, neutral theory or the Intermediate Disturbance Hypothesis. Each of these theories has also been discussed in relation with diversity in forest ecosystems.

We study competition within a tree community consisting of different functional types and focus on the outcome of competition over a fixed time period. We employ a simplified forest simulation model to analyze the influence of interspecific tradeoffs in life-history traits and buffer mechanisms like density dependent mortality on coexistence.

We find that the considered tradeoffs produce only narrow coexistence ranges. Only the addition of further stabilizing buffer mechanisms leads to enhanced coexistence. This suggests that buffer mechanisms are an indispensable ingredient for coexistence in forest communities.

**Merian award applicant**



## ARBUSCULAR MYCORRHIZAE IN A TROPICAL MONTANE RAIN FOREST IN SOUTH ECUADOR

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Interactions of species are key components of biodiversity and the backbone of key ecosystem services. Knowledge of these biotic interactions is essential to improve our understanding of how nature works. Arbuscular mycorrhiza – mutualistic interactions between plants and glomeromycotan fungi – is the dominant mycorrhizal type in a tropical montane forest in South Ecuador. Rate of mycorrhization as evaluated by microscopy was found consistently high. The involved fungi were investigated with molecular methods in the pristine forest and in reforestation plots. We found an unexpected richness of arbuscular mycorrhizal fungi. Specific pairwise plant-mycobiont interactions were absent. Each plant species was associated with several mycobionts. The structure of the plant-fungus interactions was studied with a network approach.

## EFFECT OF TOPOGRAPHY AND ALTITUDE ON DECOMPOSITION AND MICROARTHROPOD COLONIZATION OF LEAF LITTER IN A TROPICAL MONTANE RAIN FOREST

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The effect of altitude and small scale topography on the density and species composition of soil microarthropods and decomposition processes in a tropical montane rain forest was investigated. Leaf litter from *Graffenrieda emarginata* was collected and placed in litterbags in the field on three topographical positions (lower-, midslope, and ridge) at three altitudes (1000, 2000, 3000m). After 12 months the litterbags were collected and colonisation by microarthropods and remaining dry mass were determined.

Decomposition processes decreased with increasing altitude but were not affected by topography indicating that decomposition processes mainly depend on large scale abiotic factors rather than on litter quality.

The density of microarthropods did not uniformly decline with altitude, but the different taxa varied in their distribution pattern indicating that they respond differentially to altitude. At 3000 m more temperate oribatid mite species occurred, probably due to better adaption to lower temperatures.

The effect of topography was less pronounced than that of altitude and the topographical influence on soil invertebrates decreased with increasing altitude, e.g. the difference in oribatid mite species composition between the topographical positions at 3000 m was smaller than at 2000 and 1000 m. In general there was a trend of higher microarthropod densities at lower slopes indicating favorable conditions.

**Merian award applicant**



## TYPES OF ANTHROPOGENIC DISTURBANCES AND THEIR IMPACT ON PLANT SPECIES RICHNESS WITHIN A HOTSPOT OF BIODIVERSITY IN SOUTH ECUADOR

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According to Barthlott et al (2007) the tropical mountain rainforest of the Andes in South Ecuador constitutes a hotspot of biodiversity with an extraordinary high number of plant species. In the same area deforestation and forest fragmentation ratio is known to be very high. While small scale disturbances and the majority of natural disturbances have proven to have mainly positive effects on biodiversity (e.g. *gap* and *intermediate disturbance hypothesis*), land use systems and forest fragmentation by pathways and road construction are causing a strong shift in plant community assemblies.

This study aims to characterize the different types of anthropogenic disturbances fragmenting this high diverse ecosystem. For this purpose the anthropogenic disturbances are divided in areal and linear impacts. While former are composed of different pasture types, burned areas and afforestation with the exotic pine species *Pinus patula*, the latter includes linear effects along pathways and roads as well as the thereby caused landslides and embankments. Vegetation composition on these disturbed areas was investigated and the direct impact on the surrounding natural forest was studied by a transect method based on the MIREN Survey Protocol (2006).

Areal anthropogenic usage causes a high impact on the natural ecosystem which is clearly shown by a different vegetation composition and the lack of a vast majority of rainforest species. Only 14.5% of the natural forest species can be found on anthropogenic used sites. Linear disturbances serve as floristic corridors but the invasion of the adventitious flora into the surrounding high diverse flora is very low. Just a few alien plants were recorded and none of them is acting invasive. However, the cosmopolitan bracken fern *Pteridium arachnoideum* (Kaulf.) Maxon acts as an aggressive invasive species especially on burned areas.

**Merian award applicant**

## ECOLOGICAL ASPECTS OF REPASTURISATION OF ABANDONED MOUNTAIN PASTURES IN SOUTH ECUADOR

Erwin Beck<sup>1</sup>, Kristin Roos<sup>1</sup>, Ute Hamer<sup>2</sup>, Karin Potthast<sup>2</sup>, Alexander Tischer<sup>2</sup>, Brenner Silva<sup>3</sup>, Jörg Bendix<sup>3</sup>

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Fragmentation of native forests for pasture and cropland is still going on in the tropical Andes while vast agricultural areas are at the same time disused because they are heavily overgrown by highly competitive weeds. In the research area in South Ecuador almost 40% of the potential pastures are infested with bracken (*Pteridium* spp.) and many of them have been abandoned. The paper presents an experiment extending over several years to reconvert such areas into useful mountain pastures. In a first step several methods of combatting bracken were examined. Regular cutting of the fronds or treatment with a locally available herbicide proved most effective. However, due to its persistent rhizomes in various soil depths, only weakening of the weed could be achieved, but not eradication. After control of bracken the locally common pasture grass *Setaria sphacelata* was planted and its growth as well as regrowth of bracken was monitored monthly. *Setaria* as a C4-grass should be able to outcompete the C3-plant bracken, which on the other hand is slightly favoured by the climate. However, the extremely poor soils of the abandoned pastures prevent the complete suppression of the fern by *Setaria*. Compared to active pastures, the soils are more acid and extremely low in N and P. Accordingly low are also the nutrient contents of the roots and leaves of the grass, and of the rhizomes and fronds of the fern. Fertilization benefits growth of the grass more than that of bracken, which on the other side benefits from removal of grass biomass by (simulated) grazing. Following the described protocol, repasturisation requires about 2.5 years until the pastures can be used. Applying a balanced management of fertilization and grazing can lead into a sustainable reutilization of the abandoned areas and thus alleviate the pressure on the natural forests.

FRI 14:30 KILIMANJARO



## SPECIES COMPOSITION AND GENETIC DIVERSITY OF TROPICAL BRACKEN INVADING MONTANE PASTURES IN SOUTHERN ECUADOR

Kristin Roos<sup>1</sup>, Marianne Montero<sup>2</sup>, Ximena Cevallos<sup>3</sup>, Alfons Weig<sup>3</sup>, Erwin Beck<sup>1</sup>

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Growing land scarcity due to population increase promotes the conversion of natural ecosystems into areas for food and energy production, especially in the tropics. On the other hand, high proportions of degraded land are present. In the research area in the south-eastern Andes of Ecuador about 40% of the potential pastureland has been abandoned because of infestation by bracken (*Pteridium* spp.). This rhizomatous plant is one of the most aggressive weeds worldwide especially where fire is used for forest clearing or in agriculture. Taxonomically, it represents a complex that is grouped into a northern, temperate, and a southern, tropical clade. In the research area, two species of the southern bracken complex, *P. arachnoideum* and *P. caudatum*, co-occur.

We analysed the bracken species composition on active and abandoned pastures at 7 altitudinal levels between 1,000 and 3,000 m. The 2 species could be differentiated using morphological and molecular characters. Depending on the altitudinal and climate conditions, the shares of the two species in the bracken cover changed: *P. caudatum* preferred the lower altitudes, where *P. arachnoideum* was hardly found. The opposite was observed in the upper regions. At 1800 m an extensive study of the composition of the bracken population was performed using microsatellite markers. As bracken propagates readily via rhizome branching and disaggregation, a high degree of homogeneity of the ramets was expected. However, the percentage of identical ramets of both species was very low, as were distances at which genetically identical samples were found. Maximum extension of a genet (consisting of several ramets) was less than 100 m which contrasts with findings of northern bracken species. The high diversity was attributed to a high frequency of bushfires whose heat could stimulate sexual reproduction. After such fire fast colonization of the bare soil by bracken was observed. The entire developmental cycle from spore formation until ample growth of young sporophytes required less than 2 months. In addition, regrowth of bracken fronds from rhizomes was also stimulated by the heat pulse from such fires.

**Merian award applicant**

## USE OF ENVIRONMENTAL IMPACT ASSESSMENT TOOLS TO OPTIMIZE CONSERVATION STRATEGIES OF THE THREATENED ENDEMIC FLORA OF PANTEPUI (SE VENEZUELA)

Elisabet Safont<sup>1,2</sup>, Teresa Vegas-Vilarrúbia<sup>1</sup>, Valentí Rull<sup>2</sup>

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Pantepui is a biogeographical province composed of a group of approximately 50 tabular mountain summits, or *tepui*s, in the southeast of Venezuela. This region lies between 1 500 and 3 014 m a.s.l. and has an approximate extension of 6 000 km<sup>2</sup>. The summits of the tepuis are characterized by exceptional vascular plant diversity and high endemism. However, it is expected that ongoing global warming will produce upward displacements of summit taxa, which may cause the extinction of certain species due to habitat loss. This study assessed the potential extinction risk of the >600 Pantepui endemic vascular plant species during the 21<sup>st</sup> century due to global warming, revealing that 30-50% of endemic species would lose their habitat by the end of this century. In light of these results, prioritization of threatened species for conservation purposes became necessary. This was achieved through the calculation of an environmental impact value for each species, and a subsequent division of these species into priority categories, which should be used in a chronological sequence to guide decision-making and future research aimed at establishing the most suitable conservation strategies. A number of in situ and ex situ conservation alternatives were discussed. In situ conservation by means of designating protected areas does not appear a viable option because of the upward habitat displacement involved in this case. Conversely, seed banks, living plant collections and managed relocation were suggested in this chronological order to preserve the species studied here.

**Merian award applicant**

FRI 15:00 KILIMANJARO





## THE ECONOMICS OF REHABILITATING THE DEGRADED FOREST RESOURCES: THE CASE OF SEKELLA MARIAM FOREST PRIORITY AREA, NORTH WESTERN ETHIOPIA

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Forests represent an important resource base for economic development. If managed wisely, the forest has the capacity to provide a perpetual stream of income and subsistence products, while supporting other economic activities through its ecological services and functions. Despite the importance of forest in sustaining livelihood and poverty smoothening in rural communities, they are highly depleted. Besides, rehabilitation initiatives in Ethiopia to date are rarely participatory. Even community forests, are poorly conserved and highly degraded. Therefore, to enhance participatory rehabilitation initiatives, this study examined households' willingness to pay for rehabilitation of degraded forest resources in a hypothetical market. The study was conducted in Sekella woreda of the Amhara region, north-western Ethiopia. A total of 120 households had been surveyed in the study area in November and December 2010. During the survey, Contingent Valuation Method with double bounded dichotomous choice with follow up question format was applied to elicit willingness to pay for rehabilitation of degraded forest resources. Descriptive statistics were used to describe sample households in terms of some desirable variables. An ordered probit model was employed to analyze determinants of households' willingness to pay for the rehabilitation of degraded forest resources and bivariate probit model for the estimation of mean WTP. The survey result shows that mean willingness to pay for rehabilitation of degraded forest resources is ETB 14.44 to ETB 16.34 and 19.54 ETB according to the dichotomous choice and open-ended survey responses respectively. The ordered probit model result revealed that relevant indicators such as age, social participation in the kebele, contact with extension agents, perception of fertility of farm plots and total income of the household are significant predictors for the WTP. Therefore, in designing the rehabilitation projects for the woreda policy makers need to take these socio-economic and institutional factors into consideration.

**Merian award applicant**

## „NEW FORESTS FOR ECUADOR“: THE FIRST KNOWLEDGE TRANSFER PROJECT FOR SUSTAINABLE LAND USE FINANCED BY DFG

Sven Günter<sup>1</sup>, Reinhard Mosandl<sup>2</sup>

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In ten years of research in the tropical montane rain forests of South Ecuador around the San Francisco Valley the research groups FOR 401 and 816 could establish a sound scientific baseline for restoration, reforestation and enrichment plantings with native species. For example we could show that height growth of *Alnus* is almost equal to the exotic species *Pinus patula* and even better than *Eucalyptus*. Preliminary field experiments indicated that many other native species of high timber value showed surprisingly good performance in gaps of pine plantations. This shelter effect is well known from other regions of the world, but it is new for Ecuadorian pine plantations. Reforestation of native species and mixed forests with higher ecological and economic stability and with a higher potential to increase the connectivity in fragmented landscapes, are not yet considered in practical forestry in Ecuador, besides positive experiences in Central America and other regions of the world. Thus, in this pilot project we aim at fostering the establishment of mixed forests with native species by underplanting of pine plantations and *Alnus* stands and by application of silvicultural treatments. *Alnus*-dominated stands shall be comparatively underplanted in order to analyse possible positive facilitating effects of this nitrogen fixer to nutrient cycling and biodiversity parameters.

One major reason for poor acceptance of international experiences and poor implementation in Ecuadorian forestry are the lack of institutions for technology transfer and missing pilot projects, proving the practical feasibility of scientific results. In close cooperation with several counterparts in Ecuador and Germany, we are presenting a pilot project for environmental sciences to overcome these institutional barriers of knowledge transfer and to test the feasibility of scientific results of the research group under realistic practical conditions and a wide range of environmental conditions in the South Ecuadorian Andes.

Besides the technical and scientific challenge, how to establish native species in monocultures of exotics, a major challenge of the project is to enhance institutional cooperation. So far, it is the first time for South Ecuador that governmental institutions, NGOs, private land owners and scientists from Germany and Ecuador join forces for the development of scientific knowledge combined with immediate implementation in the field, and the first time for the DFG to finance a Transfer Project for sustainable land use strategies in the tropics. This new model of financing could open new pathways for fostering science based sustainable development in tropical countries.



## PLANT-ANIMAL INTERACTIONS IN DISTURBED AND FRAGMENTED LANDSCAPES

Chairs: Eckhard W. Heymann, Nina Farwig

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Pollination and seed dispersal comprise essential interactions between plants and animals. In tropical ecosystems, these interactions play a major role for vegetation dynamics and plant population structure. At the landscape scale the regeneration and colonization of modified habitats will depend on the availability of plant and animal interactions partners and their susceptibility or resilience to disturbance and fragmentation. Key questions to be addressed in this session are: (1) how does habitat disturbance and fragmentation affect plant-animal interactions, specifically pollination and seed dispersal? (2) Can this be predicted from ecological traits of the interacting plants and animals? (3) Which lessons can be learned for intervention and management that aim at supporting regeneration processes? (4) Apart from these specific key questions, we welcome contributions that fit under the general topic of this session.

FRI 11:00 GALAPAGOS

## SEED DISPERSAL AND RECRUITMENT PATTERNS OF FLESHY FRUITED TREES IN FRAGMENTED LANDSCAPES

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Seed dispersal is key ecological process to understand forest dynamics and particularly ecosystem restoration. Fragmentation of forests is a key process negatively affecting livelihoods and potentially endangering genetic diversity in afro-montane forests in the highlands of Ethiopia. We used inverse modelling (IM) approaches to quantify seed dispersal characteristics of key tree species as a baseline for assessments of fragmentation in these landscapes and as tool for planning of forest patches as stepping stones for ecosystem restoration. The RECRUITS program was used to predict dispersion patterns of recruits of *Olea europaea* ssp. *cuspidata* and *Schefflera abyssinica* in northwest Ethiopia. Fecundity was estimated using randomized branch sampling for model calibration. Species differences were observed in the abundance of recruits and also in their spatial distribution. The standard total recruitment produced by 45 cm DBH trees for *Olea europaea* ssp. *cuspidata* was (36219.10) higher than *Schefflera abyssinica* (28221.53). The mean dispersal distance for *Olea* was 190 m, and for *Schefflera* 92 m. Correlations between the model predictions and the observed number of recruits for each quadrat on the transect were significant (0.38 and 0.39 for *Olea* and *Schefflera* respectively). This is the first study quantifying dispersal distances for these key species in that region. It also underlines that inverse modelling approaches can also be used to predict the spatial distribution of recruits of bird dispersed tree species in fragmented forests. Outputs can serve as baseline for landscape planning of new forest patches in a highly degraded landscape.

**Merian award applicant**

FRI 11:00 GALAPAGOS



## FRAGMENTATION AFFECTS RODENT-SEED MUTUALISMS IN AN AFROMONTANE FOREST

Babale Aliyu<sup>1,2</sup>, Misa Zubairu<sup>1</sup>, Elena Moltchanova<sup>2</sup>, Pierre-Michel Forget<sup>1,3</sup>, Hazel Chapman<sup>1,2</sup>

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Habitat fragmentation and associated edge effects are one of the main drivers of biodiversity loss. A key contributor to this loss is the disruption of plant-animal mutualisms. In the Neotropics secondary dispersal by rodents has to some extent compensated for loss of primary dispersers in the plant-seed disperser mutualism. Here we investigate the seed fate of two large seeded Afromontane tree species (*Pouteria altissima* family Sapotaceae and *Garcinia smeathmanii* Family Clusiaceae) whose primary dispersers (primates, birds and bats) are in decline and whose seed can be secondarily dispersed by rodents. The tree species differ in certain characteristics which may affect their desirability to rodents. We classified seed fate into four categories i) immediate consumption (predation) , ii) caching under the litter iii) burying below ground and iv) removed (fate unknown) and determined the probability of each fate in each of three habitats core forest; ii) forest edge and iii) forest fragment. Fate was measured after 2, 5 and 10 days. Our results demonstrate that overall there are high levels of seed removal by rodents and that seed fate varies among seed species and among habitats. We recorded significantly higher predation rates for *P. altissima* than *G. smeathmanii*, but for both species predation was highest in the fragments and along the forest edge. In contrast saturation was apparent in the core. Rodents preferred to bury but also cached seed. The results of our study suggest that for our study species fragmentation and edge effects will lead to higher seed predation rates, and consequently less secondary dispersal, than in the core. Such findings have important implications for forest management and conservation.

## CONSEQUENCES OF FOREST MODIFICATION ON STRUCTURE AND ROBUSTNESS OF PLANT-FRUGIVORE NETWORKS

Lackson Chama<sup>1</sup>, Dana G. Berens<sup>1</sup>, Colleen Downs<sup>2</sup>, Nina Farwig<sup>1</sup>

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Plant-frugivore mutualistic networks play a key role in the regeneration and maintenance of tropical and sub-tropical forest ecosystems. However, information about how these networks respond to diverse land-use and the resulting modification of habitats is still scarce. Here, we examined the structure of plant-frugivore mutualistic networks in a human dominated heterogeneous sub-tropical forest landscape of South Africa. In three habitat types (continuous natural forest, natural forest fragments and forest fragments embedded in agricultural fields) subjected to dissimilar land-use systems, we recorded fruit removal activities by frugivores on 32 fleshy fruiting plants. Our objectives were to 1) disentangle the effect of different types of forest modification on species specialisation, network structure and robustness and 2) to identify habitat parameters that are related to these effects. Across habitats, we found a total of 54 frugivore species involved in fruit removal activities. Both species and network-level specialization did not vary between habitats, but both increased with increasing fruit abundance and decreased with increase in plant diversity and canopy cover. Interaction strength asymmetry was lower in continuous forest than in the two forest fragments while weighted nestedness was similar across habitats, but with rather lower degrees in the continuous forest compared to the fragment habitats. Plant robustness was stronger in natural fragments than continuous forest, while frugivore robustness increased with increasing plant diversity. These results suggest that the susceptibility of mutualistic interaction networks to forest modification is largely driven by changes in habitat characteristics. Therefore, conservation efforts should devise measures that promote the quality of modified forest habitats to ensure their long-term functionality.

**Merian award applicant**



## CONSEQUENCES OF INVASIVE PLANTS AND HUMAN LAND-USE ON PLANT-POLLINATOR NETWORKS

Ingo Graß<sup>1</sup>, Dana G. Berens<sup>1\*</sup>, Franziska Peter<sup>1</sup>, Nina Farwig<sup>1</sup>

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Invasive alien plant species, i.e. plants that have escaped their native range and have successfully established in non-native areas, are considered to be one of the most important ecological and economic problems worldwide. Plant invasion can lead to negative effects on native species during important regeneration processes, e.g. through competition for insect pollinators. As pollinator communities respond differently to land-use intensity, these effects may vary along a land-use gradient. So far, the interrelation between pollination of native and invasive plants and land-use intensity are poorly understood at a community level. We therefore used a network approach to investigate pollination of native and invasive species along a land-use gradient in and around Oribi Gorge Nature Reserve in Kwazulu Natal, South Africa. With the help of 180 h of sweep netting, we assessed plant pollinator interactions in 17 plant communities increasing in their degree of plant invasion and differing in their proportion of natural habitat. We aimed to understand how the degree of plant invasion affects species and network specialization as well as the robustness of plant-pollinator networks in differently used habitats. The project outcomes should help to understand the effect of invasive species on native plant communities and direct the development of effective management strategies for these species.

## SEED DISPERSAL OF RATTAN PALMS (CALAMOIDEAE) BY MAMMALS IN A LOWLAND RAIN FOREST OF PENINSULAR MALAYSIA

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Rattan palms (Calamoideae) are an important component of the forest vegetation of Southeast Asia. It is the second most important forest product after timber in the area and threatened with overexploitation through unsustainable harvesting methods. Although rattan usage is widespread not much is known about many aspects of the natural history of rattans. This study focuses on seed dispersal of several rattan species by frugivorous mammals in five 1-ha sized study plots at a primary lowland rainforest at the West coast of Peninsular Malaysia (Segari Melintang Forest Reserve, 4° 18'N, 100° 34' E) by using video monitoring of rattan frutescences and rattan seed stations, spool-and-line tracking of scatter-hoarding rodents, and examining rattan seedling distribution and distances to mother plants. Data collection is in progress until January 2012 thus only parts of the results will be presented here. A total of 10 different rattan species of 5 genera (250 stems/ha) were identified in the study plots. Species with the highest fruit availability were *Calamus castaneus*, *Daemonorops angustifolia*, and *D. calicarpa*. The Pig-tailed Macaque (*Macaca nemestrina*) and the Common Tree Shrew (*Tupaia glis*) were found to be the main consumers of rattan fruits with macaques being responsible for 95% of overall fruits removal. Rattan seeds were consumed by Pig-tailed Macaques, Long-tailed Macaques (*M. fascicularis*) (together 90% of seed removal) and Muridae (*Leopoldamys sabanus* and *Maxomys* spp.) with *Maxomys* being recorded caching rattan seeds. Although, an additional 16 species of frugivorous mammals were identified by life trapping no video evidence could be produced to link any other species than those mentioned above to rattan fruit or seed consumption. Pig-tailed macaques were found to be the main consumers of both rattan fruits and seeds, thus, presumably taking an important role in rattan seed dispersal. As primates need relative big habitats as foraging grounds and habitat loss is a crucial thread in the tropics plant species depending on a single-species seed disperser are at high risk of becoming extinct in the future.

**Merian award applicant**





## IMPORTANCE OF MICROHABITATS FOR TROPICAL BIODIVERSITY AND FUNCTIONAL ECOLOGY

Chair: Lakatos, Michael

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Microclimate and structural parameters of micro-habitats impact a variety of animals, plants and microbes more than macro- conditions. Examples of micro-scale impacts are: microstructures of ground vegetation reducing soil evaporation, epiphylls and microbes infesting tree leaves and influencing forest productivity; or micro structures of plants trapping dew or fog and delivering considerable amount of water to animals and plants in xeric environments. The session highlights the current discussion of connecting the micro- with the macro-level in the context of e.g. degradation of microstructures, phyllospheric islands and broader impacts of micro-scaled organisms. The focus is on novel patterns, functions and mechanisms which are based on micro-levels and cause responses on the macro-level. The session covers topics from tropical biodiversity to ecosystem functioning and will present up-scaling from cells to organisms, from species to communities and from microhabitats to landscapes.

FRI 14:30 GALAPAGOS

## MICROHABITAT SELECTION IN NEOTROPICAL TADPOLE COMMUNITIES

Arne Schulze<sup>1</sup>

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In the course of an integrative taxonomy approach of the Bolivian lowland frog fauna, different larval forms were distinguished to estimate the actual amphibian diversity. The combination of mitochondrial DNA (16S), tadpole morphology, and captive breeding revealed a total number of 50 distinct tadpole forms out of seven families within different habitats. The studied region is a vegetation mosaic of open Cerrado savannah and forest habitats, dominated by the endemic Chiquitano Dry Forest and represents a climatic transition zone between the humid Amazon forests and the dry forests of the Gran Chaco. Tadpoles of different stages were collected in small streams, ponds, watering holes, puddles, and flooded wet lands ranging from cultivated areas to pristine vegetation within natural reserves. In some cases, larval forms of more than 20 different anuran species shared a single water body at the same time for their development. Larval competition, food supply, and predation pressure are some of the major challenges for these tadpole communities. The aim of the study was the characterization of the different microhabitats, using field observations including underwater video sequences and sampling data from collected specimen. To determine whether the microhabitats were occupied by closely related species and/or by distantly related tadpoles with similar ecological requirements, the identified larvae were separately grouped into eco-morphological guilds. For this purpose, tadpole morphology and the (presumably) main nutrition source of the larvae were considered to assign the tadpoles to existing guilds or, if necessary, to modify the existing classification. Here I present the first results of this study, including microhabitat descriptions of several sampling sites and assignment to the guilds within the corresponding tadpole communities.

FRI 14:30 GALAPAGOS



## INTRASPECIFIC MORPHOLOGICAL AND BEHAVIORAL VARIABILITY OF TROPICAL FISH FROM DIFFERENT HABITATS (CENTRAL AND SOUTH VIETNAM)

Igor A. Stolbunov<sup>1</sup>

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Morphological variability of 43 species from 19 families of fish from lotic and limnic habitats of South Vietnam was studied. Morphological analysis was conducted on 24 plastic and 6 meristic characters of fishes. Highly variable morphological features differed mainly in cyprinid species, Cyprinidae (planktophages, benthophages and with mixed type of feeding): *Rasbora paviei*, *Puntius brevis*, *Osteochilus hasselti* etc., as well as species of euryphagous: *Anabas testudineus* (Anabantidae), *Clarias batrachus* (Clariidae). In these species the features that characterize the structure of the mouthparts of individuals were the most variable: the length of the upper (*premaxillare*) and bottom (*dentale*) jaw bones, width of mouth. The lowest level of morphological variability was observed in predatory fish - *Channa gachua*, *Ch. striata* (Channidae), *Xenotodon cancila* (Belontiidae).

It is noted that intraspecific morphological variability in riverine fish is higher than that of fish from the lake. The higher range of variability in morphological characteristics of fish from lotic habitats, probably due to the fact that the river conditions, in contrast to the lake, are characterized by high spatial heterogeneity of the environment: high biotopic diversity, the presence of more microhabitats of fish.

Phenotypic differences among groups of *Rasbora paviei* from different habitats were found. The river specimens of *Rasbora* are characterized by longer body form with longer caudal peduncle and by greater size of unpaired fins. The specimens from the reservoir have a deeper body and longer paired fins (Stolbunov, 2009).

Experimental study of defensive behavior of cyprinid fishes (*Rasbora paviei*, *Puntius brevis*, *Osteochilus hasselti*) showed that defensive reaction of individuals from lotic habitats was more effective than that of individuals from limnic biotopes. The river specimens of the species longer avoided 100% elimination by the predator. In the presence of a predator the river specimens mainly stick to the tactics of group protection, reflected in the collective maneuvering of fish in common schools, while individuals from lake mainly use elements of individual defensive behavior: separate swimming with exploitation of shelters (Stolbunov et al., 2011).

Experimental testing of the swimming ability of cyprinid fish (*Rasbora paviei*, *Puntius brevis*, *Osteochilus hasselti*) from lotic and limnic habitats showed that riverine individuals are able to withstand higher hydrodynamic loads, forming a more compact pack, compared with limnic individuals. Significant differences were found in fish from different habitats of morphohydrodynamic parameters of the body form and of streamlining of the fish body, as well as the magnitude of paired and unpaired fins.

## SOIL PROPERTIES AFFECT THE SMALL-SCALE DISTRIBUTION OF SUBTERRANEAN ANTS IN A MONTANE TROPICAL FOREST

Justine JACQUEMIN<sup>1,2</sup>, Thomas DROUET<sup>3</sup>, Yves ROISIN<sup>2</sup>, Maurice LEPONCE<sup>1</sup>

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<sup>3</sup>*Plant Ecology and Biogeochemistry, Université de Bruxelles, Brussels, BE*

Soil physico-chemical properties are known to have an indirect effect on ground-dwelling ant assemblages at regional scale. Nothing is known on their effect at microscale (m<sup>2</sup>). We hypothesized that soil properties affect subterranean ant distribution at the scale of meter; the actual scale of direct interactions between subterranean ants and their environment.

We aimed to test this hypothesis in a highly diverse tropical ant assemblage.

In a montane tropical forest in Southern Ecuador (1000 m a.s.l.), we delineated a 100 m transect and collected every meter a sample of mineral soil (15x15x10 cm) and its associated ant fauna. We measured pH, organic matter content, electrical conductivity and soil texture.

Soil texture was predominantly sandy to silty, the pH ranged from 3.5 to 5.6 and the organic matter content was on average 8% ( $\pm 2\%$  SD). The subterranean ant assemblage was remarkably diverse, with 46 species found. The species richness was not correlated to any of the measured variables. By contrast, the distribution of the dominant ant genera was differentially affected by soil properties, with *Brachymyrmex* and *Pheidole* being related to pH and *Solenopsis* to electrical conductivity. All *Hypoponera* species were strongly related to sand content.

Our results suggest that the distribution of subterranean ants is related to soil properties at small scale, and that dominant genera are sensitive to distinct factors or combination of factors. The heterogeneity of soil parameters at small scale can possibly be a driver of the high diversity of soil-dwelling ants observed in our study site.

**Merian award applicant**



## MICROHABITATS AND DESICCATION TOLERANCE: IMPLICATIONS FOR BRYOPHYTES IN THE TROPICAL LOWLAND FOREST

Alexandra Pardow<sup>1</sup>, Michael Lakatos<sup>1</sup>

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In the tropical lowland rainforest, bryophytes show a strong association to microhabitats and are at the verge of their physiological abilities. Therefore, the response to changing environmental conditions such as drier conditions induced by climate change is uncertain, particularly because nothing about their desiccation tolerance is known. We investigated desiccation tolerances of 21 species of bryophytes from contrasting microhabitats (understory vs. canopy) in the tropical lowland forest of French Guiana. Using chlorophyll-fluorescence (Fv/Fm) as an indicator of recovery, we tested i) desiccation tolerance for short (3d) and long (9d) desiccation events, ii) different desiccation intensities and, iii) recovery by rehydration with water vapor. Our results show that canopy species are tolerant to desiccation because 13 out of 18 species maintained more than 75% of their photosynthetic capacity after recovery at the strongest desiccation treatment (9 days at 43% RH). Understory species were sensitive to desiccation not only at low humidity but also at longer desiccation - a combination of which was barely survived. Bryophytes recovered their photosystem very well at the presence of water vapor, activity of photosystem II starting at 85% RH, which highlights the importance of high humidity conditions. We suggest that understory species are threatened not only under a drier climate change scenario but also by forest fragmentation and disturbance which reduces microhabitats of high humidity.

**Merian award applicant**

## GEOGRAPHICAL VARIATION IN THE ELEVATIONAL DISTRIBUTION OF MONTANE NEOTROPICAL FERN COMMUNITIES

Marcus Lehnert<sup>1,8</sup>, Laura Ines Salazar<sup>3</sup>, Priscilla Muriel<sup>4</sup>, Hugo Navarrete<sup>4</sup>, Ken Young<sup>5</sup>, Blanca León<sup>5,6</sup>, Kerstin Bach<sup>7</sup>, Jürgen Kluge<sup>7</sup>, Michael Kessler<sup>2</sup>

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<sup>8</sup>Nees Institut für Pflanzenbiodiversität, Rheinische Friedrich-Phillips Universität, Bonn, DE, [marcus.lehnert@smns-bw.de](mailto:marcus.lehnert@smns-bw.de)

The vegetation of tropical mountains is characterized by marked shifts in community composition and vegetation structure from the tropical lowland forests to the sparse vegetation near the eternal snow. Numerous zonation schemes have been proposed to describe these changes, both worldwide and specifically in the Neotropics, but there is dissent about how many vegetation belts to recognize and at which elevations to set the boundaries. We investigated the diversity patterns of fern communities along two transects on the eastern escarpment of the Ecuadorian Andes, one in the northern Prov. Napo and one in the southern Prov. Loja and Zamora-Chinchipe. Our data shows a sharp upper elevational limit of the shared species along both transects. It coincides with the 12° C annual isotherm and lies at 3271.4 m in the northern transect but is significantly lower in the southern transect with 2476.5 m. This is correlated to the topography because the southern transect lies in the Andean depressions (a.k.a. Amotape-Huancabamba region), where the mountains barely reach half height of the average elsewhere in the Andes. The same temperature-related upper limit is observed along other transects in the Neotropics (Costa Rica, Colombia, Peru, and Bolivia), indicating a universal pattern modulated by minimum temperatures. A comparably thermally constant lower limit, however, was not retrievable in any analytical approach. Higher temperatures thus do not seem to exert general restraints on the distribution of ferns as do low temperatures. We conclude that the lower limit reflects more the whole niche of the individual species and is thus modulated by more than one factor.

FRI 15:30 GALAPAGOS



**Keynote speaker: Dr. Ivette Perfecto**

**AGRICULTURAL PRODUCTION AND ECOSYSTEM SERVICES IN  
FRAGMENTED LANDSCAPES: A THEORETICAL FRAMEWORK  
AND ACCUMULATED EVIDENCE**

Ivette Perfecto<sup>1</sup>

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Agriculture is a multifunctional activity that provides food and fiber but also ecosystems services. However, frequently there are tradeoffs between the production aspects of agriculture and its biodiversity/ecosystem service aspects. Although this tradeoff is not inevitable, it is often assumed in the land sparing/land sharing debate. One important ecological aspect that is frequently ignored in this debate is that agriculture is not only a habitat (albeit high or low quality) for biodiversity but that it is a matrix through which organisms that need undisturbed natural habitat can migrate. Movement through the matrix is what makes it possible for organisms to persist in the long-term as metapopulations at the landscape level. Without migration there will be local extinctions and eventual regional extinctions. In this talk I present a theoretical analysis (a heuristic model) in an attempt to clarify the relationship between agricultural intensification, agricultural production and ecosystem services. I then review the literature that supports the role of agriculture as a matrix through which organisms move, discuss how agricultural intensification results in a low quality matrix that hinders migration and therefore increases the probabilities of extinctions, and discuss how this situation can be aggravated by climate change. I then relate the findings to the land sparing/land sharing debate, noting that the debate itself is formulated in such a way that the best options for biodiversity are likely to be hidden from view. Finally, I highlight areas of research that can help illuminate the debate, and discuss the role of small-scale farmer organizations in grounding the debate in reality.

**FREE TOPICS**

Chair: Thorsten Peters, Pia Parolin

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SAT 09:15 GALAPAGOS





## DETERMINISM IN TROPICAL FOREST BIOMASS DISTRIBUTION DUE TO FOREST SPATIAL STRUCTURE, HIGHLIGHTED BY THE STUDY OF THE EDGE EFFECT.

Jean-François Bastin<sup>1,2,3</sup>

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The spatial variability of carbon stocks was studied within several semi-deciduous forest patches of the Northern Bateke plateau, characterized by a fragmented landscape known as a forest-savannah mosaic (Democratic Republic of the Congo). Stem density, basal area and above-ground biomass (AGB) were estimated from a randomized stratified sampling design with total cover of 28.25 ha.

Stratification was applied in order to study the determinism of forest biomass variability due to forest type succession along a forest-savannah transition. This stratification provided the opportunity to study the influence of the forest spatial structure through the edge effect, and to improve estimates of AGB through consideration of spatial pattern as an additive parameter. Consequently, this study tests an application of a main theory in landscape ecology known as the “pattern-process paradigm”, where the triangular relationship between an ecological process – carbon storage, the landscape structure - edge effect - and the landscape composition – forest types - is tested.

## PATTERNS OF FUNCTIONAL TRAITS IN THE BIOGEOGRAPHY OF WEST AFRICAN SAVANNAS

Marco Schmidt<sup>1,2,3</sup>, Salifou Traoré<sup>4</sup>, Adjima Thiombiano<sup>4</sup>, Georg Zizka<sup>1,2,3</sup>

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<sup>3</sup>*Biodiversity and Climate Research Center, Frankfurt, DE, mschmidt@senckenberg.de*

<sup>4</sup>*University of Ouagadougou, Ouagadougou, BF*

With the rise of biodiversity databases and ecological niche modeling in the past decade, plant distribution studies have become more sophisticated and diverse, but are usually restricted to single species or taxonomic groups. The studies presented here use stacked species distribution models of vascular plants in combination with species-specific trait data to construct maps of functional trait distributions for the country of Burkina Faso, an area typical for the Sahelo-Sudanian savanna belt of West Africa.

The analyses focus on the two most abundant plant groups in savannas defining this biome: trees and grasses. Distribution data have been compiled from both collection and observation databases, trait data has been assembled from literature, herbarium and field observations and environmental data used in the distribution models encompass climate, topography and satellite data.

Clear trends on the level of vegetation zones from the Sahelian acacia savannas to South Sudanian woodlands and dry forests can be seen from the results, but also small scale differences linked to topography and landscape types.



## DO WOODLAND PATCHES IN A GRASSLAND MATRIX ACT AS POTENTIAL REFUGE FOR SMALL VERTEBRATES IN ARID AUSTRALIA?

Anke Frank<sup>1</sup>, Max Tischler<sup>1</sup>, Chris Dickman<sup>1</sup>, Glenda Wardle<sup>1</sup>

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Native fauna potentially find refuge and access to patchy resources in minority habitats within a surrounding matrix of the dominating habitat, particularly during times of food scarcity caused by droughts in arid environments. In the Simpson Desert, central Australia, gidgee (*Acacia georginae*) woodlands (~ 15% available habitat) occur patchily in a matrix of spinifex (*Triodia basedowii*) grassland (> 70% available habitat) and are known to be an important habitat for Red kangaroos (*Macropus rufus*), roost sites of several species of bats, nest sites for many birds and habitat for arboreal reptiles that are restricted to these wooded areas. To investigate if gidgee woodland patches also act as potential refuge habitat for native small vertebrates we compared records from a dry period with the preceding months of high rainfall using abundance data from live-trapping small mammals and reptiles and standardised bird counts. Bird abundance was consistently high in some gidgee sites during dry times, and high throughout following rain. Predictable associations between birds and gidgee suggest it is an important habitat for both resident and nomadic species. Of the more common mammal species, only the Sandy inland mouse (*Pseudomys hermannsburgensis*) used gidgee as a refuge after resources declined. Other small mammals, as well as reptiles (except for arboreal species), did not show any preference for gidgee woodlands at any time, but as most species occurred in low numbers the patterns may not have been detectable between sites. We use this information to comment on current biodiversity threats for wildlife within gidgee woodlands and the implications for management of the woodlands in terms of their potential as a refuge after wildfires.

**Merian award applicant**

## MATING SYSTEMS IN BOHOR REEDBUCK ARE LINKED TO HABITAT NUTRIENT QUALITY IN A MESIC TALL-GRASS SAVANNA

Werner Suter<sup>1</sup>, Esther Bärtschi<sup>1,2</sup>, Annette Stähli<sup>1,3</sup>

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Mating systems and tactics tend to reflect resource quality more strongly than other behavioural traits, and within a species they may thus vary in space and time. We tested the hypothesis that the ability of males in polygynous herbivores to attract (or defend) females would depend on forage quality available in their territories. Bohor reedbuck (*Redunca redunca*) is a much understudied species but current knowledge indicates that it tends to be territorial and males practice resource-defence polygyny. We studied Bohor reedbuck in Saadani National Park where the species is unusually common. Response to resource quality and quantity was modelled at grazing patch and habitat scales, and for wetter and drier conditions. Best models (Akaike criterion and weights) indicated that at grazing patch level, Bohor Reedbuck showed similar preferences as Waterbuck (*Kobus ellipsiprymnus*) and (introduced) wildebeest (*Connochaetes taurinus*) for patches rich in *Panicum infestum*, but that it selected more strongly sites offering higher greenness, i.e. a lower proportion of senescent grass. Other differences also supported the notion that Bohor reedbuck was the most selective feeder among the three species. At the habitat scale, the best models linked reedbuck density to the abundance of the three most preferred forage species during wetter conditions whereas during driest conditions, abundance of green phytomass coupled with crude protein content of forage was most important. Overall group size in Bohor reedbuck declined from wetter to drier conditions but the effect was created mostly by the decline in numbers of harem groups involved. Measured as the ratio of females to male in all groups consisting of at least one male, the number of females decreased with increasing dryness. At the end of the dry season, the occurrence of pairs and harems was significantly associated with higher nutritional quality of forage in the males' territories.

SAT 10:00 GALAPAGOS



## PATCHILY DISTRIBUTED IN A “HOMOGENOUS” ENVIRONMENT: THE CASE OF THE LIVE-BEARING NIMBA TOAD

Laura Sandberger<sup>1</sup>, Mark-Oliver Rödel<sup>1</sup>

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The Nimba Mountains are situated between Guinea, Ivory Coast and Liberia. With 69 known anurans and caecilians they comprise the highest local number of amphibian species in West Africa. The most conspicuous species is the only truly viviparous anuran on the Globe: *Nimbaphrynoides occidentalis*. This toad, endemic to the Nimba Mountains, exclusively occurs in high altitude grasslands above 1200 m. The Nimba toads are independent from open water due to their unique reproduction mode. Thus they could potentially inhabit the entire high altitude grasslands. However, the toad shows a very patchy distribution with three “populations”. A Liberian population is very small and separated from the Guinean populations by forests, a habitat usually not used by the toads. In contrast the habitat between the two Guinean populations consists of grasslands above 1200 m, hence, the appropriate habitat for the Nimba toads. We herein address the question what may cause the observed patchy distribution.

## SIBERUT ISLAND UNDER THREAT: FIRST ECOLOGICAL INSIGHTS ON THE ENDEMIC SIBERUT MACAQUE (*MACACA SIBERU*)

Christin Richter<sup>1</sup>, Keith Hodges<sup>2</sup>, Julia Ostner<sup>1</sup>, Oliver Schülke<sup>1</sup>

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<sup>2</sup>*Reproductive Biology Unit, German Primate Center, Leibniz-Institute for Primate Research, Göttingen, DE*

Siberut is the largest and most northerly of the four main islands comprising the Mentawai archipelago, some 150km off the west coast of Sumatra. The archipelago, lying in the biodiversity hotspot Sundaland, is characterized by its exceptional biological richness and high degree of species endemism. Amongst the mammals, there are five endemic primate species, one of which, found only on Siberut, is the largely unknown and only recently described Siberut macaque (*Macaca siberu*) (Roos et al 2003). Siberut's flora and fauna continues to be threatened by illegal and legal logging, conversion of the forest into palm and cocoa plantations, forest clearing, product extraction by local people as well as by hunting. As the range of Siberut macaques is restricted to the one island only, protection of Siberut's rainforest is critical for the survival of this species. After a 15-month habituation period, detailed ecological and behavioral data were collected from March 2010 through March 2011, on one group of Siberut macaques in a relatively undisturbed forest in north Siberut, at the field site of the Siberut Conservation Programme. Group size was small compared to other macaque species, with only about 30 individuals, including 3 adult males and 8 adult females. Interestingly, the group spent 64% of their daily activity time on the ground or in the lower story, and only 36% in the mid-story and canopy. The diet varied considerably throughout the year, with fruit accounting for 43 to 92% of the monthly feeding time, depending on the season. During times of low fruit availability, more time was spent feeding on insects, pith and mushrooms. Frequently, the group separated to sleep on up to four different sleeping trees per night. Although they used 240 different sleeping trees belonging to 54 different species, they preferred certain species (e.g. *Endospermum malaccense*: 23.3%). These data together with further information on home range size and use, detailed habitat description and description of resource characteristics will help to characterize the ecological requirements for this species in order to develop the necessary conservation strategies.

SAT 11:00 GALAPAGOS



## BONOBOS, *PAN PANISCUS*, IN THE FOREST-SAVANNAH MOSAICS OF WEST DR CONGO: DOES SPATIAL STRUCTURE INFLUENCE THE FOREST USE DYNAMICS?

Adeline Serckx<sup>1,2</sup>, Roseline C. Beudels-Jamar<sup>2</sup>, Marie-Claude Huynen<sup>1</sup>

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<sup>2</sup>Royal Belgian Institute of Natural Sciences, Brussels, BE

Bonobos, *Pan paniscus*, are endemic to the Democratic Republic of Congo (DRC) but the species' range is still not precisely known. For example, the populations from West DRC have only been identified in 2005, following inventories conducted by WWF. This region is characterized by a forest-savannah mosaic, a particular ecotone with naturally fragmented forests, in which bonobos have hardly ever been studied in comparison with those evolving in central DRC rainforests. The area also increasingly includes numerous anthropogenic activities including logging and cattle ranching. Effective long-term conservation programs are then essential for the survival of bonobos' populations. We decided to focus our study on bonobos' forest use dynamics, testing spatial structure influence on bonobos' density and forest use. This hypothesis is based on a landscape ecology theory, the pattern-process paradigm, establishing a triangular link between the structure, the composition and the ecological processes of a landscape. We used the interior-to-edge ratio to classify our study area (200km<sup>2</sup> of forests) in 5 categories of forest patches: (i) corridors (0.1 to 5.5km<sup>2</sup>, ratio of 0), (ii) small patches (3.4 to 4.3km<sup>2</sup>, ratios between 0.23 and 0.33), (iii) middle patch with edge area predominant (13.8km<sup>2</sup>, ratio of 0.7), (iv) middle patch with interior area predominant (22.3km<sup>2</sup>, ratio of 1.17), (v) big patch (122.2km<sup>2</sup>, ratio of 1.43). We walked transects (total effort: 126km) to identify habitats (landscape composition) and bonobos' use indices (nests and food remains – landscape ecological process). Results unexpectedly showed that bonobos use all forest patches, even corridors, mostly used for feeding. Small patches even include higher nest density than the big patch. Moreover, habitats with predominant Marantaceae understory are correlated with higher nest density. The study is still in process and sampling areas will be increased in further field work. The first results however already indicate that we could elaborate a model predicting bonobos' presence according to habitats and spatial structure and designate forest patches to protect as a priority. This information should allow formulating specific management recommendations for regional conservation programs and logging concessions.

## NEGATIVE EFFECTS OF CONSPECIFIC DENSITY ON FRUIT SET OF TWO NEOTROPICAL UNDERSTOREY PLANTS

Katharina Stein<sup>1</sup>, Mathias Templin<sup>2,3</sup>, Isabell Hensen<sup>1</sup>, Matthias Schleuning<sup>2,3</sup>

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Plant populations may experience positive, negative or even neutral effects of conspecific density on female reproductive success. The attractiveness of plants is important for pollination, because a higher local floral density often attracts a broader spectrum and a higher number of visitors resulting in an increased reproduction. In contrast, density might have negative effects on reproduction as well, such as increased competition among flowering conspecifics for pollinators. Environmental resources such as light are supposed to have an important impact on the performance of plants as well, especially of understory plants in tropical rain forests and for clonal growing plants in particular.

We investigated the impact of canopy openness, conspecific density and plant height on female reproductive success of two neotropical understory plants, *Heliconia metallica* (clonal) and *Besleria melancholica* (non-clonal). *H. metallica* benefited from increased light availability by increasing ramet density and height, whereas *B. melancholica* did not respond to light. In both species, conspecific density had a significant negative effect on pollen load per stigma and fruit set, indicating an altered competition for pollinators and the transfer of low quality pollen in dense stands. We conclude that canopy openness does not necessarily translate into enhanced growth and reproduction of our understory study species, and that conspecific density has an important impact on pollination service and reproduction. Our study combines the environmental resource light and conspecific density, and contributes to the ongoing debate on the density dependence of reproduction, indicating negative density effects on female reproductive success.

**Merian award applicant**

SAT 11:30 GALAPAGOS





## MAXIMUM GLUCOCORTICOID LEVELS VARY WITH FEEDING HABIT AND HABITAT SEASONALITY IN TWO PHYLLOSTOMID SPECIES

Daniel Lewanzik<sup>1</sup>, Detlev H. Kelm<sup>1</sup>, Sabine Greiner<sup>1</sup>, Martin Dehnhard<sup>1</sup>, Christian C. Voigt<sup>1,2</sup>

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The immediate release of adrenal glucocorticoids can be crucial for an animal's survival when facing a stressor, but constantly elevated or exceptionally high glucocorticoid levels are detrimental for health. Although baseline and maximal secretion of glucocorticoids are probably regulated within narrow ranges within species, levels vary across vertebrates. We asked what ecological factors are relevant in determining maximum blood plasma cortisol levels (CortMax) following a physiological challenge through administration of adrenocorticotrophic hormone (ACTH). Specifically, we studied whether seasonal fluctuations in food abundance relate to cortisol levels in two phyllostomid bat species with contrasting feeding habits: the sanguivorous vampire bat (*Desmodus rotundus*) and the frugivorous short-tailed fruit bat (*Carollia perspicillata*). Both species share habitats with various levels of seasonality (dry and rainforest). On a seasonal basis, resource abundance is probably more stable for vampires than for fruit bats, but previous studies suggest that daily foraging success may vary more for vampire than for fruit bats. We found that CortMax varied seasonally in *C. perspicillata* from dry forests but not in those from rainforests. Opposed to our expectation, CortMax levels of vampires were higher in rainforest than in dry forest and also higher during the rainy season than during the dry season. CortMax of vampires were among the highest cortisol levels found in free-ranging mammals; a pattern that could be related to the species' vulnerability to starvation. We conclude that the extent of habitat seasonality modulates the responsiveness to acute stress according to the species' feeding habit in free-ranging mammals.

**Merian award applicant**

## MULTI-LEVEL SOCIAL-ECOLOGICAL DYNAMICS IN PENGHU ARCHIPELAGO, TAIWAN

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Fisheries are complex social-ecological systems (SESs) influenced by globalization. Both social and environmental changes affect the way humans use the marine natural resources. Analyzing multiple levels of SESs at spatial scales helps to look at the dynamics of subsystems in a broad region and the adaptive process in a timeline of users from different social communities. The water surrounding the Penghu archipelago features rich marine natural resources. People living on the islands rely heavily on fishery for their livelihood. However, rapid industrialization and economic growth since the 1950s' at the national level created many job opportunities in industrial sectors and a decline in fishery production by the 1960s' at a regional level changed the lifestyle of the local people on these islands. Four small islands in the southern Penghu archipelago, Taiwan, are used as case studies. Each island provides a local SES while the Penghu archipelago represents a regional SES on spatial scale. Four small islands in the same geographical region have developed different strategies to adapt to the pressure of globalization. Environmental problems at a local level constrained the development of the islands, while society responses resulted in different trajectories of SESs. In order to understand the problem contexts in each SES and the linkages between SESs, results of this research show that there is a need to recognize SESs in spatial scale. This is critical when addressing the governance of marine natural resources in a linked world.

**Merian award applicant**

SAT 12:00 GALAPAGOS



## HUMAN DIMENSIONS OF TROPICAL DEFORESTATION, FOREST FRAGMENTATION AND FOREST MANAGEMENT

Chair: Perdita Pohle, María Fernanda López

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Deforestation and forest fragmentation in the tropics are ongoing processes despite global concern for preserving biodiversity and preventing climate change. According to Wade et al. (2003) nearly one quarter of the tropical rainforest biome has been fragmented or removed by humans. The extent, the rate and the consequences of deforestation, forest fragmentation and landscape change depend on the local and regional economic and social contexts within they occur. Empirical evidence shows that deforestation driven by smallholders is most likely to produce highly fragmented forest habitats. Therefore, this session would like to address deforestation, forest fragmentation and land cover change especially at household level. One aim is to reflect the social and economic context wherein loss and fragmentation takes place and to provide a farm level analysis of tropical deforestation and forest fragmentation, particularly in the frontier zones of colonization.

The future of tropical forests, whether for biodiversity conservation, carbon storage or commercial use is closely linked to the management strategies of their users. In this respect, the session also aims to discuss mitigation strategies of deforestation (e.g. payments for environmental services, carbon trading, community-based conservation, multiple forest use, extractive reserves) as well as management options of fragmented tropical landscapes (e.g. biodiversity corridors). In view of the farming households, it is furthermore essential to identify rehabilitation measures (e.g. afforestation) and sustainable land use options to conserve biodiversity and enhance rural livelihoods (e.g. silvicultural-systems, agro-and farm forestry).

Thus, contributions to this session should help to understand the processes of deforestation, fragmentation and landscape change from the social and economic context of the farming household, and should try to identify and discuss management options with special regard to rural livelihoods.

Contributions to the following subjects are particularly welcome:

1. Estimations of the extent and rate of deforestation, forest fragmentation and land cover change, especially in frontier zones.
2. Analysis of proximate causes and underlying driving forces of the deforestation and fragmentation process.
3. Understanding the process of deforestation and forest fragmentation from the household level.
4. Mitigation strategies of deforestation and management options of fragmented tropical forests.
5. Rehabilitation measures and identification of sustainable land use options to conserve biodiversity and enhance rural livelihoods.
6. Provision of environmental services and payment strategies.

## SPATIAL ANALYSIS OF FOREST FRAGMENTATION FOR BUFFER ZONE MANAGEMENT IN THE ATLANTIC FOREST OF RIO DE JANEIRO, BRAZIL

Friederike Naegeli<sup>1,2</sup>, Udo Nehren<sup>1,2</sup>, Elaine Fidalgo<sup>3</sup>, Jürgen Heinrich<sup>1</sup>

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<sup>3</sup>*EMBRAPA Solos, Rio de Janeiro, BR*

The Brazilian Atlantic Forest is one of the most diverse ecosystems on Earth, being the habitat for numerous endangered and endemic species. Historical deforestation has led to a reduction of the forest cover to only 11.6 – 16.0 % of its original extend, which is estimated with 1.0 to 1.5 million km<sup>2</sup>. The remaining forests are highly fragmented and in many places still under high land use pressure. Therefore the Atlantic Forest is considered a biodiversity hotspot.

Conservation strategies are regionally concentrated in two Biodiversity Conservation Corridors (BCCs): The Central corridor and the Serra do Mar corridor. The latter covers an area of about 120,600 km<sup>2</sup> in the states of Rio de Janeiro, São Paulo, Minas Gerais, and Paraná, and represents the largest relatively intact block of Atlantic Forest. The study area of the presented research is located in the northeastern Serra do Mar corridor, in the upper Guapi-Macacu Watershed, at the foothills of the Serra dos Órgãos mountain range in the state of Rio de Janeiro.

The study aims at analyzing land use changes during the last 70 years, as well as the actual state of forest fragmentation. The analysis was conducted based on visual interpretation of historic aerial images from 1966 and 1973 and supervised classifications of satellite images (LANDSAT 5 from 1980 and SPOT 5 from 2003 and 2008). The land use classifications of the SPOT 5 images were conducted in ENVI 4.7 using a Support Vector Machine Classifier. Visual interpretation of the historical images and subsequent comparison with the forest cover derived from image classification proved to be successful for the identification of main areas of change.

An analysis of forest patterns using FRAGSTATS and ArcGIS 9.3 to calculate landscape metrics demonstrate that out of 330 forest fragments (> 0.5 ha) located in the study area only 94 appeared to be larger than 5 ha. Assuming that the fragments are influenced by an edge effect of 100 m, only 52 fragments appeared to encompass one or more core areas. It could be shown that intensive deforestation and fragmentation processes took place in the mid-20<sup>th</sup> century. In the last two decades, deforestation slowed and some forest gaps closed most likely due to natural succession of abandoned pastures and small plantations. The results of this study are used to support the buffer zone management and define conservation and reforestation priorities in the watershed.



## CARBON SEQUESTRATION AND ECOSYSTEM SERVICES POTENTIAL IN A FRAGMENTED LANDSCAPE IN THE ATLANTIC FOREST, RIO DE JANEIRO.

T. Loaiza-Lange<sup>1</sup>, S. Schlüter<sup>2</sup>, Joyce Monteiro<sup>3</sup>, J.A. Reyes-Agüero<sup>4</sup>, J.C. Torrico<sup>2</sup>

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Carbon sequestration projects under the framework of Land Use, Land Use Change and Forestry (LULUCF) of the Clean Development Mechanism (CDM) could represent a valuable opportunity to protect severely endangered ecosystems and at the same time enhance the living conditions of the inhabitants of the surrounding areas. The municipality of Cachoeiras de Macacu (Rio de Janeiro State, Brazil) is located in a highly biodiverse but intense degraded ecosystem: the Atlantic Forest. The present paper explores the potential areas for LULUCF projects through a top-down baseline approach comparing a land cover map obtained from satellite images (1985) and a land use map of 2007. In addition, semi-structured interviews and an evaluation of the institutional framework and potential stakeholders related to forest carbon projects in national, regional and municipal levels were conducted. Historically deforested areas, like the Atlantic forests, have relatively high percentage of suitable areas for LULUCF initiatives, but also a significant demand for areas for settlements and food production. In Cachoeiras de Macacu, 27% of the municipality area has potential lands for LULUCF projects. However, the lands are highly fragmented and mainly occupied by pastures lands or agricultural lands. Difficulties to measure the available areas, the costs, the lack of local communities' engagement and finally the absence of stakeholders' participation are other important concerns. The specificity of existing methodologies and demonstration of additionality represent main obstacles. Additionally, both for large-scale and for small-scale, the specificity of the existing methodologies does extremely difficult to use them in other initiatives. Nevertheless, the existing institutional infrastructure and the megacities in the vicinity of the area make a future appliance of Payment of Environmental Services in the region possible. There is a need to develop a more holistic and integrative approach that incorporates carbon mitigation alternatives to other ecosystem services.

## SPATIAL STRATEGY FOR BIODIVERSITY CONSERVATION AND HABITAT RESTORATION OF THE BRAZILIAN ATLANTIC FOREST

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The Atlantic Forest is the fourth world biodiversity hotspot and still maintains impressive numbers of vertebrate and plant species, many of them endemics. It also provide significant ecosystems services, such as maintenance and enhancement of natural carbon stocks, recreation and tourism, and water flow and regulation for more than 120 million people that live in the Atlantic Forest domain. However only about 20% of the native vegetation cover still remains, and its scattered in thousands of small fragments. Maintain and improve landscape connectivity is the only chance to conserve biodiversity and ecosystem services in the long term. The Brazilian Ministry of Environment is working with universities and the German Development Agency – GIZ to develop a spatial strategy for the definition of priority sites for biodiversity conservation and habitat restoration. Sites for biodiversity conservation were identified by a series of gap analysis, based on the distribution of vegetation types, threatened vertebrates species, Important Bird Areas, Key Biodiversity Areas, Zero Extinction Alliance and Brazilian Zero Extinction Alliance Sites, and priority sites identified by federal and state governments. These polygons were intersected with protected areas and remnant vegetation cover, resulting in most strategic remnants for biodiversity conservation. Additionally, we used graph theory to identify the most important landscapes for forest restoration and for the maintenance and improvement of landscape connectivity. The Atlantic Forest domain covers 139 million ha, with eight biogeographical regions, each one considered one graph. These were subdivided in octagonal 5.000ha landscapes, or vertices, classified as low (85%), medium or high resilient (10%), and also as source landscapes (5%), based on the remnant vegetation cover and the connectivity probability of each one. Medium and high resilient landscapes were prioritized based on two metrics (i) *varIICflux* related to the importance of each landscape to organisms flow between landscapes in a region and (ii) *varIIC-connector*, measuring the importance of a landscape to the maintenance of connectivity between subgraphs. These two metrics were summed for each landscape to identify those most strategic. The resulting maps of this spatial strategy has been rapidly included in decision making process and regional conservation and development plans by government authorities and nongovernment stakeholders.

SAT 09:45 KILIMANJARO



## IMPACTS OF DROUGHT AND LOGGING ON TROPICAL RAINFORESTS IN AFRICA: MODELING THE DYNAMICS OF RAINFORESTS

Rico Fischer<sup>1</sup>, Amanda Armstrong<sup>2</sup>, Hank Shugart<sup>2</sup>, Andreas Huth<sup>1</sup>

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<sup>2</sup>*University of Virginia, Virginia, US*

Tropical forests cover 15% of the land and represent a large carbon pool. The long-term responses of forests on climate change are difficult to measure. For extrapolations of field measurements in time and space vegetation models are useful tools. The objective of the presented work was to understand how drought and logging modifies biomass, productivity, species composition and carbon flux of a rainforest as a function of annual rainfall.

In this study we use the process-based, individual-oriented forest model FORMIX3. The main processes of this model are tree growth, mortality, regeneration and competition. Tree growth is calculated on a carbon balance. The impact of drought on plants was modeled by calculating stress factors. We investigate tropical rainforests in the Kilimanjaro region and in the East of Madagascar.

The simulation output shows that the impact of drought on forest biomass and productivity is limited if the reduction of rainfall is not higher than 20% (prediction for Madagascar of IPCC 2007). If the rainfall decline is higher, drought has a strong influence on the carbon storage of the rainforest and on the biomass of the large shade tolerant tree species. Reduction of the annual rainfall by 50% lowered carbon storage and total biomass by 15% and 10%, respectively. This effect will be doubled by additional logging regimes.

Droughts (e.g. due El-Nino) change the structure of tropical rainforests. The biomass will be reduced only in parts and the species composition shift toward smaller and less shade tolerant tree species. Disturbances like logging could intensify the drought effect.

**Merian award applicant**

## LONG-TERM GALLERY FOREST DYNAMIC IN THE VENEZUELAN GUAYANA: IMPLICATIONS TO FOREST CONSERVATION AND FIRE MANAGEMENT IN A PROTECTED AREA

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In the Canaima National Park (CNP) the current coexistence of evergreen forests and treeless savannas has been interpreted as the product of a long-term savannization process mediated by fires and droughts. This is of great relevance considering that today the CNP is inhabited by the Pemon Amerindians whom use fire extensively in most of their everyday activities, despite the fact that Park stakeholders have developed programs for fire exclusion in the area. Conflict about the use of fire in the CNP is hindering the finding of alternative strategies of forest conservation besides fire exclusion. In this sense paleoecological studies are essential for the understanding of savanna-forest dynamic, given a broad temporal perspective about the fire occurrence in the CNP. Results of more than 10 sedimentary records studied in the area have shown that the current forest-savanna mosaic is present in the CNP since the early Holocene. Fire has been also present in the area since the beginning of the Holocene, with frequencies as high as those reported today. Highest frequencies recorded during the early and mid Holocene seem to be related with dry episodes, suggesting an ultimate climatic control on fire regimes. Although major landscape configuration has remained relatively stable, paleoecological studies also have suggested the occurrence of a regional process of fragmentation of gallery forests. Forest degradation was apparently triggered by a high recurrence of local fires in savanna-gallery forest borders, caused by the spread of uncontrolled fires from neighbor savannas. These results suggest that given the vulnerability of gallery forest to fire, and considering the mosaic of fire-dependent vs. fire-sensitive ecosystems present in the area, fire exclusion policies applied for the CNP stakeholders could give to worsen forest fragmentation under a global change scenario. Fire management in the savanna-forest borders seems to be a better alternative, in order to avoid the occurrence of future catastrophic fires in these ecosystems.

SAT 10:15 KILIMANJARO





## EXPLORING THE RELATIONSHIP BETWEEN FARMING PRACTICES AND VEGETATION CHANGE IN BENUE STATE, NIGERIA

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The study assessed the effect of farming on vegetation in Benue State. The objectives of the study were to identify and describe the major farming practices and vegetation cover in Benue State; detect and analyse the spatio-temporal change in the vegetation cover and to model the farming practices as driver of vegetation change in Benue State. Data on farming activities and vegetation change was obtained through personal interviews; questionnaire; onsite assessment and the acquisition of remotely sensed data of 1986 and 2007 covering the study area to perform change detection. The data was coded, extracted and analysed using frequencies and simple percentages while Ilwis Academic 3.2a was used to analyse land-cover change from the satellite images. The change detection and analysis done revealed that, vegetation covered 72% of the study area in 1986 but has declined to 59% in 2007. The hypothesis formulated was tested using chi-square at  $p < 0.05$  and it showed that shifting cultivation, zero-tillage and alley cropping contributed significantly to vegetation change in Benue State. The study also showed that majority of the farmers practised farming on full-time basis. The farm plots were generally small averaging 1.5ha per farmer and scattered. The major farming activities identified in the study area were also modelled as explanatory variables of vegetation change using stepwise multiple regression analytical technique. The result of the regression showed that zero-tillage and farm size were the most significant (at  $p < 0.05$ ) drivers of vegetation change. Hence, 99.7% of the vegetation change in the study area can be adequately explained by zero-tillage and farm sizes. The study concludes that farmers should minimize the practice of zero-tillage and reduce the size of their farms while alley cropping and afforestation for all vegetation types should be encouraged to conserve the vegetation in the State.

## PREDICTING AND MAPPING OF FOREST COVER SPATIO-TEMPORAL VARIABILITY USING GEOINFORMATION TECHNIQUES: THE CASE STUDY OF DENDI DISTRICT, ETHIOPIA

Berhan Gessesse Awoke<sup>1</sup>

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At these days an excessive and destructive exploitation of forest resources is tremendously a threat that exists in Ethiopia in general and the study site of Dendi District in particular. Specifically, many ongoing socio-economic activities have been damagingly affect the forest resources in the district. Therefore, this study was intended to test the application of geo-informatics technology for forest cover change assessment, detect the magnitude, rate and patterns of forest cover change over the past 32 years (between 1973 and 2005) and to identify the major causes and environmental implications of forest cover change in the study site. Forest cover change detection was carried out based on the analysis of multi-temporal Landsat images using digital change detection methods. The result of the study revealed that a remarkable spatio-temporal variability of forest cover land was observed in the district between the year 1973 and 2005. Forest cover land reduction by 80.15 percent has been observed in the year 2005 as compared with the 1973 forest cover condition with a deforestation rate of 660.33ha per year. Moreover, the amount of forest cover change process is very significant along with areas having a gradient of less than 250 and elevation values of below 2,550m. Population pressure with related socio-economic factors like expansion of agricultural lands, demand of fuel wood and constructional materials are the major causes of forest cover change. Consequently, land degradation in the form of soil erosion, and declining of biodiversity seems to have reached a critical stage attributed through forest cover change process in the study site. In light of this, the writer suggested corrective measures in harness with the problem of forest cover change and its environmental implications.

**Keywords:** Forest cover; change detection; geo-informatics technology; GIS/RS; Dendi District

**Merian award applicant**



## SCIENTIFIC POSTER SESSIONS

Session: Biogeography Patterns of Tropical Mountain Ecosystems

## **LONG-TERM VEGETATIONAL DYNAMICS OF AN ANDEAN BIODIVERSITY HOTSPOT**

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The region of the south Ecuadorian Andes has been world-renowned for its species richness since Humboldt first visited the country. Numerous ecosystems on an altitudinal gradient of more than 3000 m create a unique landscape pattern and enable an outstanding variety of vascular plant species to grow in this area. However, only little is known about the past environmental conditions of this hotspot of biodiversity. In the frame of the RU 816 of the Deutsche Forschungsgemeinschaft, vegetation, fire and land-use history have been studied in the Podocarpus National Park and its surroundings since 2003. A compilation and synthesis of these data can now give new insights into past and present vegetation changes in this region. Furthermore, multivariate analyses help to better understand the underlying causes of the landscape development and to see hidden relationships of vegetation and other environmental factors. Thus, a more reliable support can be given for the development of new and innovative conservation strategies for the protection of this unique ecosystem complex.

**Merian award applicant**

FRI 16:15 ROOM 0.014



Session: Biogeography Patterns of Tropical Mountain Ecosystems

## MOLECULAR CHARACTERIZATION OF MORPHOLOGICAL TAXA IN THE GENUS *LOPHOSORIA* (DICKSONIACEAE)

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The genus *Lophosoria* C. Presl (Dicksoniaceae) comprises large ferns that are widely distributed in the tropical and subtropical mountainous regions of the western hemisphere. The plants have a good fossil record dating back to the lower Cretaceous, which is based on their unmistakable spores as well as macrofossils. This supports hypotheses on the relatively recent termination of active genetic exchange between Australia, New Zealand and South America. It is noteworthy that the genus was able to stretch its range into Mesoamerica and the Caribbean, but is absent from the Guyana Shield. A dated phylogeographic analysis of the genus *Lophosoria* would be a valuable addition towards the ongoing discussion concerning a prominent Gondwana distribution vs. recent dispersal. However, uncertainty remains about the species number. Many species were described in *Lophosoria* and its generic synonyms but by the second half of the last century, it was considered as monotypic. Currently the genus is regarded to comprise three species, although the validity of these entities is sometimes doubted. During fieldwork in the frame of ABA-Ecuador (Accelerated Biodiversity Assessment) in southern Ecuador, further distinct morphotypes have been recognized, sometimes side-by-side, pointing out that these forms are not merely ecotypes.

A first attempt of DNA-barcoding 16 specimens spanning the whole range of the genus showed almost no variability in the plastid *trnL-F* region, a molecular marker utile in DNA-barcoding. Here, we present the first results of the primer screening for a second barcoding primer. Population-based genetic studies using AFLP and nuclear markers are planned.

**Merian award applicant**

Session: Biogeography Patterns of Tropical Mountain Ecosystems

## **LINKING ECOSYSTEM PRODUCTIVITY AND SPECIES RICHNESS USING TERRESTRIAL FERNS IN TROPICAL FORESTS OF NORTHEASTERN ECUADOR**

Laura I. Salazar<sup>1</sup>, Jürgen Kluge<sup>2</sup>, Jürgen Homeier<sup>1</sup>, Michael Kessler<sup>3</sup>

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<sup>3</sup>*University of Zurich, Zurich, CH*

The aim of this study was to find causal mechanisms that determine the relationship between energy input and species richness patterns of ferns at different spatial scales along an elevational gradient in a tropical mountain ecosystem in northeastern Ecuador. During three yearly field phases between 2009 and 2011, field work was carried out at eight elevations (500 m to 4000 m) on the eastern Andean slope in Napo province, Ecuador. Diversity and productivity of terrestrial ferns were recorded in 3 permanent plots of 400 m<sup>2</sup> each per elevation. All terrestrial fern individuals were marked by fixing number-tags with plastic-wire around the rhizomes. Number of fronds and frond length were the basic field measures. As the assessment of biomass increment requires the measurement of the gain of new and the loss of old fronds per time interval, each stipe was marked individually so that new leaves could be unambiguously identified. Biomass was calculated with this basic field measure and the measured values of the specific leaf area of each species.

A total of 91 terrestrial ferns species, in 32 genera and 18 families, were recorded in the 24 plots. Fern species richness showed a hump-shaped elevational pattern that corresponds to the common pattern of fern diversity in tropical mountains. This pattern was only weakly related to measures of ecosystem productivity, but more closely to the productivity of the fern assemblages as such.

**Merian award applicant**

FRI 16:15 ROOM 0.014



Session: Fragmentation Genetics in the Tropics

## BIOGEOGRAPHY AND INFRASPECIFIC RELATIONSHIPS OF RIVERINE TREE SPECIES IN THE WEST AFRICAN SAVANNA REGION

Ivana Kirchmair<sup>1,2,3</sup>, Birgit Kanz<sup>2</sup>, Marco Schmidt<sup>1,2,3</sup>, Georg Zizka<sup>1,2,3</sup>

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Genetic relationships among individuals of the species *Anogeissus leiocarpa*, *Diospyros mespiliformis*, *Paullinia pinnata*, *Pterocarpus santalinoides* from gallery forest habitats in Burkina Faso and Benin were investigated and related to the geographical distribution. All six species have been widely sampled throughout the study area.

The role of the dispersal mode and the fragmentation and structure of the habitat were considered when analysing the data.

*Paullinia pinnata* and *Pterocarpus santalinoides* are strictly bound to gallery forests. *Anogeissus leiocarpa* and *Diospyros mespiliformis* are closely linked to riverine habitats in the northern part of their distribution area, in the southern part, they have a broader range of habitats.

In *Paullinia*, an analysis of the historical biogeography reveals that the pattern of genetic similarity does not correlate with geographic distance nor with the drainage area of the river systems. This might be explained by the dispersal mode (birds).

Many of these species are economically important tree species and the gallery forests are within our study area an exceptionally diverse habitat in need of conservation.

**Merian award applicant**

Session: Fragmentation Genetics in the Tropics

## GENETIC SURVEY OF THE WOOLLY-MOUSE OPOSSUM *MICOUREUS PARAGUAYANUS* BRINGS NEW INSIGHTS OVER ITS POPULATION STRUCTURE IN FRAGMENTED LANDSCAPES

Fernando Pacheco Rodrigues<sup>1</sup>, Fátima Becker Guedes<sup>2</sup>, Renato Caparroz<sup>3</sup>, Flávia Souza Rocha<sup>4</sup>, Reinaldo Alves de Brito<sup>5</sup>, José Fernando Garcia<sup>6</sup>, Sergio Russo Matoli<sup>7</sup>

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Fragmentation is predict to have considerable effects on the genetic and demographic viability of populations due to the combined effects of reduced population size and increased isolation. To evaluate the consequences of recent forest fragmentation on diversity and genetic structure of the arboreal marsupial *Micoureus paraguayanus*, ten microsatellite loci were scored in 95 individual from six Atlantic forest remnants located in the west of São Paulo state, Brazil: the Morro do Diabo State Park (PEMD – 37000 ha), and five smaller fragments (30-2000 ha) around it (320-23000 m distance).

The number of alleles per loci varied between 4 and 10 (6.1 overall). After discard two loci (due to linkage disequilibrium or null alleles), all areas were in accordance with HW expectations. Observed heterozygosity varied from 0.409 to 0.609 (0.520 overall), expected heterozygosity ranged from 0.448 to 0.625 (0.537 overall), and inbreeding coefficient (FIS) ranged between -0.085 and 0.087 (0.041 overall). There was no evidence of population bottleneck in none of the areas.

Global  $F_{ST}$  was 0.063 ( $P=0.000$ ), while pairwise  $F_{ST}$  ranged from -0.005 to 0.110. All but two pairwise comparisons were statistically significant even after Bonferroni correction, suggesting the differentiation of areas despite the low values of  $F_{ST}$ . Bayesian analysis (software Structure) reinforced this found indicating five genetic clusters, almost concordant with that obtained by  $F_{ST}$  indices. There was no evidence of isolation by distance ( $r=0.078$ ;  $P=0.416$ ).

Results presented here seem to be highly elucidative about movement capability of *M. paraguayanus* in a fragmented landscape. One of the most differentiated forest patches is only 300 m from PEMD. This find, jointly with previously published data on the perceptual range of *M. paraguayanus* in fragmented landscapes (~100 m), lead us to consider that the usual view that this species is able to cross among forest patches is probably not always true. Thus, the metapopulation structure





observed in previous studies should only be possible when matrix surrounding the fragments is not so altered (which is not the case here, where the matrix consists of open pasture fields) or have some components that enhances its permeability. By this way, strategies usually thought to the management of other species, such as the creation of wildlife corridors, should also be used to maintain genetic and demographic viability of this and other species of arboreal marsupials.

Session: Fragmentation Genetics in the Tropics

## GENETIC DIVERSITY AND POPULATION STRUCTURE OF DIDELPHIS ALBIVENTRIS IN MORRO DO DIABO STATE PARK AND SURROUNDING ATLANTIC FOREST FRAGMENTS

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Habitat fragmentation represents one of the major environmental problems of present days. This process results in the reduction and isolation of populations, which may endanger the flora and fauna, in this situation as their populations become more susceptible to negative effects of a series of environmental phenomena, demographic and genetic factors. To minimize the deleterious genetic effects in fragmented populations is necessary to have the maintenance of gene flow between them through the maintenance of connectivity between fragments. Studies of population genetic structure of generalist species, which in principle tolerate environmental changes, and generate the knowledge of the species studied, can provide information for understanding the effects of habitat fragmentation on other species other than those known to be sensitive to fragmentation. Thus, this work is being developed with the marsupial *Didelphis albiventris*, through analysis of eight microsatellite loci in natural populations of Morro do Diabo State Park and six fragments of Atlantic Forest in its surroundings. Preliminary analysis indicates the existence of high genetic diversity in the studied areas, with high number of alleles and high heterozygosity. Despite the existence of unique alleles in some of the areas studied, the analysis based on the index  $F_{ST}$  indicate that they are not differentiated, while using Bayesian analysis (Structures software) shows that they form a single genetic group. The data obtained in this study, when compared with studies of related species in these same areas, provide a comprehensive look at the effects of forest fragmentation on the genetic diversity and structure in species that have different biological characteristics.

FRI 16:15 ROOM 0.014



Session: Fragmentation Genetics in the Tropics

## GENETIC DIVERSITY OF MACARANGA PIONEER TREES (EUPHORBIACEAE) IN SARAWAK (NORTHWEST BORNEO)

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The paleotropic genus *Macaranga* (Euphorbiaceae) comprises some of the most important pioneer trees of South-East Asian tropical rain forests. We investigate the population structure of *Macaranga* species to clarify their evolutionary history. Here we compare nuclear microsatellite data of four species from eastern and western Sarawak, Borneo. While the eastern part of Sarawak remained forested throughout the Pleistocene, for western Sarawak either rain forest or savannah vegetation has been postulated to have been predominant during Pleistocene cold periods. We show here that levels of genetic diversity were slightly higher in western than in eastern populations of *M. gigantea* (W:  $0.59 \pm 0.26$ , E:  $0.47 \pm 0.27$ ) and *M. hypoleuca* (W:  $0.81 \pm 0.14$ , E:  $0.69 \pm 0.26$ ), whereas they did not differ between the two regions for *M. beccariana* and *M. bancana*. Differentiation between eastern and western populations was low in all species (AMOVA: < 20 % of total variation among regions). Comparatively high levels of genetic diversity in the west and little differentiation between regions argue against a post-Pleistocenic recolonization of western Sarawak, as would have been assumed if savannah vegetation predominated during the Pleistocene.

Session: Fragmentation Genetics in the Tropics

## GENETIC DIFFERENCES BETWEEN NATURAL AND PLANTED POPULATIONS OF TWO RAINFOREST TREE SPECIES IN THE PHILIPPINES

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The rapid decline of the Philippine forests has resulted in highly fragmented tree populations. In response to this, plantation programs boomed during the late 80s and in early 90s of the last century. Plantation forests, however, were mostly established with reproductive material from unknown sources with presumably restricted diversity. .

In this study, genetic variation at nuclear microsatellite markers were estimated and compared between planted and natural populations of the ecologically important and critically endangered tree species *Shorea contorta* and *Parashorea malaanonan* (Dipterocarpaceae).

Natural populations of *S. contorta* revealed a higher mean number of alleles (4.16) and effective number of alleles (2.64) than the planted populations (3.66 and 2.21, respectively) and differed in other diversity parameters as well. Planted and natural populations of *P. malaanonan*, on the other hand, revealed no significant difference concerning their allelic richness and observed and unbiased expected heterozygosities.

AMOVA showed highly significant difference between planted and natural populations for both species. In both species, cluster analysis based on genetic distances suggests that reproductive material used in plantation frequently originates from a neighboring natural stand.

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Session: Fragmentation Genetics in the Tropics

## GENETIC PROCESSES UNDERLYING SPECIES COEXISTENCE IN TROPICAL RAINFORESTS OF BORNEO

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Differences among species in reproductive ecology, resource use together with mutualistic and antagonistic interactions are all bases for hypothesized mechanisms of species coexistence and high species diversity. Niche assembly, dispersal assembly and density dependence theories require a detailed understanding of patterns of species spatial distributions. To date the role of gene flow (by pollen and seed dispersal) as a driving force in species coexistence has been largely overlooked.

In this study, we aim to explore the genetic component of species coexistence in a tropical forest, and the role of genetic variation in seedling survival and performance. Dipterocarp trees are the dominant family of lowland tropical forest in Southeast Asia. They occur at low densities at the landscape level, but a clumped distribution at the stand level, presumably due to poor seed dispersal. Because of limited seed dispersal, we hypothesize that species with limited seed dispersal will enhance gene flow either by reducing inbreeding or by ensuring long distance pollen dispersal by mobile pollinators.

Using experimental manipulations and molecular techniques we investigate the distribution and spatial genetic structure of adult trees, relatedness among seedlings, and patterns of dispersal in a suite of dipterocarp species along a flower size gradient. We relate the observed patterns to pollen flow expectations based on flower size pollinator size associations. A field experiment tests the extent to which relatedness among seedlings affects their survival and performance.

A better understanding of gene flow processes and its relevance for species coexistence is important for managing highly diverse plant communities. The disruption of gene flow by forest fragmentation and land-use changes will affect the trees' viability and consequently the community structure of the forest. Our results will thus have relevance for conservation and forest restoration, subjects of particular importance in Southeast Asia.

**Keywords:** gene flow, seed dispersal, pollen flow, dipterocarps, flower size, species coexistence

Session: The roles of agroforestry in managing fragmented multifunctional landscape

## MORPHOLOGICAL AND MOLECULAR CLASSIFICATION OF LOCAL MANGO VARIETIES IN KENYA AS A PREREQUISITE FOR CONSERVATION OF THEIR GENETIC RESOURCES

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Local mangos (*Mangifera indica* L.) are highly appreciated for home consumption in Kenya. The local varieties are considered as drought and pest/disease tolerant; characteristics which make them interesting as rootstocks and for breeding purposes. Studies on Kenyan mangos so far mainly focussed on introduced, commercial varieties. Information on local varieties is lacking and their identification and classification is unclear. Abundance of these local varieties is decreasing and, despite their potential value as genetic resources, they are threatened by genetic erosion. The aim of this study was to identify and classify local Kenyan mango varieties using morphological and molecular approaches. In Central and Eastern Kenya, 38 local mango varieties were sampled from 90 farms and characterized by 75 selected qualitative (44) and quantitative (31) descriptors for tree, leaf and fruit traits following the mango descriptor list developed by Bioversity International (former IPGRI). A hierarchical cluster analysis was performed using Wards method and squared Euclidean distances after z-score standardisation of all variables. Dried leaves of the 38 varieties were used for molecular classification by applying 20 simple sequence repeat (SSR) markers. Genetic relatedness between the varieties was visualized using a dendrogram based on Nei's genetic distance and unweighted pair group method with arithmetic average (UPGMA). Morphological characterisation resulted in six clusters classifying the 38 varieties in six distinct types; and molecular analyses recovered eight clusters. Four of the clusters grouped identical local mango varieties for both methods. Our results indicated a high intraspecific genetic diversity of local mango varieties in Kenya. The methods used were suitable for variety identification and classification. They could be implemented for further variety evaluation and breeding purposes as well as for future efforts on *circa-situ* conservation of mango genetic resources.

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Session: The roles of agroforestry in managing fragmented multifunctional landscape



Session: The roles of agroforestry in managing fragmented multifunctional landscape

## **BIODIVERSITY CO-BENEFIT OF REDD+: HOW TO MAKE IT WORKS?**

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Biodiversity maintenance is key among the environmental services that need to be safeguarded within REDD+ mechanism. There is recognized risk that climate change mitigation action can harm biodiversity by focus on monoculture tree plantations, while the basic expectation is that REDD+ will have positive impacts on biodiversity dynamics, an effect often referred to as co-benefit. It is not clear though at this stage how the safeguard is going to be measured, monitored or even verified. Indonesia as one of the biodiversity hotspots in the tropics and at the same time one of the few leading tropical countries in REDD+ debate has a lot to offer with regards to lessons learnt on this front.

Using plot inventory data across Indonesia, empirical relationships between tree species richness and Carbon stock is derived. The shape and strength of the relationships vary among different eco-regions across Indonesia. This finding suggests strong and common non-linearity pattern in the trajectory of multiple environmental service losses. On the other hand, efforts to rehabilitate environmental services would create a spectrum of relationship patterns between C-stock and biodiversity. An S-curve will be resulted from ecological restoration while an exponential curve is likely to turn up from a C-stock enhancement focused activities. Development of low intensity management of agroforests might show ac close to linear relationship between C-stock and biodiversity, especially for those tree species regarded as being valuable by the land managers.

In achieving biodiversity co-benefit of REDD+, policies and programs should be based on the understanding of the different effects of rehabilitation efforts at the plot level, the recognition of the ecological processes at the landscape level and the identification of the critical areas for specific targets at the eco-regional level. This study investigates multiple level interlinkages of biodiversity and REDD+ in Indonesia and formulates ways to move forward.

Session: Tropical dendroecology

## GROWTH DYNAMICS OF NATIVE WOODY SPECIES ALONG AN ELEVATIONAL GRADIENT IN THE CENTRAL MARAÑON VALLEY, NORTHERN PERU

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The upper Amazon River, also called the Marañon, parallels as an inner Andean dry valley the Cordilleras of Northern Peru. The steep valley flanks cover an orographic gradient of more than 3000m within a few kilometers of horizontal distance. The local climate in this region varies within short distance from hot-arid at the valley bottom to cold-humid on the upper slopes. The Marañon Valley is also the climatic and floristic border between the dry West Andes and the tropical moist Eastern Andes. This special geographic and climatic situation, in combination with its relative remoteness, preserved the presumptive Andean natural vegetation types of woody vegetation covers in some areas. Intact relict forests can be found in some valleys covering almost uninterrupted an elevational gradient of more than 2000m.

In our present study we focus on the site characterization and growth dynamics of dominant native woody species in relict forests along this gradient.

Our objective is to document the vegetation types with relict forests as well as the seasonal and interannual variation and interaction of climate and tree growth from the arid valley bottom to the moist and cool upper tree line forests. We present results from three permanent monitoring sites at the west side of the valley from August 2010 up to now. In spite of the inner tropical location most tree species studied show very different intra-annual growth dynamics. Some tree species like *Clusia* grow continuously while e.g. *Acacia macracantha* and *Annona cherimola* show an extremely seasonal growth. *Clusia* showed a radial growth of about 1.3mm in six months. *Acacia macracantha* showed a radial growth of 1.8mm and *Annona cherimola* 0.6mm in one year. Large deciduous *Eriotheca peruviana* trees near the arid valley bottom and *Rhamnus* in a relict forest had no detectable growth at all during the observation period.

Given the large dimensions of our measuring trees in some cases and the formation of tree rings in combination with a supposed seasonal growth, we will in a second step explore the potential of very old individuals along the elevation gradient for tree age dating and dendroclimatic studies.

**Merian award applicant**

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Session: Tropical dendroecology

## GROWTH DYNAMICS OF *TABEBUIA CHRYSANTHA*, AND THEIR RELATIONSHIP WITH CLIMATIC FACTORS IN A DRY AND HUMID FOREST IN SOUTHERN ECUADOR

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The objective of our study is to evaluate tree growth of the deciduous tree species *Tabebuia chrysantha* (Bignoniaceae) in two different forest types of southern Ecuador under different climatic conditions, namely in a dry forest (Laipuna Natural Reserve) and a mountain cloud forest (Reserva Biologica San Francisco). To investigate the temporal dynamics of growth, high resolution electronic dendrometers were installed, measuring tree diameter changes in 30 minute intervals. Wood formation was studied by means of wood anatomical studies, obtaining micro cores in monthly intervals. The two independent sources of information complement each other since stem diameter variations may also be caused by changes in the hydrological status of a stem. The observed diurnal stem diameter fluctuations have been primarily controlled by radiation which increased the atmospheric vapor pressure deficit and the transpirational water loss of the trees. The formation of visible growth ring boundaries marked by a marginal parenchyma in the deciduous *T. chrysantha* has enabled us to detect the annual dynamic of growth, which is induced by the seasonality of the hydrological cycle in the dry forest. In the dry period, the trunk is shrinking and the cambium is in a state of dormancy.

Session: Tropical dendroecology

## HOW DO TROPICAL TREE SPECIES RESPOND TO NITROGEN FERTILISATION? TREE GROWTH ALONG ELEVATIONAL AND NUTRITIONAL GRADIENTS IN SOUTHERN ECUADOR.

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The tropical mountain forests of southern Ecuador are strongly threatened by environmental effects. In the near future increasing drought-events and higher nitrogen depositions in the air are expected (IPCC 2007) thereby affecting tree-physiognomic processes in a major way. As part of a scientific nutrient manipulation experiment (NUMEX) tree growth of seven different tropical tree species (*Podocarpus oleifolius*, *Graffenrieda emarginata*, *Persea feruginea*, *Alchornea grandiflora*, *Prunus sp.*, *Weinmannia elliptica*, *Weinmannia ovata*, *Graffenrieda harlingii* and *Prumnopitys montana*) were examined in a tropical mountain forest in southern Ecuador (Reserva Biológica San Francisco) along elevational (2000m and 3000m) and nutritional (nitrogen-manipulated plot and non-manipulated plot) gradients. Since July 2010 stem-diameter variations of these tree species have been measured in 30 minutes intervals by 16 high resolution dendrometers detecting the impact of nitrogen (N) fertilization on stem diameter variations. Preliminary results reveal that beside *Graffenrieda emarginata*, all individuals growing on N-manipulated plots show more stem diameter growth compared to the individuals at the non-manipulated reference plots. These stem diameter variations were linked to climatic factors. During periods of several successive days without rainfall stem diameters decrease and vary synchronously even between the different tree species of different plant functional types. These first results are extremely useful for the intra-annual analyses of stable isotopes which will be discussed in this study as well.

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Session: Tropical dendroecology

## WATER USE AND STEM GROWTH IN A MONTANE PINE PLANTATION IN S-ECUADOR

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Plantations of *Pinus patula*, a native species of Mexico, are commonly found on degraded pastures in tropical montane regions. The effects of tropical monoculture pine plantations on the water cycle are often debated. While information on annual wood productivity and management effects is numerous, data on plantation water use are scarce and eco-physiological studies of the plant control of water mass flow are virtually absent.

We studied the diurnal and seasonal water uptake as well as radial stem growth dynamics of a pine plantation in Southern Ecuador, situated in the valley of the San Francisco River at approx. 2000m a.s.l. in a tropical montane humid climate. The monospecific plantation with a tree height of up to 19m was located next to a meteorological station near the Estacion Cinetifica San Francisco. We concurrently measured site meteorological parameters and on six mature individuals stem sap flux and radial stem growth for more than three years.

Water uptake was continuous during the year. Sap flux in conductive xylem areas reached a maximum of 25 gram H<sub>2</sub>O m<sup>-2</sup> xylem area s<sup>-1</sup> and is comparable to the range of non stressed conifers of the temperate montane and boreal regions. Water uptake was primarily driven by the atmospheric vapor pressure deficit. Stomatal control of transpiration is of minor importance for the water flux in trees. Due to frequent precipitation events throughout the year, no significant seasonal effects on transpiration were detected. Stem radial growth was present throughout the year. Peak radial growth rates were 20 microns day<sup>-1</sup>, observed annual increments were up to 3mm. Radial stem shrinking was limited to diurnal patterns of less than 0.1mm, notably following phases of several days without precipitation. Overall shrinkage exceeding diurnal patterns was not observed.

The pine plantation studied, neither experienced phases of physiologic drought nor longer periods of low sap flux which may reduce mineral uptake, cambial cell enlargement or consequently radial stem growth. Total tree water consumption is low compared with precipitation and is mainly driven by the atmospheric vapor pressure deficit.

Session: Tropical dendroecology

## COMPARISON OF CLIMAX AND PIONEER TREE SPECIES IN MUNESSA FOREST (ETHIOPIA): INTRA-ANNUAL ISOTOPE MEASUREMENTS ( $^{13}\text{C}$ ) AFTER *IN SITU* $^{13}\text{CO}_2$ LABELLING

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Munessa Forest is a dry tropical mountain forest in the south-eastern part of Ethiopia. Two indigenous tree species of different life forms were selected to investigate differences in tree physiology and adaptation strategies on local seasonality of rainfall. *Croton macrostachyus* (Euphorbiaceae) is a deciduous broadleaved tree growing up fast and light demanding in natural gaps. On the other hand *Podocarpus falcatus* (Podocarpaceae) is a shade tolerant evergreen conifer tree occupying the upperstory of the forest canopy as a climax species. After  $^{13}\text{CO}_2$  labelling within a whole tree labelling chamber at the end of long rainy season 2008 (October), wood samples (increment cores) were collected of labelled trees in March 2011. Furthermore, increment cores of unlabelled more or less same aged species were also analyzed for control. Depending on wood density, thin sections of 30 or 40  $\mu\text{m}$  were cut of the increment cores with the help of rotation microtome (Leica) followed by carbon isotopes ( $\delta^{13}\text{C}$ ) measurements of bulk wood. Results are discussed and compared to previous species-specific findings of dendrometer measurements.

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Session: Tropical dendroecology

## TRACING CLIMATIC SIGNALS AND RESPONSES TO CLIMATE VARIABILITY FROM STABLE ISOTOPES IN TREE RINGS

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Since instrumental climate data are scarce or of rather short duration in vast areas of Africa, knowledge on the range of natural climate variability and the range of tree species tolerance to climatic extremes is scarce. We have used stable carbon and oxygen isotopes in tree rings to explore their potential as climate proxies and as a means to assess adaptations of key agroforestry species from East to West Africa. Most of the study sites and species in Ethiopia, Tanzania and Burkina Faso showed formation of annual rings, however double ring formation were noted in a study site in Tanzania. Stable carbon ( $\delta^{13}\text{C}$ ) and oxygen ( $\delta^{18}\text{O}$ ) mean values showed similar inter annual patterns with positive correlations. In general, both  $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$  show negative correlations with rainfall, humidity and PDSI. On the contrary, they are positively correlated with sunshine hours, maximum temperature and evaporation. The results showed the potential of stable isotopes as climate proxy, establish large-scale correlation patterns between tree growth and sea-surface temperatures, and understand hydrological cycle and source water.

FRI 16:15 ROOM 0.014

Session: Effects of fragmentation on ecosystem functioning and services of biodiversity hotspot islands in tropical high mountains

## SECONDARY GROWTH IN THE BOLIVIAN ANDES: DISPERSAL LIMITATION, HABITAT LIMITATION AND COMPETITION WITH FERNS

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Tropical forests are heavily exposed to man made disturbances, resulting in a decreasing area of mature forests and conversely in an increasing area of secondary growth. Dispersal limitation, habitat limitation and competition with grasses and ferns are important factors that influence secondary succession. Although there are many studies of ecological processes driving secondary succession of tropical lowland forests, little studies took place in tropical montane forests.

In the present study, we investigated stand structure and composition of woody vegetation of tropical montane forest secondary growth in 5 formerly burned sites along an elevation gradient from 1950 to 2450 m asl. in the Bolivian Yungas. We tested the effects of dispersal limitation (= distance to the forest edge), habitat limitation (= micro climate and soil properties) and effects of competition with ferns (*Pteridium arachnoideum* and *Lophosoria quadripinnata*).

We set up 2 vegetation plots (each 100 m<sup>2</sup>) in each site, one in 20 m and one in 80 m distance from the adjacent forest edge. We recorded diameter at ground level and height of all free standing woody plant with height  $\geq 1$  m. Micro climate and soil properties (0 – 20 cm depth) were analyzed and compared with results from the forest interior. Fern abundance was measured and fern canopy structure characterized by hemispherical photography.

Analysis of data is still in progress but will be finished till the congress. Our results will help to understand better the driving factors of secondary succession of tropical montane forests.

**Merian award applicant**



Session: Effects of fragmentation on ecosystem functioning and services of biodiversity hotspot islands in tropical high mountains

## **MONTANE FOREST REMNANTS IN THE BOLIVIAN ANDES: HOW DOES ELEVATION, EDGE & TOPOGRAPHY EFFECT STAND STRUCTURE**

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Andean montane forests are highly diverse ecosystems. These outstanding biodiversity is partly caused by altitudinal and topographical gradients, which help to generate very heterogeneous environmental conditions. In many areas, montane forests are degraded by human activities resulting in a mosaic of remnant forest patches in a matrix of secondary growth. Edge effects are proved to alter environmental conditions and thus stand structure and composition of forest vegetation.

In the present study, we investigated the effects of edge, elevation and topography on stand structure of tropical montane forests.

We set up 6 sites in an area of heavily fragmented montane forests in the bolivian Yungas along an elevation gradient from 1950 to 2500 m asl. We installed 24 vegetation plots (each 400 m<sup>2</sup>), distributed inside the forests in gorges ("quebrada") and ridges ("loma") and at forest edges. We recorded DBH (diameter at breast height) and height of all free standing woody plant and tree ferns with DBH ≥ 2.5 cm. Canopy structure was characterized by hemispherical photography. Micro climate and soil properties (0 – 20 cm depth) were analyzed.

Analysis of data is still in progress but will be finished till the congress. Our results will help to understand better how stand structure of tropical montane forests is affected by elevation, topography and edge effects.

**Merian award applicant**

Session: Effects of fragmentation on ecosystem functioning and services of biodiversity hotspot islands in tropical high mountains

## **EFFECTS OF FRAGMENTATION ON TREE SPECIES COMPOSITION AND DIVERSITY IN THE ATLANTIC RAINFOREST OF RIO DE JANEIRO, BRAZIL.**

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The study aimed to analyze effects of forest fragmentation on diversity and composition of tree species communities in the ombrophilous submontane forest at the foothills of the Serra dos Órgãos in the state of Rio de Janeiro. In the study region a floristic survey of the tree community was carried out in 9 forest fragments of varying size (ranging from 5 ha to 130 ha) and one mature continuous forest using the point-centered quarter method. In each study site 220 trees with dbh  $\geq$  5 cm were sampled. The sampled 2,200 trees comprised 59 families, 176 genera and 299 species. The level of endemism was high in the mature forest (47 %). In contrast, only 21 % to 35 % of the species sampled in the fragments are endemic to the Atlantic Rainforest of Brazil. Species diversity of the largest fragment was comparable to that of the continuous forest (effective species sensu Jost 2006: 52 and 53 respectively), meanwhile species diversity of the other fragments was lower (22 to 45). All fragments showed a low floristic similarity to the mature forest with a Horn-Morisita Index of dissimilarity between 0.78 and 0.99. Remarkable differences in the floristic composition have been detected with respect to the occurrence of Myrtaceae and Sapotaceae, which belong to the main producers of fleshy fruits. Both families were found to be much more important in the continuous forest (FIV 40.4 and 22.7, respectively), than in the forest fragments (Mean FIV 13.6 and 6.4, respectively). Despite these effects on species composition and diversity resulting from fragmentation, some species, being considered as threatened, rare or even previously never observed in the state of Rio de Janeiro, were sampled exclusively in the forest fragments. The occurrence of these species highlights the importance of preserving those small fragments to maintain regional floristic diversity.

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Session: Effects of fragmentation on ecosystem functioning and services of biodiversity hotspot islands in tropical high mountains

## FERN AND LYCOPHYTE DIVERSITY IN SUBMONTANE FOREST FRAGMENTS OF THE ATLANTIC FOREST OF RIO DE JANEIRO, BRAZIL

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The study aimed to analyse the floristic differentiation and the diversity patterns of Pteridophytes (Ferns and Lycophytes) in three different sized submontane forest fragments at the foot of the Serra dos Órgãos. Especially we focused on species turnover along the edge-interior-gradient and among the forest fragments. Using a plot based approach the Pteridophyte communities were sampled within 44 sample sites (100 m<sup>2</sup> each), established along edge-interior transects. In the sample sites the cover-abundance of all terrestrial individuals were registered as well as the frequency of trunk epiphytes, growing up to a height of two meters above ground. Furthermore, we documented topographic data, soil parameters, light conditions and supplementary information of the vegetation structure. In addition to the plot based studies, a general inventory of Pteridophytes occurring in the fragments was carried out.

All together we recorded 84 species of Pteridophytes in the studied forest fragments. The majority (ca. 62%) of the considerable species rich Pteridophyte flora was restricted to certain habitats like escarpments, swampy sites, stream gullies or rivulet margins, which cover only a small part of the fragment area. This fraction of species is also the principal cause for differences in species richness between the studied fragments. Along the edge-interior gradient, which was studied using the plot based approach, we recorded a decrease of species richness, which can be explained by environmental parameters related to air and soil humidity. The species turnover along this gradient was lower than the species turnover between the fragments. Later indicates a high b-diversity at local scale. Besides to the two dominating species of all fragments, *Adiantum latifolium* Lam. and *Lygodium volubile* Sw., only three other species, *Lomariopsis marginata* (Schrader) Kuhn, *Danaea geniculata* Raddi and *Saccoloma elegans* Kaulf., were found in study plots of all fragments.

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## HOW TO DETECT THE TROPICAL BRACKEN COVER IN A FIRE-DISTURBED ECOSYSTEM IN SOUTH ECUADOR USING A QUICKBIRD SCENE AND FIELD-DERIVED SPECTRA?

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The megadiverse tropical mountain forest of South Ecuador is mostly threatened by the “slash and burn” activity. During the dry season forested areas are burned to establish new pastures lands for cattle ranching, but often fires are not well controlled and wider areas are burned. Moreover, the pasture lands if not well managed, loose fertility and finally are abandoned. In these two environments (burned areas and abandoned pastures lands) the tropical bracken (*Pteridium arachnoi-deum* and *P. caudatum*) is widely distributed. After a fire, the tropical bracken grows vigorously in large homogeneous stands; then, together with some other pioneer species - grasses and bushes -, it forms a very mixed and stable ecosystem. To contribute to a better management of these pasture lands, an understanding of the distribution patterns of the tropical bracken in this region is fundamental. Field-derived reflectance of the three bracken states (vital, senescent/dead and fungi-infected) was employed to classify a QuickBird scene. First results suggest that there is a substantial potential of combining field-derived reflectance and high resolution multispectral satellite images to detect the tropical bracken cover in this fire-disturbed ecosystem.

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## MODELING AND MONITORING SOUTHERN BRACKEN IN THE SAN FRANCISCO VALLEY IN THE ECUADORIAN ANDES

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The infestation of pasture areas by the ubiquitous bracken fern (*Pteridium* sp.) still is an unsolved problem in the tropical mountains of Southern Ecuador [1]. Once natural vegetation is converted to pasture, the bracken problem emerges. Even if a competitive C4-grass species (*Setaria sphacelata*) is cultivated, effort is needed to control the invasive weed. Environmental, exogenous factors (e.g. recurrent pasture burning) and direct competition between plants have been hypothesized to drive bracken occurrence. To investigate these hypotheses a dynamic vegetation model has been developed and initially tested in a plot scale. The vegetation model was first parameterized with field observations on plant traits [2, 3] and executed using in situ meteorological data in a diagnostic approach [3]. Validation on photosynthesis was carried out at leaf scale using independent measurements and the simulated annual productivity was compared with literature. New data of land cover derived by balloon aerial photography were combined with ground measurements to a prognostic simulation approach based on [4]. The results are in agreement with literature and contain local particularities, which can provide us a better understanding of bracken occurrence and its competition with pasture. In addition, parameterization work has continued to improve this knowledge, for instance through statistical evaluation of physiological traits. A further step is the spatial extrapolation of the results, starting within the valley in which the experimental plot is located.

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## **CLIMATE CHANGE EFFECTS ON TROPICAL MOUNTAIN RAIN FORESTS IN SOUTHERN ECUADOR AFTER IPCC SRES-AR4 SCENARIOS A1B AND B1**

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The Andes Mountains of Ecuador are one of the most biologically diverse regions of the world with a great richness of species and high ecosystem diversity. The climate of Ecuador is strongly influenced by this topographical structure with a variety of climate systems determined by altitude and the impinging easterly trade winds.

Within the DFG research unit 816 investigations of the interactions of abiotic and biotic factors in the highlands of South Ecuador; Rio San Francisco valley, provide a profound knowledge of the ecological and climate system. Over the last years various information about temperature development and precipitation dynamics were collected. These observations reveal highland-lowland interactions, early morning rainfall events in the study area and temperature development over the last decade.

Based on the IPCC AR4 an increase in air temperature and changes in precipitation behaviour is predicted for the Andean regions. During the wet seasons an increase in rainfall is expected and during dry seasons a decrease in rainfall, which both affect the hydrological cycle. The climate change projections of the IPCC AR4 GCM model output have coarse resolution. For this reason they cannot adequately capture the highly complex structure of the Andes. But spatial fragmentation due to the topography, naturally as well as anthropogenic, is a major issue in this tropical region. Land cover and land use changes can affect the climate system by climate feedbacks and vice versa. Therefore, a downscaling method for the IPCC emission scenarios A1B and B1 of the GCM CCSM (Community Climate Model) was implemented to make an altitudinal adaption in the ECSF region. In doing so climate station measurement data at different altitudes, reanalysis data as well as the CCSM data were used. On the basis of minimum and maximum air temperature as well as precipitation time series the future climate projection of CCSM is examined and adjusted to the study area of southern Ecuador.

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## FLORISTIC COMPOSITION, DIVERSITY AND STRUCTURE OF ULUGURU FORESTS IN MOROGORO, TANZANIA

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The Uluguru forests in the eastern arc mountains of Tanzania are recognized as important biodiversity hotspots. High population pressure and encroachment threatens their conservation value. A study in the region was undertaken in 2010 with the main objectives to: (1) determine floristic composition, structure and species diversity of seven forests in Uluguru; (2) compare floristic similarity of the forests with other thirty selected inventories in the wider region; (3) examine influence of geographical distance on floristic similarities. All trees (DBH  $\geq 10$  cm) were inventoried from 4.56 ha in all the seven forests. Most important families and species were determined using familial importance value (FIV) and species importance value (IVI) indices respectively. Diversity was analyzed using species richness, Shannon-wiener, Fisher- $\alpha$  and Simpson's indices. Floristic similarities were examined using a clustering technique based on Sorensen similarity coefficient. Association between geographical distance and floristic similarity was tested using the Pearson correlation test. Overall, 900 individual trees, 101 species, 73 genera and 31 families were identified. Fabaceae and Moraceae were the most speciose and important families. The five species with higher IVI were: *Ehretia amoena*, *Khaya anthotheca*, *Synsepalum cerasiferum*, *Sorindeia madagascariensis*, *Diospyros squarrosa*, all accounting for 27 % of the total IVI. 41 % of species had up to three individuals and 15 % occurred only once in all sample plots, showing a large occurrence of rare species. All diversity indices revealed Kilengwe and Kimboza being the most diverse forests. The overall Shannon-wiener of 4.03 indicates that Uluguru forests have high tree species diversity. The dendrogram showed four groups of forests with low similarity between them and assembling together forests by their geographical proximity. The average density and basal area were 197.6 stems ha<sup>-1</sup> and 8.99 m<sup>2</sup> ha<sup>-1</sup> respectively. The size class distributions revealed good regeneration in all the forests. The findings highlight the local and regional heterogeneity of the environments in the Uluguru and other coastal forests of Tanzania, and the high occurrence of rare species, which should be considered in management and conservation programs in the Uluguru and other eastern arc forests in order to maintain its structure in the long run.

Keywords: Eastern arc forests, Biodiversity hotspots, Cluster analysis, Floristic Similarities, IVI

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Session: Plant-animal interactions in fragmented landscapes

## MODELLING THE DISTRIBUTION OF TREE SPECIES USED BY LION TAMARINS IN THE BRAZILIAN ATLANTIC FOREST IN A FUTURE SCENARIO OF CLIMATE CHANGE

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We used three IPCC climate change scenarios (A1B, A2, and B1) in a dynamic vegetation model (CARAIB), to determine the potential future distribution of 75 species of trees used by two endemic primate species from the Brazilian Atlantic Forest (BAF). Habitat conservation is a vital part of strategies to protect endangered species, and this is a different approach to understanding how key plant species needed for survival of golden-headed lion tamarins (*Leontopithecus chrysomelas*) and golden lion tamarins (*L. rosalia*) might be affected by climate change and what changes to their distribution are likely. In the simulation experiments for the future, 72 out of 75 tree species maintained more than 95 % of their original distribution and all species showed a range expansion. The results suggested that the trees may benefit from an increase in temperature, if and only if soil water availability is not altered significantly as was the case with climate simulations that were used. The survival of these key tree species in their original range and as forest bodes well for conserving the associated BAF fauna, the two tamarin species. However, these results must be coupled with other information to maximise their usefulness to conservation since BAF is already highly fragmented and subject to high anthropic pressure. Future studies should particularly include plant-animal interactions by way of seed dispersal, which is an important aspect for natural regeneration processes. Models such as CARAIB may prove to be a useful tool for conservation practitioners interested in understanding how vegetation responds to changes in climate patterns.

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## DISPERSAL AND REGENERATION CAPACITY OF A LARGE-SEEDED TREE SPECIES IN A FOREST-SAVANNA MOSAIC IN WESTERN DR CONGO

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It is widely recognized that the Congo Basin is affected by numerous anthropogenic pressures. A number of studies proved that hunting and forest fragmentation diminish the diversity and abundance of large vertebrates, more specifically, of large frugivores. The depletion of those animals can directly affect large-seeded tree species as large seeds closely depend on the community of large frugivorous vertebrates for their dispersal. Then, the disruption of animal mediated seed dispersal is thought to deeply impact the plant regeneration capacity. The forest-savanna mosaic situated in Western DR Congo is an ecotone characterized by naturally occurring forest fragments which are also subject to numerous anthropogenic pressures. Those are very likely to disrupt seed dispersal mechanisms and to alter forest regeneration processes. To date, few studies have considered the effect of such an ecosystem on plant-animal interaction dynamics such as seed dispersal, and none have been done in this region. This study will examine if the early stages of regeneration of the large-seeded tree species *Anonidium mannii*, namely the dispersal capacity and seedling establishment is affected by forest fragment size. We predict that the small fragment size will negatively affect the regeneration capacity of this species. To test this assumption, we will work along a gradient of forest fragment sizes to define the composition of the seed disperser communities. For each disperser assemblage, we will evaluate the quantitative capacity of seed dispersal by combining direct focal observations and camera trapping. A literature review on each disperser species seed retention time and habitat use will allow the computation of the seed dispersal kernels. We will also evaluate the effect of seed ingestion by a presumably important seed disperser, the bonobo, *Pan paniscus*, on its germination capacity. Seeds will be collected from dung to evaluate the effect of seed ingestion on the rate and velocity of germination. Finally, we will study the predation pressure exerted on dispersed and non-dispersed seeds and seedlings by setting up two sets of seeds below the canopy of parent trees and away from any conspecific trees. One set will be dispersed unprotected to seed predators; another one will be enclosed in a cage and permit seeds to germinate, allowing us to evaluate the herbivores pressure on seedlings.

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## SEED DISPERSAL BY BATS AND BIRDS IN DIFFERENTLY MODIFIED SCARP FORESTS OF SOUTH AFRICA

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Modification of forest ecosystems can lead to changes in biodiversity and might have an influence on processes like seed dispersal. Vertebrate frugivores play a key role for the dispersal of woody forest plants in the tropics and subtropics. Still, the influence of forest modification on seed dispersal is poorly understood and especially comparisons between birds and bats are often missing.

We investigated seed dispersal by birds and bats in a heterogeneous South African forest landscape. We chose three forest types along an increasing intensity of modification: continuous natural forest, natural forest fragments and agricultural forest fragments surrounded by sugarcane fields. We studied animal-mediated seed dispersal in 15 study plots using seed traps. Seeds dropped in traps during the night were assumed to be dispersed by frugivorous bats, those during the day by birds. Distances of every fruiting tree inside the plots to seed traps were calculated, so that seeds could be classified in a) seeds from outside the study plot (external dispersal) and b) seeds from within the study plot (within-plot dispersal). We further assessed fruit availability, canopy cover and vertical heterogeneity of the forest plots. Our results show that, in general, bats dispersed slightly more seeds than birds, but dispersal by birds and bats did not differ between forest types. Overall seed species richness differed slightly among forest types and was marginally higher in natural fragments than in natural and agricultural forests. This effect was mainly driven by external dispersal events, whereby natural fragments received the highest species richness of externally dispersed seeds. Seed species richness and abundance resulting from within-plot dispersal was mainly driven by distance to the nearest fruiting tree and by vertical heterogeneity of the forest. Concludingly, it seems forest modification does not differentially affect bird and bat seed dispersal. Even though within-plot dispersal was comparable across forest types, dispersal from outside, and thus long-distance dispersal, seemed to be affected by forest modification. Our results highlight the importance of connectivity of remaining forest patches in a heterogeneous human-modified landscape.

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Session: Plant-animal interactions in fragmented landscapes

## SPATIAL GENETIC STRUCTURE OF SYMPHONIA GLOBULIFERA POPULATIONS FROM DIFFERENT CONTINENTS

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*Symphonia globulifera* (Clusiaceae) is a widespread and very old tropical rainforest tree species with fossil pollen records dating back to ~45 Myr bp. Today it is found in tropical Africa, America and the West Indies, whereas its ca. 20 congeners are endemic to Madagascar. Fossil records indicate sweepstakes dispersal from Africa during the Miocene as origin of Neotropical *S. globulifera* populations. The flowers of *S. globulifera* are insect-, or bird-pollinated and its fruits are dispersed by birds and various mammals. Due to the widespread distribution of the species and the long-term geographical separation of its populations, individuals from distinct regions and on different continents are associated with specific pollen and seed dispersal vectors. Pollen and seed disperser communities shape local gene flow patterns, and determine thereby the plant's spatial genetic structure (SGS) within populations, in conjunction with plant density. We investigated and compared the SGS within *S. globulifera* populations from Atlantic Equatorial Africa, Central and South America with nuclear microsatellite markers and tested whether the strength of the observed SGS corresponded to the *a priori* expectations based on the respective local disperser communities.

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Session: Plant-animal interactions in fragmented landscapes

## THE EFFECT OF SEED PREDATION, SEED SIZE AND HABITAT ON SEEDLING RECRUITMENT IN AN AFROMONTANE FOREST.

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In this study we determine the role of habitat, seed size and seed predation on seedling recruitment. We used five seed species - *Carapa* sp. and *Anthonotha noldea* (large seeded), *Garcinia smeathmannii* and *Pouteria altissima* (medium size seeds) and *Syzygium guineensis* (small seeded) in three forest habitats - 'core', 'edge' and 'riparian fragment'. Seeds were placed in each of four treatments: buried/uncaged; buried/caged; surface/caged; surface/uncaged. We recorded the fate of each seed as either 1) germinated, 2) infected by fungal pathogens, or 3) predated by vertebrates. Seedling survival was also assessed. Our results after one year over all the four treatments demonstrate that i) seed predation is significantly higher in the fragments than in the core or edge. ii) Seed germination was significantly higher in the core than in the edge or the fragments. Fungal pathogens killed relatively fewer seedlings in the core than in the fragments or the edges. iii) Overall habitats survival of seeds and seedlings was higher in the caged treatment than open plots. Our findings have important implications for forest restoration and conservation. Data collection is ongoing.

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Session: Importance of microhabitats for tropical biodiversity and functional ecology

## **BIODIVERSITY OF AEROTERRESTRIAL MICROALGAE IN TROPICAL MOUNTAIN RAIN FOREST HABITATS IN PODOCARPUS NATIONAL PARK (ECUADOR)**

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Biodiversity of aeroterrestrial microalgae in tropical mountain rain forest habitats in Podocarpus National Park (Ecuador)

Terrestrial habitats like epiphytic crusts and soils in tropical rainforests are among the least known habitats for microalgae world-wide. Recent studies have almost exclusively concentrated on members of the Trentepohliales (Ulvophyceae) in epiphytic habitats. Molecular methods have not yet been used to microalgae in these habitats.

This project is aimed at the acceleration of existing workflows to discover and describe ecologically important species using molecular methods. These techniques are used upon tropical mountain rainforest habitats in Podocarpus National Park (Ecuador) in order to register the alpha-biodiversity in these little explored habitats. Additionally, the differences between the biodiversity of the terrestrial algae along a gradient of elevation (1000m-3000m absolute altitude) shall be investigated. A Combination of culture-dependent and -independent methods is used in order to get a preferably complete insight in the biodiversity as well as to gather large amounts of molecular data and references for phylogenetic analysis and barcoding. For both approaches, a specific primer combination is used for PCR that allows an easy and fast amplification of a small part of the SSU-rDNA as well as the complete ITS1, 5.8S-rDNA- and ITS2-regions. The information from approximately 300bp of 18S-rDNA is accessible for phylogenetic analysis using references from NCBI and the EPSAG-Database. The ITS2-Information is used as the unique barcode and to create secondary structures that allow a screening for compensatory base changes (CBCs) to separate species. First results indicate that, among the green algae and aside from Trentepohliales, relatives to the genera Heveochlorella, Coccomyxa and Chloroidium play a decisive role.

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Session: Importance of microhabitats for tropical biodiversity and functional ecology

## **WOODY SPECIES FRUIT PRODUCTION IN CERRADO SAVANNA: SEASONAL PATTENS, NUTRIENT CONTENT, AND MICRO-ENVIRONMENTAL INFLUENCE**

*Maria Gabriela Gutierrez de Camargo<sup>1</sup>, Eliana Cazetta<sup>2</sup>, L. Patrícia C. Morellato<sup>1</sup>*

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Fruiting can be constrained by different factors such as climate seasonality, microenvironmental conditions, species composition and phylogeny. Among animal-dispersed plants, biotic interactions also influence fruiting seasonality and patterns of fruit production, and are closely linked to fruit nutritional content. We quantified, the fruit production, availability and nutrient content over time in a woody cerrado-savanna vegetation in Southeasten Brazil. We also investigated if local environmental conditions, here represented by the cardinal orientation of the faces (east and south) of our study site affected: (1) the fruiting pattern and the amount of fruits produced by dispersal syndrome; and (2) the relative contribution of dominant species on fruiting pattern and fruit production at different faces. We sampled all woody individuals within 36 transects equally distributed between east (lighter and warm) and south (darker and colder) faces of the cerrado-savanna study site. We monitored phenology, counted fruits and estimated fruit biomass fortnightly during 17 months and, for zoochoric fruits, we estimated protein, lipids and carbohydrates content (pulp or aril). Fruiting patterns were similar between faces. The nutrient content availability followed the seasonal pattern of zoochoric fruits production. However, total number of fruits produced was significant higher in the east face, regardless the seed dispersal syndrome. Instead, the total biomass of zoochoric fruits did not differ between faces but was 2-fold higher on east face. The species contribution to fruiting patterns also differed between faces. We demonstrated the influence of local environment and species composition on the fruiting patterns, mostly for abiotic seed dispersal. The results stress the relevance of the cerrado as a food source for frugivores in quantity and quality and the importance of vegetation heterogeneity ensuring diversity and availability of resources throughout the year.

FRI 16:15 ROOM 0.014



Session: Free Topics

**SMALL MAMMAL DIVERSITY AND ABUNDANCES IN A LOWLAND RAIN FOREST IN PENINSULAR MALAYSIA**Nadine Ruppert<sup>1</sup>, Asyraf Mansor<sup>1</sup>, Shahrul Anuar Mohd Sah<sup>1</sup><sup>1</sup>Universiti Sains Malaysia, Penang, MY, [ruppert.nadine@googlemail.com](mailto:ruppert.nadine@googlemail.com)

Small mammals contribute to important biotic forest ecosystem processes like seed dispersal or pollination but despite their importance not much is known about their community composition and diversity in Malaysian rain forests. To find out more about small frugivorous mammals at ground level we conducted a mark and recapture trapping programme in five 1 ha-sized study plots in a primary jungle reserve in Peninsular Malaysia (Segari Melintang Permanent Forest Reserve, 4° 18'N, 100° 34' E). Plots were set at the forest edge joining oil-palm plantations and away from the forest edge and hosted different vegetation types i.e. Dipterocarp dominated vegetation and alluvial fresh water swamp vegetation. 100 wire mesh life traps were set with banana bait in each plot once a day for a total of 50 days per plot from July 2010 until December 2011 (ongoing). Population sizes for each species were calculated using MARK software and diversity indices, body measurements, sex-ratios, age structure and breeding seasons were assessed. A total of 325 small mammals of 13 species and 9 genera were caught comprising rodents and tree shrews. The most abundant species was the Common Tree Shrew (*Tupaia glis*, 32.2% of overall captures, mean estimated population size by MARK 22.6 individuals per hectare), followed by the Grey Tree Rat (*Lenothrix canus*, 12.8%, 7.8 ind/ha), Whitehead's spiny Rat (*Maxomys whiteheadi*, 11.6%, 8.4 ind/ha), the Plantain Squirrel (*Callosciurus notatus*, 11.3%, 8.6 ind/ha), and the Long-tailed Giant Rat (*Leopoldamys sabanus*, 11.0%, 8.2 ind/ha). Diversity indices in the study plots ranged between 1.34-1.81 (Shannon Wiener Index, Hmax= 2.89) and 0.51-0.72 (Evenness) during different seasons and between the plots. Small mammals play a crucial role for the rain forest's biotic ecosystem processes and studying their behaviour and biology is vital if one wants to fully understand the jigsaw of rain forest dynamics in order to be able to act on conservation of this vulnerable ecosystem.

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Session: Free Topics

## DIVERSITY AND BIOACOUSTICS OF ORTHOPTERANS OF THE CHIQUITANIA (SAN SEBASTIÁN, BOLIVIA)

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Bolivia has a high biodiversity that might be caused by the variety of different South American vegetation types that encounter here. Fundamental evolutionary processes that lead to high species diversity are only partly understood. In orthopterans acoustic signalling is considered to have significance in reproductive isolation between species. Males produce species-specific songs and females choose their mates according to their acoustic preferences. For that, fast ethological differentiation could promote rapid radiation in this group. Whereas comprehensive and regional studies about bioacoustics of European and Northern American orthopterans exist, less is known about regions of highest biodiversity, as the Neotropics. A recently initiated project focuses on diversity and bioacoustics of orthopterans of the Chiquitania, a poorly studied region in Eastern Bolivia. During our first field stay in the 3500-hectare study area of the *Centro de Investigaciones Ecológicas Chiquitos* in San Sebastián – between May and June 2011 –, a total of 66 Orthoptera species were found, comprising members of the families Acrididae, Romaleidae, Proscopiidae, Eumastacidae, Tetrigidae, Tettigoniidae, Gryllotalpidae, Gryllidae, and Anonostomatidae. Furthermore, first bioacoustic recordings were made and daily calling activities of different species were determined to get information about acoustic niche partitioning and acoustic interferences between species. As our behavioural observations also revealed, many species of the diverse group of Acridomorpha (short horned grasshoppers) do not produce sound. How the sexes meet and how the females choose their mates in these grasshoppers is completely unknown. In several species there are indications that other communication systems are used, e.g. contrastingly coloured body parts and distinct enhanced eyes in these diurnal grasshoppers are clear hints for visual signalling.

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## **ABUNDANCE, RICHNESS AND COMPOSITION OF BUTTERFLY ASSEMBLAGES IN CREEK, SLOPE AND RIDGE RAINFOREST IN THE PACIFIC LOWLANDS OF COSTA RICA**

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Rainforests situated in creeks, on slopes and on ridges are characterized by different plant richness and composition. Using butterflies as model organisms, our study in the Piedras Blancas National Park in the Pacific lowlands of Costa Rica analysed to what extent such topographically-shaped forest heterogeneity affects the diversity and composition of assemblages of herbivorous insects. Butterflies were sampled between November 2009 and February 2010 along transects (all species) and by using fruit baits (only fruit-feeding nymphalids) in all three forest types (creek, slope and ridge forest). In total, 578 specimens belonging to 77 species were recorded by transect runs and 140 fruit-feeding nymphalid butterflies belonging to 33 species were sampled by bait-trapping. Butterfly assemblages sampled along transects showed lowest species richness in slope forest. Species richness of fruit-feeding nymphalid butterflies increased from creek to ridge forest. The three forest types differed significantly in their butterfly composition. Our study demonstrates strong effects of topography on the structure of rainforest butterfly assemblages, which has to be considered when analysing patterns of biodiversity on smaller spatial scales.

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## MORPHOLOGICAL SPECIALIZATION INFLUENCES NECTAR EXTRACTION EFFICIENCY OF SYMPATRIC NECTAR-FEEDING BATS

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Neotropical flower-visiting bats (Phyllostomidae: Glossophaginae) largely depend on nectar resources and show distinct adaptations to a nectar diet. Glossophagine bats form local guilds of 2-6 species that may differ distinctly in skull morphology. In order to test how and to what extent this morphological diversity influences the efficiency of nectar extraction and hence also resource partitioning within the local bat guild, we conducted flight cage experiment with three sympatric nectar-feeding bats (*Glossophaga soricina*, *Leptonycteris yerbabuenae* and *Musonycteris harrisoni*) that presents different degrees of morphological specialization. During the experiments we presented to the bat an artificial flower and measured the amount of nectar extracted and the time spent in hovering flight at different nectar depth (1-7 cm). All species showed at deeper nectar levels a decrease in the amount extracted per visit and an increase in time spent hovering at the flower, indicating increased energetic cost when foraging on longer-tubed flowers. The lowest nectar extraction efficiency (g/s) was found in the small *G. soricina* and the highest in the largest species *L. yerbabuenae*. However, when considering also the different energy requirements of the different-sized bat species, the morphologically most specialized *Musonycteris harrisoni* showed consistently the highest foraging efficiency. As nectar-feeding bats experience significantly diminished extraction efficiency at long-tubed flowers, they should prefer the shorter-tubed flowers within a plant population, while long flowers should be avoided and selected against. Our data suggests that the oversized feeding apparatus of the small *M. harrisoni* enable it to use the widest range of bat flowers available in the area, allowing *M. harrisoni* to persist year-round with a strict nectar diet, while other nectar-feeding species need to migrate or to complement their diet over the annual cycle with other food items, such as fruits and insects.

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## SWEET TOOTH WITH GOOD TEETH - LOW PERCENTAGE OF DENTAL CARIES IN THE NEOTROPICAL FRUGIVOROUS BAT *A. JAMAICENSIS* AND PROBABLE CAUSES

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Caries is in today's human society one of the most widespread diseases. It affects humans as well as most of all other mammal species. While there are many studies focussing on dental decay in humans and in animal models, there is only little known about the complex microbiological and environmental interactions that lead to dental caries in wild animals.

Although the frugivorous bat *Artibeus jamaicensis* (Chiroptera: Phyllostomidae) consumes fruits with high content of sugar, its teeth are far less affected by cavities than those of humans. In order to confirm this initial observation and to look for possible explanations, we conducted a multidisciplinary study on Barro Colorado Island (Panama). Teeth of captured bats were examined and categorized using dentist's criteria for determining the incidence of cavitations. Only 1.3 % (3 from 230) of the captured *A. jamaicensis* showed damaged teeth. Using (Mira<sup>2</sup>-Ton) staining, we found that only 0.9 % of the bats' teeth surface was covered by bacterial plaque, which is clearly less than in humans.

To characterize the oral microbial community of these bats, saliva samples were extracted and the amplified 16S rDNA from these samples was analysed by 454-Pyrosequencing. With regard to the composition of microorganisms the oral microbiota of healthy bats is very similar to that of humans. We detected biofilm-producing bacteria, which are capable of building dental plaque, as well as facultative anaerobic bacteria. Obligate anaerobes were only detected in a caries-affected *A. lituratus* specimen. All these anaerobic genera are potentially cariogenic. Teeth of bats were examined in hardness, surface structure and enamel, and compared to human teeth. First results show that bat teeth have a smoother surface structure and thinner enamel layer. These preliminary results suggest that the particular surface structure is related to less caries incidence in *A. jamaicensis*.

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## JAMMING AVOIDANCE IN FREE-RANGING GREATER BULLDOG BATS (NOCTILIO LEPORINUS)

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Bats use echolocation as an active sensory system for orientation in space and for foraging. They rely on the information content provided by the echoes of their emitted signals. In the presence of conspecifics, signals of several individuals may overlap and interfere with each other (jamming), thus diminishing the bats' ability to extract information from the respective echoes. Behavioural responses generating an enhancement of differences in call parameters between individuals, e.g., by shifting the peak frequency of search calls has been proposed as a technique to overcome such jamming situations (Jamming avoidance response, JAR).

We conducted field experiments in Panama with the Greater Bulldog Bat *Noctilio leporinus* (Noctilionidae), a bat that emits calls with the peak energy in the constant frequency (CF) component of its calls. We confronted free flying bats with playbacks from conspecific search signals and recorded their echolocation calls.

Contrary to expectation, *Noctilio leporinus* did not perform JAR by shifting the frequency of its CF components. We suggest that bats with highly sensitive, narrow acoustic foveae such as *N. leporinus*, may cope with jamming situations by other strategies than frequency shifts.

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## RAIN INCREASES THE ENERGY COST OF BAT FLIGHT

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Similar to insects, birds and pterosaurs, bats have evolved powered flight. But in contrast to other flying taxa, only bats are furry. Here, we asked whether flight is impaired when bat pelage and wing membranes get wet. We studied the metabolism of short flights in *Carollia sowelli*, a bat that is exposed to heavy and frequent rainfall in neotropical rainforests. We expected bats to encounter higher thermoregulatory costs, or to suffer from lowered aerodynamic properties when pelage and wing membranes catch moisture. Therefore, we predicted that wet bats face higher flight costs than dry ones. We quantified the flight metabolism of bats under three treatments: dry pelage, wet pelage and no rain, wet pelage and rain. Dry bats showed metabolic rates predicted by allometry. However, even though bats did not differ in body mass among treatments, flight metabolism increased twofold when bats were wet, no matter if they were additionally exposed to rain or not. We conclude that bats may not avoid rain only because of sensory constraints imposed by raindrops on echolocation, but also because of energetic constraints.

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Session: Free Topics

## **TACKLING THE CHALLENGE OF MONITORING A CRYPTIC PREDATOR'S ROLE IN CURRENT DRAMATIC TROPICAL MAMMAL DECLINES**

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Since European settlement, Australia has experienced the worst mammal extinctions of any country in the world. These mostly occurred in arid and temperate Australia. Recently, however, there is another wave of dramatic mammal declines in Australian tropical savannas. While cats were blamed for historical extinctions in other parts of Australia, their role in the current declines is not clear, partly because cats have been present for a long time, but also as they are cryptic and there is little reliable information on abundance or most aspects of their ecology. To understand the role of cats we will monitor their impact on re-introduced Pale field rats (*Rattus tunneyi*) which have declined severely in the tropical savannah of the Northern Territory. Using a detection dog and soft-jaw traps, we will catch 10 cats around two pairs of cat-accessible and cat-inaccessible rat enclosures. Cats will be fitted with GPS collars to track their movements. Cat density will be estimated using camera-trap arrays and sandplots at different distances from the enclosures. As the project will start in April 2012, no results will be presented, but we would like to use this presentation to exchange ideas about catching and monitoring this cryptic predator.

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Session: Free Topics

## ESTIMATING FOREST DUIKER (CEPHALOPHINAE) DENSITY IN KORUP NATIONAL PARK: A CASE STUDY ON THE PERFORMANCE OF THREE LINE TRANSECT METHODS

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Forest duikers (Cephalophinae) are important targets of the bushmeat trade but a reliable and efficient assessment of these shy animals is often regarded as problematic. Using a power analysis approach, we assessed the performance of three established methods (diurnal, nocturnal and indirect dung surveys) in producing density estimates for the Blue and the Ogilby's duiker (*Cephalophus monticola*, *Cephalophus ogilbyi ogilbyi*) in a 16 km<sup>2</sup> section of primary forest, systematically sampled using line transects.

Direct survey methods (diurnal and nocturnal) yielded density estimates between 8.3 and 6.8 (Blue duiker) and 6.5 and 4.3 animals / km<sup>2</sup> (Ogilby's). The coefficients of variation of density estimates implied a resolution of 44% density change detectable in diurnal surveys but only of 140% in nocturnal surveys. Density estimates derived from the dung survey were lower than those of direct surveys (1.5 animals / km<sup>2</sup> and 1.4 animals / km<sup>2</sup>, respectively). Associated coefficients of variation imply a resolution of change in density estimates detectable for changes far larger than 100%. However, dung pile density was susceptible to variation in key parameters (decay and production rates) and difficulties in data acquisition lead us to reject the dung survey as a suitable method in our particular setting. Our results suggest that diurnal direct surveying from line transects can be reliable and effective even for shy forest ungulates under (some) hunting pressure.

Session: Free Topics

## SYMMERIA PANICULATA IS THE WORLD'S BEST DIVING TREE

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*Symmeria paniculata* Benth. (Polygonaceae) is a light-demanding evergreen tree species which is distributed in tropical South American wetlands. In Brazilian Amazonia, it grows in the lowest levels of the flooding gradient in nutrient-poor blackwater inundation forests.

*S. paniculata* is one of the most submergence tolerant trees known to date. It does not shed its submerged leaves despite flooding durations of up to seven months. The whole plant may be flooded for prolonged periods at the sapling stage, partly in complete darkness.

This extraordinary capacity might lead to the assumption that leaf characteristics indicate special features which allow the tolerance and survival of prolonged flooding. This however is not the case. Comparisons of anatomical and morphological leaf structures with other tropical tree species or other Polygonaceae revealed that *S. paniculata* follows the general pattern of the family, i.e. the leaves did not appear to be related to particular floodplain conditions. However, several features such as thick epidermis cells and cuticula, cuticular wrinkles, epicuticular waxes, raised stomatal rims, and sunken stomata should facilitate the survival under floodplain conditions.

Chlorophyll fluorescence measurements at up to 8 m under water showed that the leaves were able to maintain an undamaged photochemical apparatus, also when submerged in complete darkness for up to 163 days.

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## THE INFLUENCE OF TOPOGRAPHY ON TREE REGENERATION IN CANOPY GAPS IN A TROPICAL MONTANE FOREST IN SOUTHERN ECUADOR

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Topography plays a major role in controlling the environmental conditions of montane forests. But in contrast to lowland forest, where canopy gaps are a key component of forest dynamics, there is little known about the importance of gaps in montane forests.

Aim of this long-term study was to investigate the influence of the topographic position on tree regeneration in canopy gaps in an Ecuadorian montane forest at c. 2000m asl. We monitored the growth of tree seedlings and saplings over a period of 7 years (five inventories from 2003 – 2010). Permanent transects were installed under six natural canopy gaps and their adjacent understory in ridge and ravine forests.

At the beginning of our study, mean seedling density on the ridge was more than twice as high as in the ravine, with a decrease of plant density during the monitoring period at both positions. In general, height increment in the ravine was higher than on the ridge, the mean height increment rates decreased over the course of the study. On average, saplings and seedlings in the ravine started out higher than those on the ridge (mean plant height 2003: 34.0 cm ridge vs. 35.9 cm ravine) and the difference between the sites has increased with time (mean plant height 2010: 66.8 cm ridge vs. 89.7 cm ravine). Both mortality and recruitment rates decreased from 2003 to 2010, although there was a small peak in recruitment between our second and third inventory (2004 – 2006).

Since climate conditions are similar, variation in soil nutrient availability related to topography is likely to cause the observed differences in primary succession.

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## FERN AND LYCOPHYTE DIVERSITY ALONG AN ALTITUDINAL GRADIENT IN THE SERRA DOS ÓRGÃOS, SOUTHEASTERN BRAZIL

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Within the BMBF funded project DINARIO (Climate change, landscape dynamics, land use and natural resources in the Atlantic Forest of Rio de Janeiro) we studied the floristic differentiation and the diversity of Pteridophytes (Ferns and Lycophytes) along abiotic gradients. The study was carried out in the submontane, montane and high montane forest of the Mata Atlântica in the Serra dos Órgãos in three different, but connected nature reserves: the Parque Nacional da Serra dos Órgãos (PARNASO), the Parque Estadual dos Três Picos (PETP) and the Estação Ecológica Estadual do Paraíso (EEEP). In this study area the flora of the Pteridophytes was characterised along an altitudinal gradient (200 to 2100 m a.s.l.) within 114 sample sites (each 100 m<sup>2</sup>). These sample sites were established along three different transects. Within the sample sites all terrestrial individuals, as well as trunk epiphytes growing up to a height of two meters above ground, were registered. In addition to the species data for all Pteridophytes (cover-abundance, life form) we documented topographic data, soil parameters, light conditions (using hemispherical photographs) and supplementary information on the vegetation structure.

The Pteridophytes showed a high species diversity in the understory of the study area. In total we recorded about 37 % of the Pteridophyte species (so far 203 of 553 spp.) known for the state of Rio de Janeiro. Most of the species (143) were inventoried within the 114 sample sites. The most diverse families were the Dryopteridaceae, Polypodiaceae, Aspleniaceae and Hymenophyllaceae. The most diverse genera were *Asplenium*, *Elaphoglossum*, *Campyloneurum*, *Pteris* and *Diplazium*. The floristic composition of the Pteridophyte communities changed between the different altitudinal forest types (submontane, montane and high montane forest) and several species showed clear preferences for one of these types.

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Session: Free Topics

## EFFECTS OF EXPERIMENTAL NUTRIENT ADDITION ON THE ESTABLISHMENT AND GROWTH OF TROPICAL MONTANE FOREST TREE SEEDLINGS IN SOUTHERN ECUADOR

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In the mountain forests of southern Ecuador a nutrient manipulation experiment (NUMEX) is carried out with the aim to investigate changes in forests dynamics as a consequence of increased nutrient deposition. The growing availability of nutrients such as N and P may affect the regeneration and establishment of tree seedlings in these ecosystems and, through it, cause changes in the floristic composition of mature forests since the seedling stage is one of the most vulnerable phases during tree establishment.

Composition and growth of tree seedlings have been analyzed after one and a half year of monitoring 192 regeneration plots (1m<sup>2</sup> each) equally distributed to control and nutrient addition treatments (+N, +P, +N and P) in the NUMEX plots at 2100m asl (San Francisco Reserve).

First effects in seedling performance show that N and the combination of N and P seem to have a general positive effect on the growth rate in most of the species hence supporting the hypothesis that N is a limiting plant growth in the study area. In contrast, P alone had no apparent effect. Plant families such as Melastomataceae and Euphorbiaceae showed a positive effect to N addition (N and N+P), while others (e.g. Arecaceae) only responded to the combination of N and P.

Other families, such as Myrtaceae and Rubiaceae, have shown a significant decline in seedling density in plots where N was added (N and N+P).

Based on these first data and considering that some of the most abundant tree species in the old-growth montane forests of the study area are *Graffenrieda emarginata* (Melastomataceae) and *Myrcia* sp. (Myrtaceae), we expect the continuous addition of nutrients to affect the population size of these species and thereby to influence the future tree species composition.

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Session: Free Topics

## **EFFECTS OF DISPERSAL LIMITATION OF SOIL SEED BANKS IN TROPICAL MONTANE FOREST SECONDARY GROWTH IN THE SOUTHERN YUNGAS OF BOLIVIA**

Florian Walter<sup>1</sup>, Denis Lippok<sup>1</sup>, Isabell Hensen<sup>1</sup>

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Effects of dispersal limitation of soil seed banks in tropical montane forest secondary growth

Note: The study we want to present is currently under progress. Results will be shown by the presentation.

Soil seed banks are obviously one of the elementary components for the natural regeneration ability of tropical rain forests. Recent studies revealed dispersal limitation as an important influencing factor. The studies have shown, that the general vegetation structure of the forest, for instance the canopy structure, influences especially the dispersal success of animal-dispersed species. Thus are border and disturbed regions often dominated by wind-dispersed species.

In this study, we investigate soil seed banks of tropical montane forest secondary growth and compare the results with soil seed banks of "mature" montane forests in the Southern Yungas of Bolivia. To investigate a possible dispersal limitation or expected edge effects, we sampled the soil seed banks in varying distances along a transect: two distances in forest interior; three distances in border and forest exterior. The sampling was replicated in six distinct sites, each consisted of forest remnant with adjacent secondary growth with different land use history and vegetation structure. Identified seeds will be classified in morphospecies, seed viability will be tested by a TTC-test.

The expected results are the following:

The distances to the forest edge have an effect on the seed composition in the soil seed banks. An edge effect leads to a special seed situation along the forest border. The ambient vegetation structure of the forest has an impact on the heterogeneity of the soil seed banks. It is assumed that different types of seed dispersal, especially animal-and wind-dispersal, lead to dispersal limitation of forest plant species.

FRI 16:15 ROOM 0.014



Session: Free Topics

## GENETIC VARIATION OF TEAK (*TECTONA GRANDIS* LINN. F.) AND DAHAT (*TECTONA HAMILTONIANA* WALL.) IN MYANMAR

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Teak (*Tectona grandis* Linn. f.) is a tropical forest tree species naturally occurring in India, Lao, Myanmar and Thailand while dahat (*Tectona hAMILTONIANA* Wall.) is an endemic tree species restricted to Myanmar. Sixty-nine Amplified Fragment Length Polymorphism markers (AFLP) and two conserved chloroplast Simple Sequence Repeat loci (cpSSR) were used to investigate genetic variation of four *T. grandis* populations (N=86) and three *T. hAMILTONIANA* populations (N=72) in Myanmar. AFLP analysis showed that genetic diversity varied between species revealing a slightly higher variation in *T. grandis* (He=0.31829) than in *T. hAMILTONIANA* (He=0.30520). Genetic diversity varied among populations. An Analysis of Molecular Variance (AMOVA) revealed that the two species were significantly differentiated (38.42%,  $p < 0.05$ ). Further AMOVAs also showed higher genetic variation within populations and lower but significant genetic differentiation among populations. An Unweighted Pair Group Method with Arithmetic Mean (UPGMA) cluster analysis based on Nei's genetic distance illustrated a clear genetic differentiation between species and among populations. AFLP diagnostic markers were also detected to differentiate between species and among populations. The cpSSR analysis confirmed a clear genetic differentiation between species showing only one single haplotype in *T. grandis* populations while detecting two haplotypes in *T. hAMILTONIANA*. Thus, all *T. grandis* populations were fixed for a single haplotype. In summary, both species were unambiguously distinguished by AFLP and cpDNA markers indicating strong phylogenetic divergence.

**Merian award applicant**

Session: Free Topics

## LAND USE CHANGE AND SOIL CARBON STOCKS IN THE PERUVIAN AMAZON REGION

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Land use change contributes to 12-15% of total anthropogenic CO<sub>2</sub> emissions with the bulk of emissions occurring in the tropics. Accounting of greenhouse gas emissions following forest clearing in the tropics has been focused mainly on CO<sub>2</sub> through changes in aboveground carbon stocks even though considerable changes in soil organic matter (SOC) stocks have been reported. The objective of this work to quantify soil carbon stocks from land use changes at tropical forest margins. With this aim we examined SOC stocks up to 3 m depth in two mayor land use trajectories in the Peruvian Amazon region. The trajectories were: native forest to pasture to oil palm plantation and native forest to cropland to young fallow to secondary forest. We expected SOC to decrease with the conversion of from native forest to cropland and from pasture to oil palm plantations, and to increase with the conversion from native forest to pasture and from crops to secondary forest. First results of fine root biomass show the expected decreases in fine and coarse root biomass of the upper 20 cm after conversion from native forest to pasture and cropland. Conversion from pasture to oil palm plantations did not increase fine and coarse root biomass. Conversion from cropland to young fallow increased fine and coarse root biomass, however further succession to ten year old secondary forest did not increase fine and coarse root biomass.

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## GEOSTATISTICAL SIMULATIONS OF ATMOSPHERIC NITROGEN DEPOSITIONS IN AN ECUADORIAN HOTSPOT OF BIODIVERSITY

Sandro Makowski<sup>1</sup>, Rütger Rollenbeck<sup>1</sup>, Nicolas Caspari<sup>1</sup>, Peter Fabian<sup>2</sup>, Jörg Bendix<sup>1</sup>

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Since nitrogen depositions are expected to rise in the upcoming decades, nitrate concentrations in fog and rain water samples were monitored since 2002 until present in an altitudinal gradient on the leeward slope of the South-eastern escarpments of the Ecuadorian Andes. Transmissions of  $\text{NO}_x$  and  $\text{NO}_2$ , atmospheric precursors of nitrate, from upwind sources were simulated for the time period 2004-2009 and then contrasted with the observations at the research site in the San Francisco valley. The main intention was to look for some patterns in the teleconnections between distant upwind emissions and nitrate inputs in the ecosystem.

The results suggest that ion concentrations in fog and rain at the uppermost stations are mostly teleconnected with distant emission sources by the synoptical circulation. This could be explained by its unsheltered location regarding the synoptical wind system. The opposite applies to the station at the valley bottom, where its sheltered situation at the leeward side makes it more prone to the effects of the local breeze circulation.

FRI 16:15 ROOM 0.014

Session: Free Topics

## **VALIDATION OF MULTI-RESOLUTION SATELLITE IMAGE BASED LAND-USE/LAND-COVER CLASSIFICATION IN THE MODJO WATERSHED OF ETHIOPIA: A METHODOLOGICAL DISCOURSE**

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Geospatial tools coupled with remotely sensed data have been increasingly used to generate valuable environmental information and transformation processes. This environmental context information is vital to examine the status of natural resources. However, before using the information for any further applications and policy decisions, the quality of this information should be subjected to validation. Thus, the objectives of this study were to generate spatially explicit three dates (i.e., 1973, 1995 and 2007) of LULC thematic layers and to validate the usability of these classified thematic maps using the principle of accuracy assessment. Landsat and SPOT images were used as an input datasets for the LULC classification. These classified maps together with reference datasets for classification validation extracted from panchromatic aerial photographs and field survey using GPS navigation were also used as an input for the accuracy assessment. A supervised classification thematic accuracy assessment was employed and three error matrices were generated. Various univariate and multivariate statistical measures were also used to test its validity. The computed overall accuracy of the 1972, 1995 and 2007 image classifications were 88.1%, 87.8% and 92.2%, respectively. On the other hand, about 86.7%, 89.2% and 91.2% of Khat coefficients of agreement were achieved from the 1972, 1995 and 2007 classifications, respectively. The classified LULC maps fulfilled the minimum 85% of standardized value of overall accuracy and Khat coefficients of agreement. Therefore, all the LULC classifications resulted in reliable maps and can be used as an input for sound and integrated land resource management and sustainable land use planning in the study watershed.

**Merian award applicant**

FRI 16:15 ROOM 0.014



Session: Free Topics

## DAMMED RIVERS AND VEGETATION CHANGES IN AMAZONIA

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In Amazonia, many large rivers have already been dammed or are in various stages of planning in order to provide energy from hydroelectric plants. Once dammed, rivers turn into huge lakes which flood the original vegetation in the former river basins. Mountains are left as islands in these artificial lakes. The former vegetation suffers from the strong impacts of fragmentation, including 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 (unless they are pre-adapted to wet conditions) and shifts in floristic composition. In this presentation we analyze the short-term responses of three Amazonian vegetation units, and medium-term response 15 years after flooding in Lago Guri, Venezuela.

FRI 16:15 ROOM 0.014

Session: Free Topics

## ASSESSING CONSERVATION VALUES: BIODIVERSITY AND ENDEMICITY IN TROPICAL LAND USE SYSTEMS

Matthias Waltert<sup>1</sup>, Kadiri Serge Bobo<sup>2</sup>, Stefanie Kaupa<sup>1</sup>, Moses Nsanyi<sup>4</sup>, Marcela Leija Montoya<sup>3</sup>, Heleen Fermon<sup>1</sup>

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Despite an increasing amount of data on the effects of tropical land use on continental forest fauna and flora, it is debatable whether the choice of the indicator variables allows for a proper evaluation of the role of modified habitats in mitigating the global biodiversity crisis. While many single-taxon studies have highlighted that species with narrow geographic ranges especially suffer from habitat modification, there is no multi-taxa study available which consistently focuses on geographic range composition of the studied indicator groups. We compiled geographic range data for 180 bird, 119 butterfly, 204 tree and 219 understorey plant species sampled along a gradient of habitat modification ranging from near-primary forest through young secondary forest and agroforestry systems to annual crops in the southwestern lowlands of Cameroon. We found very similar patterns of declining species richness with increasing habitat modification between taxon-specific groups of similar geographic range categories. At the 8 km<sup>2</sup> spatial level, estimated richness of endemic species declined in all groups by 21% (birds) to 91% (trees) from forests to annual crops, while estimated richness of widespread species increased by +101% (trees) to +275% (understorey plants), or remained stable (-2%, butterflies). Even traditional agroforestry systems lost estimated endemic species richness by -18% (birds) to -90% (understorey plants). Endemic species richness of one taxon explained between 37% and 57% of others (positive correlations) and taxon-specific richness in widespread species explained up to 76% of variation in richness of endemic species (negative correlations). The key implication of this study is that the range size aspect is fundamental in assessments of conservation value via species inventory data from modified habitats. The study also suggests that even ecologically friendly agricultural matrices may be of much lower value for tropical conservation than indicated by mere biodiversity value.

FRI 16:15 ROOM 0.014





Session: Free Topics

## MANAGING FOREST WILDLIFE FOR HUMAN LIVELIHOODS: A MULTI-AGENT SYSTEMS MODEL TO ASSESS SOCIO-ECONOMIC AND ECOLOGICAL SUSTAINABILITY

Matthias Waltert<sup>1</sup>, Kadiri Serge Bobo<sup>1,2</sup>, Emeka Obioha<sup>3</sup>, Roger Ngoufo<sup>1</sup>, Saka Oladunni Jimoh<sup>5</sup>

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Bushmeat consumption, the consumption of meat from wild forest animals, is an important part of livelihoods in rural West- and Central Africa. Based on extraction-production models it has been suggested that in the Congo Basin bushmeat protein supply would drop by 81% by 2050 in a 'no-change' scenario of current extraction levels. In order to secure this resource for the future, sustainable harvesting in community-based wildlife management (CWM) approaches is a potential option, aiming at maintaining the recommended daily protein allowance (RDA of 52 g per person per day, FAO). However, the social, economic and ecological sustainability of forest wildlife management has rarely been investigated in a holistic approach.

The poster presents the approach of an international and interdisciplinary African-German research team to assess conditions under which CWM can be made socio-economically and ecologically sustainable. In a multi-agent system (MAS) approach, we study principal actors (or 'agents': e.g. hunters, traders, wildlife), their characteristics and their relationships and simulate effects of different approaches to manage wildlife, in particular populations of two species of small- and medium-sized antelopes ('duikers' *Cephalophus* spp. on household economy. Data are being gathered for an 'artificial' model landscape of the Korup / Oban Hills region (CMR and NGR) on site, and aims at simulating a realistic picture of the current system in this and other, similar regions. We use the CORMAS platform, which serves as main tool both for scientific analysis and for companion modelling in negotiations with stakeholders. The project is composed of five subprojects and has a strong research capacity building component: during 2008-2011 it supported four PhD, nine Master level (including two Diploma, six M.Sc., one M.A.), nine Forest Engineer (Diplome d'Ingenieur des Eaux et Forêts) and an uncounted number of B.Sc. level students. Nineteen of these 23 students are African nationals.

Session: Free Topics

## **MARINE PROTECTED AREA AS A SOCIAL-ECOLOGICAL SYSTEM: A CASE OF A MPA DESIGN IN SMALL ISLANDS IN SOUTHERN PENGHU ARCHIPELAGO, TAIWAN**

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Many institutions have been formed by human societies in order to deal with the marine natural resources depletion crisis; however, the rapid social-ecological dynamics under the influence of globalization have generated mismatch problems between the institutions and the social ecological systems (SESS) these intended to govern. Under globalization, the actors in a specific location are not only local people but also the people who have power and accessibility to the marine natural resources. At the same time, the interests of utilizing marine natural resources are increasing in dimension. All these have made the SESSs become more complex on spatial and functional scales. Marine protected areas (MPAs) as institutions for managing the impact of human activities on the marine environment, regulate the behavior of actors who have interests in utilizing marine natural resources in a specific location. In order to form effective institutions and understand the problem context in multi-level and cross-scale systems, there is a need to delimit the boundaries of SESSs. By conducting stakeholder analysis, this study aims at identifying the boundaries of linked SESSs in spatial and functional scales and their problem context through recognizing the actors and their interests. Four small islands and their surrounding waters in the southern Penghu archipelago, Taiwan is used as a case study. The result shows that stakeholder analysis can help identify linked SESSs in a specific location, which is critical when designing an institution such as MPA. In this sense, the MPA is not only a new institution, but also a new SES that links subsystems with different spatial and functional boundaries. However, further studies into MPA design are needed in bringing together different groups of actors to form networks and linkages in SES for matching boundaries between institutions and SESSs.

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Session: Human dimensions of tropical deforestation, forest fragmentation and forest management

## A STUDY ON FOREST RESOURCES USE BY LOCAL COMMUNITIES IN SIMILIPAL TIGER RESERVE

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Forests provide a wide variety of resources for the benefit of mankind. On the one hand, it needs to be conserved for keeping healthy biodiversity and on the other hand, the local communities living in or, around the forest largely depends on the resources for their sustenance of livelihood which ultimately leads to loss of biodiversity. Such human mediated disturbances on forest are permeating in Indian subcontinent. In the current study, we accessed the dependence of the local communities on the forest resources of Similipal Tiger Reserve (STR), Odisha, India by questionnaire survey method. We selected 30 villages, 4 in the core zone and 26 in the buffer zone of STR. A total of 143 (10% of total households) comprising of a subset of the local tribal communities were selected for the interview. The average family size in this region which ranged between 3.1-11.2 persons per household which is higher than the national average size. About 59% of the households are involved in agriculture and 29% households worked as small holdings cultivators and wage labor. The majorities of the respondents (81%) were from the low-income classes. Overall, 53% harvested and sold fuel-wood for a living and collected 1.6 times more fuel-wood than they would need just for household use. Younger people from lower income classes tended to be fuel-wood sellers, and this suggests that lack of economic opportunities for the younger people in this region is a serious problem. The region is populated with tribals and mostly very poor people who have lived in the forests for generations. Therefore, the relationship between marginalized tribal households and their dependence on the forest needs to be taken more serious. Political extremism (Maoist) is a factor that augments the prevailing problems of illegal harvesting of forest products, poaching and bushmeat hunting, since the local communities believe they are beyond the law. This has resulted in ongoing rapid loss and degradation of forests and decline in endangered species such as the Royal Bengal Tiger and Asian Elephant.

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Session Human dimensions of tropical deforestation, forest fragmentation and forest management

## CONCEPTUAL FRAMEWORK FOR THE ASSESSMENT OF LANDSCAPE VULNERABILITY AND LAND USE POTENTIALS IN VU GIA THU BON RIVER BASIN IN CENTRAL VIETNAM

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The midlands of the Vu Gia Thu Bon river basin (VGTB) are characterized by a highly dynamic land use development including the expansion of the road and electricity network, construction of hydropower plants, intensification of agricultural and forestry production, gold mining and other activities promoting economic growth of the area. At the same time, however, this development leads to fragmentation of landscapes and forests, forest loss, soil and water pollution, and soil erosion. The present study aims at analyzing the landscape vulnerability of VGTB and future land use potentials.

Landscape vulnerability is analyzed with respect to three degradation processes: forest loss and degradation, soil erosion and river water pollution. Like in many remote areas, data availability to assess landscape vulnerability in VGTB is low. Available data for land use classification follow the national Vietnamese classification system, and its classes had been jointly defined with Vietnamese experts before they were used for analyses. Accordingly, the present study uses the classes rich, medium, poor forest, and bare land to define very highly vulnerable, highly vulnerable, vulnerable, and less vulnerable forests. In addition, buffer areas along rivers are classified based on distance ranging from very high (0-50m) to low vulnerability (>200m) to contaminant input. Vulnerability to soil erosion is assessed on the basis of the USLE factors using primary and secondary data. By overlaying the vulnerability of the different criteria, a landscape vulnerability map is generated. This map shows those areas which are particularly vulnerable and for which more sustainable land use practices have to be developed.

The study is conducted as part of the LUCCi project (<http://www.lucc-vietnam.info>). With further development of the project, more data will be available to provide a more accurate picture of the spatial distribution of vulnerability in the study area.

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Session: Human dimensions of tropical deforestation, forest fragmentation and forest management

## IDENTIFICATION OF SPATIAL FRAGMENTATION PATTERNS IN VU GIA THU BON WATERSHED IN CENTRAL VIETNAM

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Vietnam is one of the countries in the world which has been able to increase forest coverage in recent years. However, the quality of the forest areas is difficult to assess, and large stretches of landscape are dominated by stands of non-endemic *Acacia* and *Eucalyptus* species planted for commercial use. The application of spectral-based classification of satellite imagery to distinguish natural vegetation from such areas has been proven insufficient. Reasons for these difficulties are the similarity of spectral information of pixels for the different forest types and the topographical heterogeneity contained in the spectral information of a pixel.

An alternative is the application of segment-based classification methods. The application of segments from remote sensing data and delineated products has proven to be superior compared to classical pixel based classification when human activities and landscape metrics such as forest fragmentation are assessed. Segment-based remote sensing application requires medium-high to very high resolution imagery. For this study, a multi-temporal and high resolution data constellation is available: high resolution aerial photography from 1953, high resolution space borne Corona data (1973-1975) and Landsat data from 1973 up to date.

The study area is the Vu Gia Thu Bon river system in tropical Central Vietnam with a size of c. 10.000 km<sup>2</sup> which encompasses the foothills of the Truong Son Mountain range in its western part. The purpose of the study is to use a combination of segment-based and spectral-based classification techniques to identify forest fragments and their spatial patterns by measures such as connectivity, shape, minimum area. Patterns of segments will be identified to increase the spatial understanding of the current forest fragmentation status in the study area. Further, temporal trends of fragmentation in VGTB will be deduced by comparing satellite images of different years.

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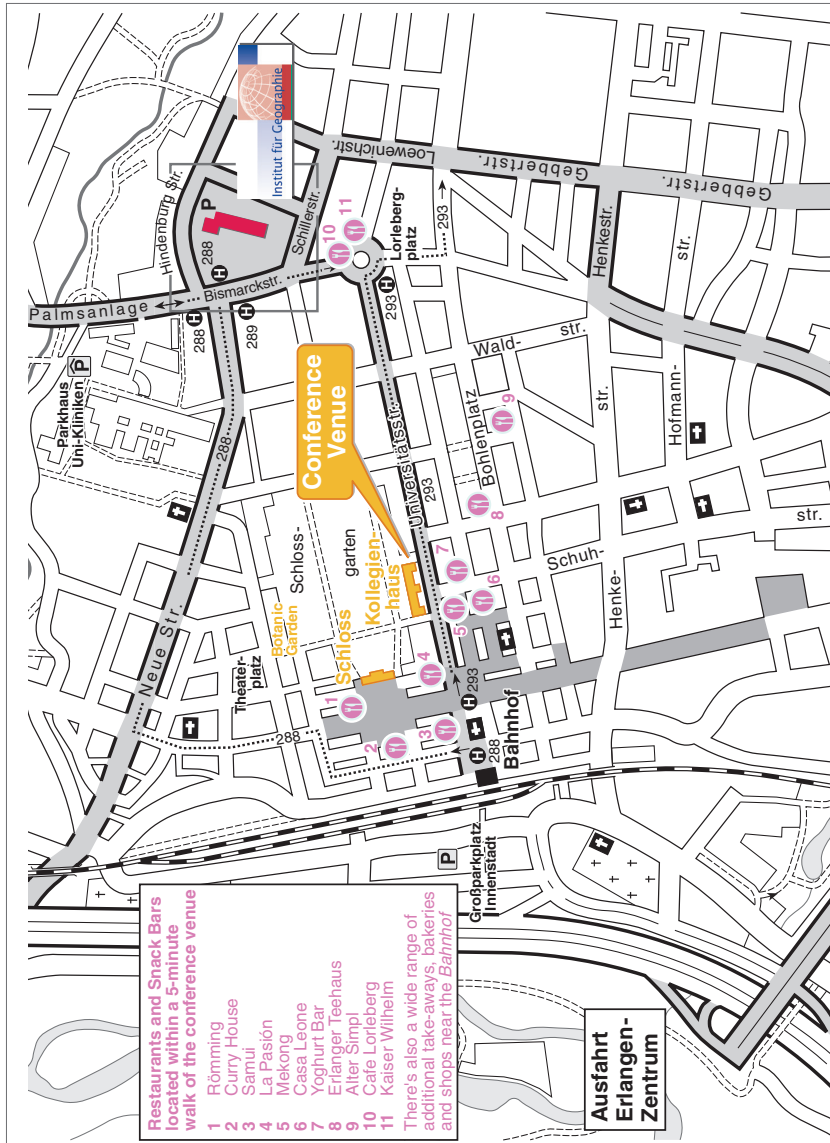


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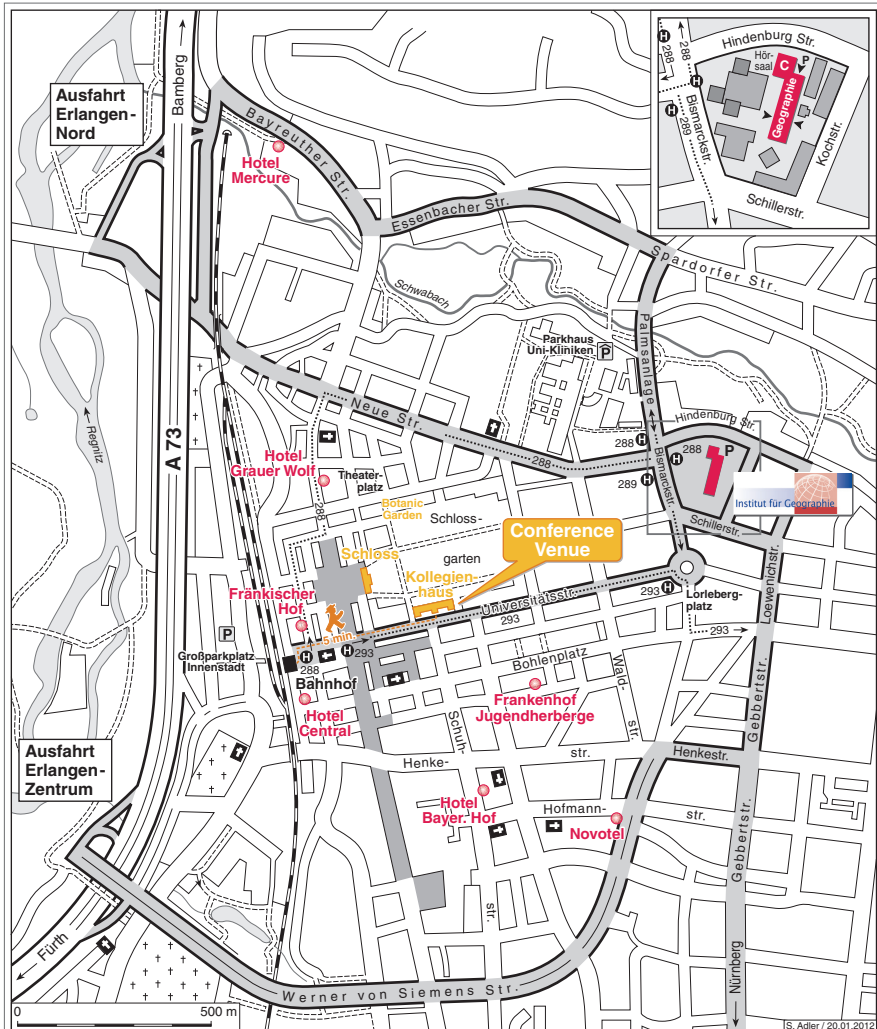








## MAP OF CONFERENCE VENUE



### Anfahrt / How to get there (public transportation from train station):

Buslinie 288 Richtung Waldkrankenhaus, Haltestelle Hindenburgstraße  
 Bus line 288, destination „Waldkrankenhaus“, exit at bus stop „Hindenburgstraße“ or  
 Buslinie 293 Richtung Sebdalussiedlung, Haltestelle Lorlebergplatz  
 Bus line 293, destination „Sebdalussiedlung“, exit at bus stop „Lorlebergplatz“

Parkhaus Uni-Kliniken  
 Parking Garage „Uni-Kliniken“  
 Schwabachanlage 14,  
 91054 Erlangen

Großparkplatz Innenstadt  
 Central Parking Lot  
 Schwabachanlage 14,  
 91054 Erlangen

Parkgebühren: pro ½ Std. 0,50 EUR  
 Tagesgebühr 5,00 EUR  
 7-Tages-Gebühr 35,00 EUR

Parkgebühren: Mo-Sa von 8.00 bis 19.00 Uhr  
 Preis je 1/2 Stunde: 0,50 EUR  
 Mindestparkdauer: 1/2 Stunde  
 Höchstparkdauer: 4 Stunden  
 Tageskarte: 5,00 EUR

### Abfahrt / Return:

Buslinie 288/289, Haltestelle Bahnhofplatz  
 Bus line 288/289, destination „Bahnhofplatz“

Bushaltestelle / Bus Stop

Parking fee: 0,50 EUR / 30 min  
 Day ticket: 5,00 EUR  
 Seven-Day ticket: 35,00 EUR

Parking fee: Mo-Sa from 08:00 to 19:00  
 0,50 EUR / 30 min  
 Minimum fee: 0,50 EUR  
 Maximum parking for 4 hours  
 Day ticket 5 EUR