International Symposium
Socio-ecological transformations of tropical lowland rainforests

EFForTS

CONFERENCE GUIDE

Bali,
October 7–11, 2018

Scope of the Symposium:

Welcome to the International Symposium on *Socio-ecological transformations of topical lowland rainforests*, held in Bali from October 7 to 11, 2018.

This is the first International Symposium focusing on the full complexity of changes associated with the transformation of tropical lowland rainforest into plantations systems such as rubber and oil palm with a focus on Southeast Asia. The Symposium aims at bridging disciplines and bringing together researchers from all fields of science integrating ecological and socioeconomic perspectives as well as stakeholders in the field of land use changes in tropical lowlands. It focuses on science-based approaches targeting at improving the ecological and socioeconomic functions of tropical lowland forests and agricultural transformation systems at a landscape scale.

The meeting will start on Sunday with registration. Monday to Wednesday are devoted to talks and Thursday to field trips. There will be no concurrent sessions, in order to provide the greatest opportunity to interact, and posters will be displayed for the entire duration of the meeting.

We welcome your contribution to a stimulating conference and wish you a pleasant stay and inspiring discussions.

The Organisers

Content

Program Overview

Sunday, 7 October 2018

13:00	**Registration**
19:00	**Welcome reception**

Monday, 8 October 2018

8:15	**Opening / Welcome address** ***Stefan Scheu*** (Speaker of EFForTS) ***Arif Satria*** (Rector IPB & Speaker JMB) ***Johni Najwan*** (Rector UNJA) ***Laksana Tri Handoko*** (Chairman LIPI) ***Svann Langguth*** (German Embassy Jakarta)
9:00	**Opening Keynote** Chair: ***Stefan Scheu*** ***Voitech Novotny***: Conservation of biological and cultural diversity in lowland rainforests of Papua New Guinea by tribal societies
10:00	Session 1: **INTEGRATIVE EXPERIMENTS** Chairs: ***Teja Tscharntke & Leti Sundawati*** **Keynote** – ***David F.R.P. Burslem***: Tree species and functional diversity across heterogeneous tropical forest landscapes
10:30–11:00	**Coffee Break**
11:00	***Sarah H. Luke***: Large-scale experiments testing impacts of within-plantation management on oil palm ecosystems: the BEFTA Programme
11:15	***Delphine Clara Zemp***: Biodiversity enrichment experiment in oil palm plantations: tree growth and structural complexity
11:30	Session 2: **BIOGEOCHEMISTRY** Chairs: ***Amanda Matson & Suria D. Tarigan***
11:30	**Keynote** – ***Yit Arn Teh:*** Synergistic effects of land-use, functional diversity and soil properties on ecosystem processes in lowland tropical forests
12:00	***Amanda Matson***: Soil and tree-stem N_2O fluxes of a large-scale oil palm plantation in Sumatra, Indonesia
12:15–13:30	**Lunch**
13:30	***Josephus Koks***: Soil and tree-stem nitrous oxide emissions from smallholder oil palm plantations in riparian areas in Sumatra, Indonesia
13:45	***Fitri K. Aini***: Termites contribution to nitrous oxide and methane emissions along a gradient of forest disturbance in Sumatra

14:00	***Greta Formaglio***: Asymbiotic nitrogen fixation in soil and litter in a large-scale oil palm plantation
14:15	***Nina Hennings***: Fertilization in oil palm plantations: Microbial biomass activity and soil organic matter (SOM) decomposition under glyphosate stress
14:30	***Damris Muhammad***: Effects of soil carbon and metal contents on sorption of dissolved organic carbon on soils of tropical rainforest transformation systems
14:45	***Syahrul Kurniawan***: Decomposition and nutrient mineralization from oil palm empty fruit bunch
15:00	***Christanti Agustina***: Profile pattern of soil texture and basic cations in different land uses in Jambi, Indonesia
15:15	***Joyson Ahongshangbam***: Tree and palm water use assessed by drone based imagery
15:30–16:00	**Coffee Break**
16:00	***Tania June***: Aerodynamic characteristics and turbulent transfer of oil palm canopy
16:15	***Christian Stiegler***: El Niño–Southern Oscillation and the oil palm: Effects of drought and haze on evapotranspiration, CO_2 exchange and surface energy budget
16:30	***Martyna Kotowska***: Comparison of aboveground biomass and carbon sequestration in Indonesian rainforest conversion systems
16:45	***Suria D. Tarigan***: Impact of soil degradation and change in plant transpiration on the catchment water balance in tropical rainforest transformation systems
17:00	***Dodo Gunawan***: The analysis of vegetation change and rainfall variability in Lore Lindu National Park, Central Sulawesi, Indonesia
17:15	Poster Session

Tuesday, 9 October 2018

8:30	Session 3: **BIODIVERSITY**
	Chairs: ***Holger Kreft & Damayanti Buchori***
8:30	**Keynote** – ***Holger Kreft:*** From bacteria to birds: heterogeneity, vegetation structure and species turnover in tropical smallholder landscapes
9:00	***Hermann Behling***: Tropical ecosystem and plant diversity dynamics and the impact of climate, fire and humans during late Quaternary times
9:15	***Christina Setyaningsih***: The effect of volcanism on the submontane rainforest vegetation composition: palaeoecological evidence from Danau Njalau, Sumatra (Indonesia)
9:30	***Fabian Brambach***: The impact of rainforest transformation in Sumatra on plant taxonomic, phylogenetic, and functional diversity
9:45	***Soekisman Tjitrosoedirdjo***: *Asytasia gangetica* ssp. micranthea in the coming release of glyphosate resistance corn in Indonesia
10:00	***Sri Sudarmiyati Tjitrosoedirdjo***: Status on the studies of invasive alien plant species in Sumatra
10:15	***Fifi Gus Dwiyanti***: Population genetics of endangered Dipterocarps in Indonesia: Implication for conservation strategy and sustainable utilization
10:30–11:00	**Coffee Break**

11:00	***Pierre-André Waite***: Xylem vulnerability to embolism in natural and intensively used tropical systems
11:15	***Andrea Polle***: Tropical land transformation shifts ecological functions of fungal communities
11:30	***Johannes Ballauff***: Land-use changes restructure fungal communities and alter their ecosystem functions
11:45	***Adisti Permatasari Putri Hartoyo***: Correlation between biodiversity and carbon stock status on agroforestry practices of Berau, East Kalimantan, Indonesia
12:00	***Damayanti Buchori***: Indirect effect of land-use change on species richness and abundance of braconid parasitoid wasps
12:15–13:30	**Lunch**
13:30	***Akhmad Rizali***: Different region shapes dissimilar trophic interactions between pest and parasitoid in oil palm plantation
13:45	***Purnama Hidayat***: Diversity of butterflies across rainforest transformation systems in Bukit Duabelas National Park and Harapan Forest Landscape, Jambi
14:00	***Jochen Drescher***: Community phylogenetics and trait dispersion of arboreal ants after rainforest conversion to monocultures in Sumatra
14:15	***Anton Potapov***: Distribution of energy between basal and high trophic levels of belowground food webs under tropical land-use change
14:30	***Valentyna Krashevska***: Composition of protist trophic groups changes with conversion of rainforest into rubber and oil palm plantations in tropical lowlands of Sumatra
14:45	***Alena Krause***: Trophic plasticity in Oribatida (Acari) in transformation systems in Sumatra (Indonesia) investigated by stable isotopes (15N, 13C)

15:00	Session 4: **INTERDISCIPLINARY SOCIOECOLOGICAL APPROACHES** Chairs: *Meike Wollni & Rosyani*
15:00	**Keynote** – ***Lian Pin Koh***: Promises and pitfalls of conservation drones
15:30–16:00	**Coffee Break**
16:00	**Keynote** – ***Daniel Murdiyarso:*** Tropical peatland fires and opportunities for climate change mitigation
16:30	***Ingo Grass***: Widespread trade-offs between multifunctionality and profit in smallholder agricultural landscapes
16:45	***Jan Salecker***: Land-use change in oil palm dominated tropical landscapes: An agent-based model to explore ecological and socio-economic trade-offs
17:00	***Carola Paul***: Which degree of diversification to achieve truly multifunctional landscapes? Using land-use optimization as a basis for participatory research
17:15	***Katrin Rudolf***: The effect of information and sapling provision on smallholder tree planting in oil palm plantations
17:30	***Jennifer Merten***: Land use transformation and changing flooding regimes
17:45	Poster Session

Wednesday, 10 October 2018

8:30	Session 5: **CONSERVATION**
	Chairs: ***Dirk Hölscher & Bambang Irawan***
8:30	**Keynote** – ***Oliver Frör:*** Conservation and society - current trends in socio-ecological valuation of ecosystem services
9:00	**Keynote** – ***Jane Hill***: Conserving biodiversity in tropical agricultural landscapes
9:30	***Kartika Anggi Hapsari***: Improving conservation design using paleo-ecology
9:45	***Michael Pashkevich***: Spider community response to oil palm riparian buffers
10:00	***Lan Qie***: Integrating carbon and species conservation - making a case for Borneo ironwood as a conservation flagship
10:15–11:00	**Coffee Break**
11:00	***Chairil Anwar***: Exploring strategies applied in promoting community agreements on conservation in Lore Lindu National Park, Indonesia
11:15	***Sri Rahayu Utami***: Soil macroporosity and its related physical properties after forest conversion to rubber and oil palm plantation in Jambi, Indonesia

11:30	Session 6: **SOCIOECONOMIC DIMENSIONS**
	Chairs: ***Heiko Faust & Nunung Nuryartono***
11:30	**Keynote** – ***Rob Cramb***: Human interaction with the rainforests of Sarawak
12:00	***Edwine Setia Purnama***: An analysis of land use transitions in Jambi Province, Sumatra, Indonesia from 1990 to 2013
12:15–13:30	**Lunch**
13:30	**Keynote** – ***Alin Halimatussadiah:*** Human pressure on lowland ecosystems: what can be done?
14:00	***Matin Qaim***: Socioeconomic effects of oil palm cultivation for rural farm and non-farm households in Indonesia
14:15	***Nunung Nuryartono***: The analysis of inequality using carbon footprint approach in Indonesia
14:30	***Edison***: Financial feasibility study of smallholder palm oil in Muaro Jambi district, Jambi province
14:45	***Arieska Wening Sarwosri***: Risk attitude and time preference: crucial factors for planting oil palm by smallholders?
15:00	***Jonas Ibrahim Hein***: Green territorialisation, rural development, peasants, and indigenous groups' rights to land. Insights from Guaviare, Colombia
15:15	***Elias Cisneros***: Beyond the sum of its parts: A counterfactual simulation of Brazil's forest conservation recipe
15:30–16:00	**Coffee Break**
16:00	***Krisztina Kis-Katos***: Political deforestation cycles in Indonesia
16:15	***Soeryo Adiwibowo***: Land control under two different regimes of forest governance
16:30	***Sebastian Renner***: Acceptance, implications, and perspectives of palm oil certification in Indonesia
16:45	***Angga Eko Emzar***: International rubber price transmission and policy
17:00	***Dodik Ridho Nurrochmat***: Economic feasibility of the peat restoration in Sungai Bram Itam forest area, Jambi

KEYNOTE LECTURES

Opening keynote

Monday, October 8, 2018, 9:00 am

Vojtech NOVOTNY
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I have a PhD in Ecology from the Czech Academy of Sciences. In the Czech Republic, I am directing the Centre for Tropical Biology, a research consortium of three institutions (the Czech Academy of Sciences, the University of South Bohemia, and the Charles University), active throughout the tropics. In Papua New Guinea, I co-founded and have been directing the New Guinea Binatang Research Centre, a research organization active in rainforest conservation and training of postgraduate students.
I am a tropical biologist interested in the ecology of rainforests, particularly their food webs. My research, increasingly using field-based experiments, focuses on ecological mechanisms of species coexistence of rainforest plants and animals and on ecological drivers of biodiversity along succession, latitudinal and altitudinal gradients in forest ecosystems. I am also interested in the development of ecological research capacity, from paraecologists to postgraduate students, in tropical countries and in the conservation of tropical forests, particularly with indigenous communities. For the past 20 years, I have been dividing my time equally between Europe and Papua New Guinea, spending it on scientific, conservation and science policy issues, facilitating interaction and understanding between extra-tropical and equatorial scientists.

CONSERVATION OF BIOLOGICAL AND CULTURAL DIVERSITY IN LOWLAND RAINFORESTS OF PAPUA NEW GUINEA BY TRIBAL SOCIETIES

Papua New Guinea (PNG), where indigenous rainforest tribes control 97% of land and with it 5% of the terrestrial biodiversity and 15% of linguistic diversity of the planet, represents an extraordinarily important model for the potential of indigenous cultures to become guardians of biological and cultural diversity in their environment. The attempts at rainforest conservation on indigenous lands have been largely unsuccessful in PNG, mostly because they have been based on misleading assumptions about the developmental aspirations of indigenous cultures. Here we review 20 years of conservation activities in Papua New Guinea, provide examples of success and failure, and chart promising approaches that could combine diversity conservation, research and economic development in the future. Papua New Guinea (PNG), where indigenous rainforest tribes control 97% of land and with it 5% of the terrestrial biodiversity and 15% of linguistic diversity of the planet, represents an extraordinarily important model for the potential of indigenous cultures to become guardians of biological and cultural diversity in their environment. The attempts at rainforest conservation on indigenous lands have been largely unsuccessful in PNG, mostly because they have been based on misleading assumptions about the developmental aspirations of indigenous cultures. Here we review 20 years of conservation activities in Papua New Guinea, provide examples of success and failure, and chart promising approaches that could combine diversity conservation, research and economic development in the future.

SESSION 1

Integrative experiments

Monday, October 8, 2018, 10:00 am

David BURSLEM
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Professor David Burslem is tropical forest ecologist and biodiversity specialist with 25 years' experience working on Southeast Asian tropical forests. He is currently Professor of Forest Ecology and Diversity and Keeper of the Cruickshank Botanic Gardens at the University of Aberdeen, UK. His research group investigates the origin, maintenance, description and conservation of tropical forest biodiversity. There has been a recent focus on monitoring effects of land-use change on biodiversity and biogeochemical cycling in Sabah, where his group has characterised tree species composition and functional trait diversity along gradients of logging disturbance and soil chemistry. He is currently Principal Investigator for a new 50-ha forest dynamics plot at Danum Valley, Sabah, which is part of a worldwide network of plots coordinated by the Smithsonian Institution.

TREE SPECIES AND FUNCTIONAL DIVERSITY ACROSS HETEROGENEOUS TROPICAL FOREST LANDSCAPES

Tree species and functional diversity respond to combined effects of abiotic drivers and human-induced disturbance. However, the high diversity of these communities and the complexity of responses to multiple environmental variables pose challenges for characterising these patterns and their consequences. Traditional networks of distributed plots capture important elements of community structure at intermediate spatial scales, but are poorly suited to detecting mechanistic or functional responses at very small or large scales. Here I present recent studies in Borneo that address the complexities of co-variation among environmental variation and tree community structure and functional diversity using spatially resolved field measurements and remote sensing. At fine scales, tree distributions, community structure and key functional traits are driven by spatial variation in soil chemistry and hydrology, which co-vary with parent material and topography. These responses define repeatable patterns in the emergent properties of communities and ecosystems across landscapes. A key element of this response reflects contrasting mechanisms of nutrient acquisition among dominant species and families possessing different mycorrhizal associations. Selective logging initially disrupts the mechanisms that generate these spatial patterns and triggers recruitment of a community with high values of functional traits for carbon capture and growth. However, rapid recovery combined with heterogeneity in disturbance impacts enhance species and functional diversity in logged forests, leading to significant overlap of these metrics on 1-ha plots of old-growth and logged forests within a decade of logging, even when community composition is highly distinct. Although disturbance is the primary driver of trait variation in logged forest, soil chemistry explains an independent axis of functional diversity linked to leaf size and nutrient concentrations, which hints at the dominant relationships detected in old-growth forests. These studies highlight the multi-dimensionality and context-dependency of the link between environmental variation and species and functional diversity, requiring highly resolved data capture across spatial scales and gradients of disturbance impact.

SESSION 2

Biogeochemistry

Monday, October 8, 2018, 11:30 pm

Yit Arn TEH
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Yit Arn Teh is Reader in Biogeochemistry in the School of Biological Sciences at the University of Aberdeen. His research explores carbon, nitrogen and trace gas dynamics in terrestrial ecosystems, with a specific focus on tropical forests, wetlands and managed environments. He currently leads major research initiatives in Malaysian Borneo (i.e. Sabah, Sarawak) investigating the effects of forest degradation and land-use change on biodiversity, ecosystem functioning, carbon storage and greenhouse gas flux. Other active projects include research on methane dynamics in papyrus wetlands in Southern Africa (i.e. Uganda, Botswana) and the role of water management in mitigating the environmental impacts of rice. In addition to enhancing our process-based understanding of human-modified environments, his research aims to engage with policymakers and stakeholders in order to develop more sustainable land management practices that minimize negative environmental impacts and mitigate against climate change.

SYNERGISTIC EFFECTS OF LAND-USE, FUNCTIONAL DIVERSITY AND SOIL PROPERTIES ON ECOSYSTEM PROCESSES IN LOWLAND TROPICAL FORESTS

Land-use change in the lowland tropics is irrevocably altering biodiversity, and transforming ecosystem structure and function. However, even though we have an emerging understanding of how land-use change independently influences functional diversity, soils or biogeochemistry, we have a poorer grasp of how these factors interact to modulate ecosystem structure and function. Here we report on findings from landscape-scale manipulation experiments conducted in northern Borneo (i.e. Sabah, Sarawak) that investigated the role of land-use change, functional diversity and soils in regulating C and N dynamics in lowland tropical forests. These experiments encompassed a representative range of soils (e.g. acrisols, histosols) and land-uses (e.g. old-growth, secondary forest, oil palm) that are common throughout insular Southeast Asia. Stocks and fluxes of C and N were quantified at multiple spatial and temporal scales using data assimilation, process-based modelling, remote sensing, eddy covariance, intensive carbon plots and soil flux measurements. The functional diversity of the plant, microbial and invertebrate communities across different soils and land-uses were quantified through field surveys that combined ecological, physiological and molecular sampling techniques. Several key ecosystem processes, such as net primary productivity (NPP), were comparable among land-uses. Other processes, such ecosystem respiration or C sequestration, were altered due to changes in biogeochemistry and environmental conditions. Ecosystem responses to disturbance were determined and constrained by a mixture of the functional traits of the biotic community and soil properties, with evidence of both positive and negative feedback effects in operation. Changes in the functional traits of the plant community were linked to shifts in the structure and function of the heterotrophic community, implying a high level of top-down control by primary producers, with knock-on effects for ecosystem processes. However, we also found evidence for strong bottom-up controls on ecosystem structure and function; e.g., termites appeared to minimize the effects of drought on seedlings, soil moisture and decomposition. Data assimilation appeared effective in extrapolating our ecosystem-level measurements to the region.

SESSION 3

Biodiversity
Tuesday, 9 October 2018, 8:30 am

Holger Kreft
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Holger Kreft is a Professor of Biodiversity, Macroecology and Biogeography at the University of Göttingen. His research focuses on unravelling the natural and anthropogenic drivers and mechanisms that cause spatial gradients in biodiversity, from local to global scales. He studies different facets of biodiversity, including species richness, endemism, and functional and phylogenetic diversity combining fieldwork, meta-studies, and ecoinformatics. He applies scientific knowledge and principles to define conservation priorities and conflicts between land-use and biodiversity and identify options for restoration. He and his team member currently conduct fieldwork in Indonesia, Mexico, Madagascar and Tenerife. He is a Principal Investigator of two projects of CRC 990 EFForTS.

FROM BACTERIA TO BIRDS: HETEROGENEITY, VEGETATION STRUCTURE AND SPECIES TURNOVER IN TROPICAL SMALLHOLDER LANDSCAPES

Land-use change is a major threat to tropical biodiversity. To assess the conservation value of tropical land-use systems and to manage biodiversity-friendly landscapes, we need to understand how land-use change affects the composition of species assemblages. Here, we analysed patterns and drivers of species turnover, the compositional differences between local communities, in Sumatran smallholder landscapes that had undergone severe land-use change in the last two decades. We studied a land-use intensity gradient from rainforest, over jungle rubber agroforests, to smallholder rubber and oil palm plantations. Biodiversity and environmental data were collected in a plot-based sampling scheme and represent a uniquely comprehensive assessment of 15 different taxonomic groups. We found strong differences in the composition of forest communities and rubber and oil palm plantations. However, the different taxonomic groups showed overall highly variable responses to land-use intensification. In four groups, pairwise species turnover was highest in forests and consistently decreased with land-use intensity towards the plantations, indicating a trend of homogenization in species composition in intensively managed land uses. Five groups showed an opposite trend, with higher species turnover in the intensively managed plantation systems compared to forest, indicating heterogenisation. Another six groups did not show any consistent trend. Furthermore, species turnover was strongly correlated among soil bacteria, protists, fungi, and plants, but surprisingly weakly correlated among the other taxa, making it generally difficult to predict the community composition of one group based on another and questioning the utility of indicator taxa. Vegetation structure, soil attributes and microclimate emerged as strong predictors of species turnover but their relative importance varied considerably among taxa and land-use systems. Our results suggest land-use intensification does not consistently lead to homogenization of species assemblages in tropical smallholder landscapes, as we found divergent effects of land-use change on species turnover of different taxonomic groups. Our results highlight the need to consider multiple taxonomic groups in assessing the effects of land-use change on tropical biodiversity at larger spatial scales.

SESSION 4

Interdisciplinary socioecological approaches
Tuesday, October 9, 2018, 15:00 pm

Lian Pin KOH [1,2]

1 Conservation International, Arlington, US, lianpinkoh@gmail.com
2 University of Adelaide, Adelaide, AU, lianpinkoh@gmail.com

Lian Pin is Principal (Vice President) of Science Partnership and Innovation at Conservation International, USA. He is also an Adjunct Professor at the University of Adelaide, Australia. His research focuses on developing the Science and Science-based decision support tools to help reconcile society's growing consumptive needs with environmental protection. Lian Pin has published over 110 peer-reviewed articles in journals, including Nature and Science. His research has received over 12,000 citations. Lian Pin is also a World Economic Forum Young Global Leader, TED speaker and Founder of ConservationDrones.org.

PROMISES AND PITFALLS OF CONSERVATION DRONES

Low-cost drones are gaining popularity among ecologists as a tool for conservation research and practice. In this presentation, I will discuss a few examples of promising applications of conservation drones, as well as a few common challenges.

SESSION 4

Interdisciplinary socioecological approaches
Tuesday, October 9, 2018, 16:00 pm

Daniel MURDIYARSO
Centre for International Forestry Research, Bogor, ID, d.murdiyarso@cgiar.org

Daniel Murdiyarso is currently holding a position as Principal Scientist at the Center for International Forestry Research (CIFOR) and Professor at the Department of Geophysics and Meteorology, Bogor Agricultural University (IPB). He received his first degree in Forestry from IPB and PhD from the Department of Meteorology, University of Reading, UK.

His research works are related to land-use change and biogeochemical cycles, climate change mitigation and adaptation. He has published more than 100 articles in peer-reviewed high impact journals. He is part of the 2007 Nobel Peace Prize winning IPCC (Intergovernmental Panel on Climate Change) as Coordinating Lead Author of several IPCC Reports. Dr. Murdiyarso served the Government of Indonesia as Deputy Minister of Environment (2001-2002), during which he was also the National Focal Point of the UNFCCC (United Nations Framework Convention on Climate Change) and CBD (Convention on Biological Diversity). Since 2002, Professor Murdiyarso is a member of the Indonesian Academy of Sciences.

TROPICAL PEATLAND FIRES AND OPPORTUNITIES FOR CLIMATE CHANGE MITIGATION

Tropical peatlands are known to provide a number of ecosystem services including the storage of large quantity of carbon belowground. The accumulation of organic substrates over thousands of years creates these carbon-rich ecosystems that are now attractive for inclusion in climate change mitigation strategies. Peatlands cover about 3% of the earth's land area, but store as much as one-third of all soil carbon. In Southeast Asia, mostly Indonesia where 70% of the world's tropical peatlands reside, the emission of some 55 Pg. C stored in peatlands due to deforestation and degradation is alarming. Appropriate policy responses and governance system to conserve intact peatlands and to restore degraded peatlands could potentially mitigate climate change. Recent scientific findings including emission factors and activity data may be used to reduce uncertainties in monitoring, reporting and verification of carbon accounting. The numbers could eventually be used in the refinement of the Nationally Determined Contributions (NDCs) and accounting in reducing emissions from deforestation and forest degradation (REDD+) mechanism.

SESSION 5

Conservation

Wednesday, October 10, 2018, 8:30 am

Oliver FRÖR
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Oliver Frör has been professor of environmental economics at the University of Koblenz-Landau since 2012. Oliver Frör studied environmental sciences at the University of Bayreuth, Germany and economics at SUNY Albany, USA before receiving his PhD in economics from University of Hohenheim, Germany. He has worked in various international collaborative research projects in the fields of sustainable agriculture and resource use (China, Vietnam, Thailand, Morocco, and Brazil), adaptation to the consequences of climate change in coastal regions (Germany) with a special focus on empirical approaches and methodical aspects of environmental economic valuation of ecosystem services. He is member of and locally coordinates two EU-projects in the trinational metropolitan region Upper Rhine in the field of sustainability research and adaptation to climate change. At the university, he coordinates the international M.Sc. study program Environmental Sciences that has become a thriving interdisciplinary nucleus for socio-ecological studies and international research cooperation.

CONSERVATION AND SOCIETY - CURRENT TRENDS IN SOCIO-ECOLOGICAL VALUATION OF ECOSYSTEM SERVICES

In many regions around the globe natural habitat like e.g. lowland tropical rainforests are threatened by development and land use change. Increasing scarcity of such habitat calls for an intensification of conservation efforts. From a socio-ecological perspective these habitat fulfil essential functions for society interacting in a complex and changing way through a wide array of ecosystem services. However, conservation comes at a cost mostly in form of foregone opportunities to develop and exploit these natural resources and generate economic profits. Thus, conservation decisions should be based on reliable information on the beneficial effect of ecosystem services to society enabling decision makers to analyse the trade-offs involved. Since human-environment interactions are complex and adaptive in nature, the valuation of ecosystem services should be able to account for these properties. This presentation aims at showcasing the current trends in socio-ecological valuation of ecosystem services with a focus on tropical rainforests. It will be distinguished between normative aspects of valuation as the basis for empirical valuation methods and the restrictions imposed by the conditions in the field like lack of knowledge about and understanding of ecosystem processes and their direct and indirect effects on society as well as procedural requirements of valuation methods. Using practical examples from own research in Southeast Asia as well as from literature studies the state of the art of valuing ecosystem services will be demonstrated and the usefulness for decision making in the context of conservation projects will be critically discussed. It will be shown that in real-world socio-ecological systems the focus on purely monetary valuation as usually favoured by environmental economists falls short of practical necessities of decision makers. Consequently, in addition to monetary valuation approaches like contingent valuation and choice experiments a focus will be laid on approaches combining multiple measurement units (monetary, non-monetary, qualitative) in a multi-criteria setting. The presentation will identify the main types of research gaps in the empirical application of ecosystem service valuation and contrast those to the typical requirements imposed by decision makers in practice.

SESSION 5

Conservation

Wednesday, October 10, 2018, 9:00 am

Jane HILL
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Jane Hill is a professor of ecology in the Department of Biology, University of York, UK. Jane's research examines the impacts of climate change and habitat loss on biodiversity. Previously extensive tracts of natural habitats have been degraded by human activities, and in SE Asia, remaining patches of tropical rainforest are isolated within oil-palm dominated landscapes. The focus of Jane's research is to examine the conservation value of forest fragments (e.g. for supporting biodiversity and maintaining connectivity for range-shifting species), and testing the impacts of RSPO environmental sustainability standards for oil palm cultivation. Jane is a trustee of the SE Asia Rainforest Research Partnership (SEARRP), and a trustee and member of Council of the British Ecological Society (BES). She received a Marsh/ZSL Award for Conservation Biology in 2011 and is an Honorary Fellow of the Royal Entomological Society. Jane is involved in promoting women in science and led the York Biology Department to an Athena SWAN Gold Award in 2014.

CONSERVING BIODIVERSITY IN TROPICAL AGRICULTURAL LANDSCAPES

Expansion of agriculture to feed a growing human population has resulted in the loss and fragmentation of tropical rainforests. To reduce biodiversity losses in oil palm-dominated landscapes, sustainability certification schemes (i.e. RSPO) require the conservation of forest set-asides that support High Conservation Values (HCV) and/or High Carbon Stocks (HCS). I will review the research from my lab, which is examining the effectiveness of forest set-asides for maintaining biodiversity, in particular the importance of forest patch size and placement for enhancing biodiversity and forest connectivity. Most of my research examines animal diversity but I will also discuss how fragmentation affects plant diversity and evidence that regeneration is disrupted in forest remnants. Many species are shifting their distributions to track climate changes, and we are examining connectivity in SE Asia landscapes and the impacts of RSPO certification for enhancing connectivity, particularly in relation to range shifting to higher elevations. I will discuss my lab's research that is based on field surveys and computer modelling, focusing on Sabah (Malaysian Borneo), and highlight how small forest patches can play an important role in conservation.

SESSION 6

Socioeconomics dimensions
Wednesday, October 10, 2018, 11:30 am

Rob CRAMB
School of Agriculture and Food Sciences, University of Queensland, Australia, r.cramb@uq.edu.au

Rob Cramb is Professor of Agricultural Development and Deputy Head of the School of Agriculture and Food Sciences at the University of Queensland. His research centres on agricultural development, rural transformations, and natural resource management in Southeast Asia, focusing on the evolution of farming systems, land tenure arrangements, and community-based resource management in a variety of agro-ecological zones. He graduated in agricultural economics and rural sociology from the University of Melbourne, then worked in Sarawak, Malaysia, for six years with the Department of Agriculture, first as a volunteer with Australian Volunteers International and then as a consultant for a World Bank agricultural extension project. He subsequently undertook PhD studies at Monash University in development economics and Southeast Asian studies, returning to Sarawak for fieldwork on the evolution of swidden agricultural systems and customary land tenure. Since taking up a position at the University of Queensland, he has continued to lead research on agricultural development and natural resource management in Southeast Asia in collaboration with colleagues in the social and natural sciences. Most recently, he has been involved in assessing the impacts on customary landholders and small-scale farmers of the rapid expansion of oil palm plantations in Malaysia and Indonesia, resulting in the publication with John McCarthy of The Oil Palm Complex: Smallholders, Agribusiness and the State in Indonesia and Malaysia.

HUMAN INTERACTION WITH THE RAINFORESTS OF SARAWAK

Humans have been interacting with the rainforests of Sarawak in northeast Borneo for 50,000 years. The modes of interaction have been foraging, vegeculture, swidden agriculture, commercial smallholdings, industrial logging, and commercial plantations, with successively greater impacts on the forest ecosystem. The dominant modes have changed over time as humans adapted to the rainforest environment, as new technologies and cultigens were brought into the region through migration and trade, as some groups spread and gained dominance over others, and as the modern Sarawak state asserted increasing control over the disposition of the forest. Each mode of interaction has involved not just a particular set of techniques but an array of rights and obligations governing access to and management of the forest. In this paper, I review this long-term interaction with the forest, focusing on lower-impact, smaller-scale modes. I argue that these modes of interaction, while still impacting on the rainforest, help to minimize the trade-off between conservation and development goals.

SESSION 6

Socioeconomics dimensions
Wednesday, October 10, 2018, 13:30 pm

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Alin Halimatussadiah is currently active as the assistant professor at the Department of Economics, Universitas Indonesia since 2007 and act as the head of environmental economics research group at the Institute for Economic and Social Research (LPEM), Universitas Indonesia. Alin received PhD in economics at Universitas Indonesia in 2013 with the field of environmental economics. Her research interest includes green growth planning, sustainable resource use, sustainable finance and waste management with the application of range of method such as economic valuation, cost-benefit analysis, and behavioral economics/experimental method. Outside university, taking a role as the vice director, she is actively involved at the Economy and Environmental Institute Indonesia (EEII), a partner of the Economy and Environment Partnership for Southeast Asia (EEPSEA).

HUMAN PRESSURE ON LOWLAND ECOSYSTEMS: WHAT CAN BE DONE

Looking at their economic potential, lowland ecosystems are prone with degradation as the result of human activity in exploiting land-based resource. Aside of that, the government may create incentive that may lead to unintended consequences such as land use change of essential ecosystem, e.g. subsidy to palm oil sector. Understanding what kinds of human (community, firm, government) interventions take in place in lowland and which one drive ecosystem degradation in lowland is important as the basis of constructing sustainable spatial development planning and identifying what kind of fiscal and other regulatory incentive that encourage sustainable lowland management. This presentation will examine risky sectors that most likely encourage land use change and ecosystem degradation in lowland area in Indonesia, and identify what kind of regulatory framework that may lead to sustainable lowland management.

SESSIONS AND ABSTRACTS

SESSION 1

Integrative experiments

Chairs: **Teja Tscharntke**, University of Göttingen (ttschar@gwdg.de) and **Leti Sundawati**, Bogor Agricultural University (lsundawati@gmail.com)

Scope

Integrative experiments addressing the socio-ecological causes and effects of rainforest transformation may focus on processes maintaining biodiversity in tropical human-dominated landscapes and the mechanisms that control the distribution of species, populations and communities as well ecosystem functioning. In addition, integrative experiments may provide insights into the potentials and limitations of improved management practices, biodiversity enrichment and forest restoration. Furthermore, the social and economic forces of ecological change and possible measures of forest conservation help understanding the full picture of tropical rainforest transformation.

Scientific talks - Abstracts

Large-scale experiments testing impacts of within-plantation management on oil palm ecosystems: the BEFTA Programme

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Oil palm agriculture has expanded rapidly in Southeast Asia, leading to widespread conversion of forest habitat to plantation, and consequent losses of habitat complexity, reduced biodiversity, and changes in ecosystem functions and services. With demand for palm oil predicted to increase further over coming decades, there is a need to develop conservation strategies to try to balance the competing demands of production and ecosystem protection.
Although there is a consensus that remaining areas of natural habitat should be protected wherever possible, the potential for conservation within oil palm plantation landscapes themselves has been less well studied. Whilst it is important that yield in plantations is maintained (in order to justify their existence at all, and to reduce need for additional land conversion), there are likely

to be possibilities for more sustainable management that could provide environmental benefits without substantially harming yield.
The Biodiversity and Ecosystem Function in Tropical Agriculture (BEFTA) Programme involves a collaboration between academia and industry to conduct a set of large scale, long term experiments in Sumatra, Indonesia, to test the effects of different oil palm management strategies on plantation ecosystems. In particular, we are conducting large scale, replicated, understory vegetation management experiments, along with one of the first large scale experimental tests of strategies for riparian buffer restoration within oil palm. Early results indicate that greater habitat complexity and reduced intensity management provides benefits for biodiversity, pest control, and ecosystem function, but mixed results for yield. We suggest that oil palm management strategies should be re-assessed in order to provide the best suite of multiple benefits that includes environmental considerations in addition to yield.

Biodiversity enrichment experiment in oil palm plantations: tree growth and structural complexity

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The transformation of structurally complex rainforests into simplified oil palm monocultures has led to dramatic losses in biodiversity and in ecological functioning. To alleviate the negative ecological impacts and maintain socio-economic benefits in existing plantations, designer plantation landscapes have been proposed, in which agroforestry zones can enhance structural complexity. In December 2013, we established a biodiversity enrichment experiment (EFForTS-BEE) by planting tree islands in a conventional oil palm landscape in Sumatra, Indonesia. The plantings comprise six native multi-purpose tree species at different species diversity levels (0, 1, 2, 3 and 6) arranged in a random partitions design with four different tree island sizes (5 x 5 m to 40 x 40 m) resulting in a total of 52 tree islands. Based on terrestrial LiDAR data, we showed that stand structural complexity in the tree islands is already significantly higher compared to oil palm monoculture, but still lower compared to rainforests. Furthermore, stand structural complexity increased with tree species diversity. The increase in stand structural complexity was associated with tree „over-yielding", i.e. the positive effect of tree growth on basal area observed in mixture compared to statistical expectations. Hence, we found a clear link between tree diversity, structural complexity and tree growth already three years after planting. These results may contribute to the development of ecologically improved management concepts in oil palm landscapes.

Scientific Posters - Abstracts

Mycorrhiza in cacao agroforestry systems in Central Sulawesi

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Arbuscular mycorrhizal fungi (AMF) are obligatory symbiotic soil fungi, which colonize the roots of the majority of plants. We investigated the contribution of shade tree cover and tree species diversity in cacao plantation on the AMF spore status in the soil-root zone of cacao. This study was conducted in the Kulawi valley in Central Sulawesi, Indonesia. The annual mean temperature was 25°C and precipitation amounted to 2.165 mm year^{-1}. The soil type was a Cambisol with alternating strata of sandy loam and loam texture. Three cacao plots of 25 by 25 m were studied, which were no more than 800 m apart of each other and were located on a smooth terrain with 2.5 - 4.5 inclination at an elevation between 550 m and 570 m a.s.l. Cacao trees were studied in three different cultivation types: monoculture-only cacao (892 stems ha^{-1}), under a Gliricidia tree shelter of the same age (total of 1.497 stems ha^{-1}), and in mixture with a multi-species tree assemblage (total of 1.741 stems ha^{-1}). We analysed the distribution of AMF spores density as well as soil properties in all cultivation types. Soil chemical properties of the mono, dual and mix, were 5.3, 5.2 and 5.7 (pH H_2O), 0.18%, 0.10%, 0.22%, (Norg), 16 Mg ha^{-1}, 18 Mg ha^{-1}, 23 Mg ha^{-1} (Corg pool), 106 µmol$_c$ g^{-1}, 82 µmol$_c$ g^{-1}, 130 µmol$_c$ g^{-1} (CEC), respectively. The AMF spores average density was 42, 135 and 96 spores per 20 g of dry soil, respectively. The correlation between soil properties and the status of mycorrhization was unclear. Whereas, under both shaded Gliricidia-cacao and mix trees-cacao showed clear increasing spore numbers 2-3 times than unshaded cacao monoculture. Furthermore, spore morphotypes such as its colour and shape varied between regions. This study stressed that in cacao agroforestry systems, the shade trees did not only promote tree diversity in a cacao plantation but also enhance AMF spores density in cacao root zone.

Peat land restoration through biodiversity enrichment experiment on smallholder oil palm at Jambi Province: Establishment process and initial results

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Rapid degradation of peat land forest in Indonesia is due to conversion into plantation forest and agriculture land. Since 2015, national program of peat land restoration is being conducted by Indonesian government involving various institutions including universities. One of peat land restoration project at Tanjung Jabung District, Jambi Province by Bogor Agricultural University used the approach of biodiversity enrichment experiment. The objectives are to restore the peat land and to increase community participation and welfare. The biodiversity enrichment experiment is established at the oil palm plantation of smallholders in Sinar Wajo Village, in which 30 plots in sizes of 25 m^2, 100 m^2, and 400 m^2 and placed systematically at distance about 50 m to each other over about 21 Ha oil palm plantation. There were 1,180 trees of six species (*Shorea blangeran*, *Areca pinanga*, *Parkia speciosa, Durio zibethinus, Archidendron pauciflorum, Coffea liberica*) with 0, 1, 3, and 6 diversity levels, created tree islands on the sea of oil palms. The average depth of peat on the plots was 2.25 m with peat soil type of *sapric* and has low pH (about 3-4), so that liming and chemical fertilizer were applied for the tree planting. On the project establishment process, local leaders were approached first, tree species selected by farmers through focus group discussion, and seedling, labour wages were provided to ensure farmer willingness of participation. Capacity building, such as trainings on tree cultivation, bio-fertilizer production and study tour to CRC990 project at Batanghari District was given as incentive for farmers. The initial result of plant growth observation and measurement from the experiment plots showed that about 4 months after planting, most trees grow well. *Shorea blangeran* as native species to peat land showed good growth performance. Durian and *Coffea liberica* were also showed good growth performance.

SESSION 2

Biogeochemistry

Chairs: **Amanda Matson**, Scion / New Zealand Forest Research Institute Limited (amanda.matson@scionresearch.com) and **Suria Darma Tarigan**, Bogor Agricultural University (surya.tarigan@yahoo.com)

Scope

Biogeochemical cycles link biota, climate, soil and water, and are strongly affected by socio-ecological transformations. The integrity of biogeochemical cycles is regarded as one of the keys to sustainable land use and development. In this session, we want to explore carbon, water and nutrient dynamics as affected by land cover and land use change. We thus welcome contributions on biogeochemistry addressing effects of socio-ecological transformations and options for more sustainable land use.

Scientific talks - Abstracts

Soil and tree-stem N_2O fluxes of a large-scale oil palm plantation in Sumatra, Indonesia

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Oil palm plantations cover large areas of Southeast Asia, with Indonesia and Malaysia currently the principal oil palm producers worldwide. As compared to smallholder plantations, large-scale oil palm plantations have the potential for much higher soil nitrous oxide (N_2O) fluxes, but measurements from large-scale plantations are scarce, especially measurements that include soil-mediated tree-stem N_2O fluxes. We quantified N_2O fluxes from the soil and tree stems of a large-scale oil palm plantation in Sumatra, Indonesia. Soil and tree-stem fluxes were measured bi-monthly for one year (2015-2016), using vented, static chambers with permanent bases (soil) and removable stem chambers (palm stem). The source of tree-stem N_2O emissions was confirmed using a nitrogen (15N) tracer. Tree-stem N_2O emissions from the twelve measurement trees were strongly correlated with soil N_2O concentrations ($R = 0.85$; $P < 0.01$) and fluxes ($R = 0.44$; $P = 0.01$). The seasonal pattern showed strong response of both soil and tree-stem fluxes to soil N amendments and soil moisture; soil concentrations and tree-stem fluxes were positively related to soil water-filled pore space across the 34 sampling dates ($R = 0.67$; $P < 0.01$ and $R = 0.71$; $P < 0.01$ respectively). The 15N tracer showed that tree-stem N_2O fluxes were a direct result of N fertilizer application to the soil. Our study shows the potential significance of tree stem fluxes in intensively managed plantations and highlights the importance of sustainable nutrition management.

Soil and tree-stem nitrous oxide emissions from smallholder oil palm plantations in riparian areas in Sumatra, Indonesia

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Increasing global demand for palm oil is causing large-scale forest-to-plantation conversion across Indonesia. While land-use conversion is known to increase soil N_2O fluxes in fertilized plantations on well-drained soils, no study has yet investigated the changes in N_2O fluxes in riparian areas. Our study aimed to quantify soil N_2O fluxes from these areas, and to assess the contributions of tree-stem N_2O fluxes, another recognized pathway of soil- atmosphere gas exchange in moist environments.
Four replicate plots (50 m x 50 m) of smallholder oil palm plantations (7-17 year old) were selected in riparian areas in Jambi, Indonesia. In each plot, we delineated upper and lower slope positions. We conducted soil N_2O flux measurements in fertilized area around the palm base, unfertilized inter-row and frond-stacked area, and tree-stem N_2O flux measurements on five trees, within both slope positions. Soil and tree-stem fluxes were measured using vented, static chambers and stem chambers, respectively. Measurements were conducted monthly from March 2017 to March 2018. A quantification of fertilizer-induced N_2O fluxes was conducted early 2018 with more intensive measurements within 60 days following fertilization.
On upper slope, average soil N_2O fluxes in μg N m^{-2} h^{-1} (mean + SE) were 48±34, 4±1 and 5±2 from fertilized, inter-row and frond-stacked areas, resp., and 52±49, 6±3 and 9±6, resp., on lower slope. Tree-stem N_2O fluxes in μg N m^{-2} stem area h-1 were 1±0 and 3±1, on upper and lower slope resp. During inundation, soil N_2O fluxes approached zero, whereas tree-stem N_2O fluxes increased by a factor of up to 40. Fertilizer-induced soil N_2O fluxes increased following fertilization, with a peak at 30 days (5104±645) and lasted for 60 days. Fertilizer-induced tree-stem N_2O fluxes were dependent on slope position: N_2O fluxes peaked at 5 days after fertilization (260±44) on lower slope and at 30 days (322±10) on upper slope. The influence of soil controlling factors on the spatial and temporal patterns of soil and tree-stem N_2O fluxes will be presented as well as spatially based extrapolation of annual N_2O fluxes.
Our findings showed that N_2O fluxes from smallholder oil palm plantations in riparian area were substantial, and therefore are an important factor to be included in a landscape-scale estimate of total N_2O fluxes.

Termites contribution to nitrous oxide and methane emissions along a gradient of forest disturbance in Sumatra

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Termites are widely accepted as methane (CH_4) emitters but the role of termites in N_2O fluxes is less well known. A series of field and laboratory studies were conducted in Pasir Mayang, Jambi, Sumatra, to determine termite contribution to CH_4 and N_2O fluxes in mineral soil. The in situ field measurements took place in an undisturbed forest, a disturbed forest, a one-year-old rubber plantation, a twenty-year-old rubber plantation and an eight-year-old oil palm plantation. Smallholders operate all of the plantations. We established 100 m transects to determine termite diversity and relative abundance and concomitantly along the transect, 20 static chambers were installed to measure the soil N_2O, CH_4 emissions, which were measured in once in the wet season and once in the dry season. Ex situ, the mounds soil alone, termite workers alone and with mound soil, termite soldiers alone and with mound soil were collected from the field, incubated in the laboratory and the gas samples were evaluated to determine the N_2O and CH_4 emissions from termites. There was no significant difference of

soil N_2O annual budget emissions across land-use systems. The soil CH_4 annual emissions followed a gradient from the disturbed forest = the oil palm plantation = the twenty-year-old rubber plantation > the undisturbed forest = the one year-old rubber plantation. The average of termite relative abundance and termite species in the plantation systems were significantly lower in the forested systems. We found that the termite workers and soldiers emitted a similar amount of N_2O whereas termite workers emitted significantly higher rates of CH_4 than the soldiers did. The presence of termites decreased the uptake of CH_4 from the soil in the undisturbed forest and one-year-old rubber plantation, the twenty-year-old rubber plantation and increased CH_4 uptake in the disturbed forest and oil palm plantation. The presence of termites increased cumulative N_2O fluxes from soil and termite in all land-use systems. Considering the potential contribution of termite to the total cumulative CH_4 emissions (4 - 88%) and N_2O (0.9 - 14%) from soil and termites, the contribution of termites should be included to refine the recent calculation of global N_2O and CH_4 emissions, especially in tropical ecosystems where termites are abundant.

Asymbiotic nitrogen fixation in soil and litter in a large-scale oil palm plantation

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Oil palm production is rapidly expanding in Indonesia due to increasing global demand in biofuels and cheap oils. Large-scale oil palm plantations account for 38% of the palm oil production in Jambi, Sumatra. These plantations are intensively managed with high rates of fertilizer inputs and herbicides application for weed control, which ensure high yield but may be associated with negative environmental impacts. In November 2016, we started an oil palm management experiment in a large-scale plantation in Jambi to evaluate whether lower-intensity management practices can reduce negative environmental impacts while maintaining current productivity level. This on-going experiment has the following treatments: conventional fertilization (260 N, 50 P, 220 K kg ha^{-1} yr-1) with herbicide spraying (2.25 L Glyphosate ha^{-1} yr^{-1}), conventional fertilization with mechanical weeding, reduced fertilization (136 N, 17 P, 187 K kg ha^{-1} yr^{-1}) with herbicide spraying, and reduced fertilization with mechanical weeding. There are three distinct spatial structures in oil palm management practices: fertilized area around palms, inter-rows and frond-stacked area. In our present study, we aimed to assess the differences in asymbiotic N_2 fixation between conventional and reduced management practices and among management spatial structures. We quantified asymbiotic N_2 fixation using acetylene reduction assay with monthly measurements from March 2017 to February 2018. Soil factors (water content, temperature, mineral N, extractable C, available P and Mo) known to control asymbiotic N_2 fixation were also measured. Preliminary data analysis showed no clear trends in differences among management treatments but revealed clear differences among spatial structures. Asymbiotic N_2 fixation in top 5-cm soil were 2.1 ± 0.3, 1.4 ± 0.2, 0.4 ± 0.1 Kg N ha^{-1} yr^{-1} for the fertilized, inter-row and frond-stacked areas, respectively, while in leaf and rachis litter were 3.0 ± 0.6 kg N ha^{-1} yr^{-1} and 5.8 ± 1.0 kg N ha^{-1} yr^{-1}, respectively. These results indicated that the management spatial structure shaped the spatial pattern of natural input of N into the ecosystem. Large asymbiotic N_2 fixation from the litter signified the importance of putting back senesced fronds instead of removing them.

Fertilization in Oil palm plantations: Microbial biomass activity and soil organic matter (SOM) decomposition under glyphosate stress

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Agricultural soils have experienced large anthropogenic nitrogen (N) inputs and herbicide treatments in recent decades, leading to problems like biodiversity loss, eutrophication and a decrease of soil fertility. Our mechanistic understanding of the impact of added fertilizer and herbicide use on the carbon (C) cycle of tropical soils under agricultural management is still marginal. The effects of fertilization and herbicide use on microbial activation and thus increased CO_2 emissions due to soil organic matter (SOM) decomposition in the interrow and the weeding circle of an oil palm plantation were investigated in a 30 days incubation experiment. Furthermore, the effect of herbicide use on SOM stabilization in interrows was examined. Here, we challenge the question whether herbicides hamper the microbial activity and lead to lower CO_2 emissions and consequently support carbon storage. The soil was amended with the fertilizer composition identical to field application, consisting of Urea (N), Triplesuperphospate (TSP), Potassium chloride (KCl) and dolomite in a conventional (9.8 mg g^{-1} soil) and reduced fertilization level mixture (5.7 mg g^{-1} soil). Application occurred in the weeding circles and an herbicide treatment was used in the plantation's interrows (glyphosate, 2.2 µl g^{-1} soil). Microbial biomass and CO_2 emissions were measured in order to analyse microbial activation by different management practices. The conventional fertilization increased soil CO_2 emissions up to a factor of three compared to the reduced fertilization, which is indicative for a strongly nutrient limited ecosystem. Amendment of easily accessible nutrient sources caused microbial activation and destabilisation of SOM, emitted as CO_2 to the atmosphere. Consequently, our results point towards a risk for management intensification of oil palm plantations reducing SOM stocks under increased greenhouse gas emissions.

Effects of soil carbon and metal contents on sorption of dissolved organic carbon on soils of tropical rainforest transformation systems

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Concentrations of dissolved organic carbon (DOC) in soil water could be altered substantially due to interactions through sorption mechanism with soil mineral particles. The ability of soil to bind DOC is likely to be influenced by initial soil carbon content. This study investigated the effect of carbon and metal contents on the sorption of DOC in the soil of tropical forest transformation system Jambi, Indonesia. Soil heavy metals (Al and Fe), total organic carbon and DOC contents in the soils were measured. In order to determine whether and to what extant variation in soil properties affect the DOC sorption, two soils with different metal and carbon contents (top and sub-surface soils) from two transformation systems (lowland tropical forest and palm oil plantation) were used. Water extractable DOC from organic-rich surface soil was used and added to the soil in batch experiments. Dissolved organic carbon correlates negatively with soil metal contents particularly at sub surface soils. In presence of high carbon organic content the correlation is not significant. This may be explained by repulsion of DOC bearing negative changes by organic rich soil particles.

Decomposition and nutrient mineralization from oil palm empty fruit bunch

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Oil palm empty fruit bunch (EFB), which constitute a large by-product from oil palm mill, may potentially increase soil fertility and decrease inorganic fertilizer application in smallholder oil palm plantations. Our present study aimed to: 1) assess nutrient mineralization from oil palm waste products (EFB, fibre, and EFB + fibre), and 2) assess decomposition rate and nutrient mineralization from different techniques of EFB application. For the first objective, we conducted incubation experiment in the laboratory by applying EFB, fibre, and EFB + fibre in two soil types which was collected from Desa Baru and Sungkai villages in Jambi province with soils types of clay Acrisol and sandy loam Acrisol, respectively. Soil samples (400 g) and by-product materials (EFB, fibre, and EFB + fibre with equivalent rates of 16 Mg ha^{-1}) were mixed in plastic bags with three replicates of each, and mineralization were measured for total C, total N, available P, and exchangeable K in the soil at 0, 4, 6, 8, 10, and 12 weeks after incubation. For the second objective, we set up field research in smallholder oil palm plantations, located in Sungkai village in Jambi province. The fresh EFB (16-ton ha^{-1}) was inserted in the litterbag (nylon bags with 2-mm mesh in diameter and 20 cm X 20 cm X 10 cm in size), then placed in soil surface (commonly practiced as mulch) and buried in 10-cm depth of soil (as practiced for organic fertilizers) at ± 2.5 m from the palm stem. Every sampling period, each EFB practices had four litterbag replication. Sample collection were conducted monthly from October 2017 to May 2018 for measuring dry weight and element concentration (i.e. C, N, P, K, Fe, Zn, Mn, B).
During 12 weeks of laboratory incubation, element released (i.e. C and P) was higher (P = 0.05 – 0.08) in the EFB application as compared to EFB + fibre in sandy loam Acrisol soil, whereas the application of fibre was not significantly different from the others. In the field experiment, buried EFB resulted in higher nutrient mineralization as compared to surface-placed EFB, as shown by lower nutrient remaining for N, P, Mn, and B (P = 0.00 – 0.07) and higher decomposition rates (k values) and lower mean residence time. Our results suggest that EFB incorporation in the soil can partly replenished nutrient export from harvest, and possibly decrease dependency on chemical fertilization.

Profile pattern of soil texture and basic cations in different land uses in Jambi, Indonesia

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Changing of land characteristics and soil properties as an impact of forest transformation to other land uses may affect leaching intensity in the soil. Translocation of soil particles as well as nutrients in the soil profile can describe the leaching process occurring in the soil. A study on the distribution of different soil fractions and cation bases was then conducted in Jambi, a region with very rapid land-use changes and high rainfall intensity in Sumatra, Indonesia. This research was conducted in three land-uses (forest, jungle rubber, and rubber plantations) in Bukit Duabelas (clayey) and Harapan (loamy) landscapes, each repeated three times. Soil samples were taken every 10 cm to 200 cm depth, in a representative profile in every land-uses. Different soil fractions were separated (sand, silt, clay fractions, each divided into 3 sub-fractions: coarse, medium and fine) using Na-hexametaphosphate as dispersing agent and measured using wet sieving and pipette method. The content of basic cations (Ca, Mg, K, Na) were measured using NH_4OAc pH 7 extraction.
In three land-uses, clay content was lower in the forest than others and increased with depth in forest and jungle rubber. Sand and silt content showed otherwise pattern than clay. In both landscape, fine clay accumulation in the forest (40 cm depth in Bukit Duabelas and 80 cm depth in Harapan) relatively

deeper than in the jungle rubber and rubber plantations (20 cm depth in Bukit Duabelas and 40 cm depth in Harapan). Maximum fine clay accumulation (at 100-140 cm depth) clearly showed in rubber plantations than other land-uses. The translocation of fine clay in Harapan was deeper than in Bukit Duabelas. However, both locations showed that clay translocation in rubber plantations is more intensive than other land-uses. In general, the total content of exchangeable basic cations decreased with depth. There was no significant difference between the total content of exchangeable basic cations in the three land-uses. However, rubber plantations tend to have the lowest content, especially in Harapan. This could be related to coarser soil texture and older rubber plantations than in Bukit Duabelas, which leads to a more intensive leaching. Distribution of Ca, Mg, K, and Na individually with depth has the similar pattern with total cation.

Tree and palm water use assessed by drone based imagery

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Land cover and land use changes can have strong effects on the hydrological cycle. For a better understanding of these effects, information on plant water use and stand-level evapotranspiration is needed. These variables are often assessed with ground-based sap flux and eddy covariance techniques. Complementary remote sensing techniques for the assessment of plant water use and evapotranspiration are becoming available by using drones as an aerial platform. Using drones, we tested two approaches: (1) photogrammetry derived crown volumes for predicting plant water use, and (2) thermal imagery based energy balance modelling for predicting stand-level evapotranspiration. Photogrammetry was applied in an oil palm agroforest, where tree and palm water use rates were measured by sap flux techniques. Crown volumes explained much of the observed spatial variability in plant water use for both, palms (69%) and trees (81%). Among the trees crown volume explained more than other plant size variables, and thus uncertainty estimates at the stand-level resulting from scaling were reduced. Thermal imagery was applied in a commercial oil palm plantation, where evapotranspiration was assessed by the eddy covariance technique. Models based on land and vegetation surface temperatures supplemented by net radiation measurements yielded high temporal agreement with eddy covariance measurements (up to $R^2 = 0.82$), even under different weather conditions. Both airborne methods offer opportunities of assessments at high spatial resolution covering reasonably large areas. In conclusion, we propose that the two tested methods using drones as an aerial platform, photogrammetry and thermal imagery, are very valuable in the assessment of plant water use and stand-level evapotranspiration.

Aerodynamic characteristics and turbulent transfer of oil palm canopy

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The transfer of momentum, heat, water vapour and carbon dioxide between plant canopy and the air above it depends on the aerodynamic characteristics and turbulent exchange properties of the canopy. Measurement of radiation, wind, air temperature and relative humidity profiles (at 0.9, 2.3, 8.1, 12.3,16.3 and 21.7 m height) were conducted in an oil palm plantation at PT Perkebunan Nusantara VI Batanghari, Jambi, Sumatra, Indonesia (plant height = 14.8 meters, LAI 2.1, coverage 78.6 %) for the period 2015-2017, using conventional instrumentation and an Eddy Covariance system. The wind profile above the canopy forms a logarithmic and within canopy an exponential pattern. Roughness parameters (zero plane displacement, d, roughness length, z_o, drag coeffi-

cient, CD) vary with atmospheric stability and wind speed. Turbulence intensity and turbulence kinetic energy (TKE) are significantly correlated with friction velocity and turbulent transfer of momentum and heat. Both show clear diurnal pattern with maximum turbulent transfer during daytime. The magnitude of turbulence controls the amount of momentum and heat transfer and affects the energy balance of the oil palm surface. Most of the net radiation available is used for latent heat fluxes and related evapotranspiration, followed by sensible heat fluxes. Conductive ground heat flux forms the smallest component in the surface energy budget.

El Niño–Southern Oscillation and the oil palm: Effects of drought and haze on evapotranspiration, CO_2 exchange and surface energy budget

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The 2015-2016 El Niño–Southern Oscillation (ENSO) resulted in a strong drought in Southeast Asia and particularly Indonesia experienced severe forest-, peat- and grassland fires. These fires spread over vast areas and the emitted smoke and dense haze covered the region, including tropical lowlands of Sumatra, for two months. During the past decades, large areas of tropical forest in Sumatra have been converted into commercial oil palm (*Elaeis guineensis* Jacq.) plantations. To what extent the ENSO related drought and haze affect the carbon, water and energy cycles of the new oil palm dominated landscape is still unclear. In this study, we investigate for the first time in this area the impact of drought and haze during the ENSO event on evapotranspiration, CO_2 exchange and surface energy budget in a commercial oil palm plantation in Jambi province (Sumatra, Indonesia) by using micrometeorological measurements and the eddy covariance method. Our analyses show that during the period May-October 2015 the oil palm plantation experienced increasing air temperature and vapour pressure deficit, and declining soil moisture. From mid-September until mid-November 2015, increasing smoke and haze decreased incoming photosynthetically active radiation (PAR) by 35% in relation to the pre-ENSO months and diffuse radiation became almost the sole PAR component. With the absence of precipitation, midday Bowen ratio increased from 0.17 to 0.40. Haze reduced the magnitude of both sensible and latent heat fluxes by 45% compared to pre-ENSO conditions. The strength of carbon (*C*) accumulation during 2015 varied substantially, e.g. during the peak of the drought in mid-July 2015, *C* flux was at its peak, with 2.7 ± 0.8 gC m^{-2} d^{-1} while during the haze, *C* flux was at its minimum, with 0.0 ± 0.1 gC m^{-2} d^{-1}. In the context of expected future expansion of oil palm plantations and increase in climate extremes, our results provide valuable information on the response of oil palm to ENSO and haze.

Comparison of aboveground biomass and carbon sequestration in Indonesian rainforest conversion systems

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Natural forests in Southeast Asia have been extensively converted into anthropogenic land-use systems in the past decades. This is true particularly for Borneo and Sumatra, where rainforests have been replaced mainly by rubber agroforestry systems in the past, while recently oil palm plantations are the most common land-use form. Although these large-scale conversions are expected to strongly affect carbon cycles, detailed attempts to quantify carbon pools in plant biomass and net primary production in ecosystems replacing rainforests are still rare. We have measured carbon pools in biomass as well as aboveground woody production in natural old-growth forests, rubber agroforests under natural shade tree cover ('jungle rubber'), rubber monocultures, and oil palm plantations over the course of six consecutive years from 2013-2018 and additionally in riparian forest and rubber systems from 2017-2018 in Jambi province, Sumatra (40 plots in total). Leaf litter production was measured between 2013-2014 and again from 2017-2018 to allow observing interannual fluctuations and seasonality effects. Aboveground carbon stock in the natural forest stands (mean: 159 Mg ha^{-1}) was more than two times higher than in jungle rubber stands (57 Mg ha^{-1}) and more than four times higher than in monoculture rubber (29 Mg ha^{-1}) and oil palm plantations (33 Mg ha^{-1}). Leaf litter production ranged from 4 Mg $ha^{-1}y^{-1}$ in rubber monocultures to 7 Mg $ha^{-1}y^{-1}$ in the natural forests without significant differences between riparian and non-riparian sites. We conclude that conversion of natural forest to anthropogenic land-use systems in both riparian and non-riparian sites reduces the carbon pools immensely and does strongly affect aboveground carbon sequestration via net primary production.

Impact of soil degradation and change in plant transpiration on the catchment water balance in tropical rainforest transformation systems

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Local inhabitants often claim that there is an association between the land use change in the oil palm expansion and the local water-related problem such as water shortage during dry season and flooding during rainy season in the study area. In contrast, plantation owners believe that oil palm expansion does not have significant impact on the local water-related problem. In this respect, the aim of this research is to study whether and how the water related problem in the study area is associated with the land use change in the oil palm expansion. We focused our analysis on the two factors closely related to the water flow regulation in a catchment including soil degradation and plant transpiration. The specific research questions are: a) do the soil degradation and the increased plant transpiration under oil palm plantation had caused significant impact on the local water-related problem, and b) which one of these factors is dominant. For this purpose, we calibrated and validated catchment hydrological model (SWAT) in a 100-ha catchment entirely covered by oil palm plantation and simulate impact of soil degradation and plant transpiration on the catchment water balance. The soil degradation under oil palm plantation are shown by reduced soil infiltration, slow soil moisture replenishment and increased bulk density. We found that the soil infiltration is lower, the soil bulk density is higher, and the soil moisture replenishment is slower under the oil palm plantation compared to those of the other land-use types. Low infiltration reduces the amount of the water stored in the soil profile and in the shallow aquifers causing water shortage during dry season and excess of surface runoff leading to flooding during rainy season. The result of this study showed that the soil degradation under oil palm plantation is important factor on the seasonal fluctuation of the catchment discharge. Good plantation management practices should be directed to mitigate soil degradation through im-

provement of the physical and biological characteristics of the soils leading to the higher infiltration rate.

Scientific Posters - Abstracts

The analysis of vegetation change and rainfall variability in Lore Lindu National Park, Central Sulawesi, Indonesia

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Lore Lindu National Park is one of the National Parks in Indonesia located in Central Sulawesi Province, which is one of the biological protection sites in Sulawesi. This National Park consists mostly of mountain and sub-mountain forest (± 90%) and a small part of lowland forest (± 10%). Climate change and variability is one of the global, regional and local problems that have a major impact on vegetation changes in a region. The purpose of this research is to analyse NDVI (Normalize Difference Vegetation Index) correlation with rainfall variability in Lore Lindu National Park. The data used are rainfall data from 2015 to 2017 in several rain stations around Lore Lindu National Park, and NDVI satellite data taken from NOAA satellites using AVHRR (Advanced Very High Resolution Radiometer) sensor. This research uses Pearson correlation method between Rainfall and NDVI vegetation index which is used to find out how big the effect of rainfall on vegetation changes that happened in Lore Lindu National Park Bariri. The results of this study indicate that rainfall is negatively correlated to NDVI which means rainfall change followed by NDVI changes regularly in opposite directions. The rainfall, which has the highest rainfall correlation value to the vegetation changes in the Lore Lindu National Park area, is the Doda rainfall post, which has a correlation of 56%.

Controls on soil water potential and nutrient limitation explains low carbon and water dynamics in Rubber plantations from Indonesia

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Land use changes (LUC) have strong impacts on carbon, energy and water fluxes in tropical regions. Uncertainties exist in the prediction of future LUC impacts on these fluxes by land surface models due to scarcity in the observational data and also due to poor representation of key biogeochemical processes associated with tropical vegetation types. Rubber plantations are a land use type that has largely expanded in the tropics, replacing tropical rainforests. Here, we first synthesized the data relevant for biogeochemical processes of rubber from past measurement campaigns in Jambi province, Indonesia. Then we used these data-sets to develop a rubber plant functional type (PFT) in the Community Land Model (CLM4.5). Measured data-sets on above ground litter fall, latex harvest, leaf area index, transpiration, net primary productivity, and biomass were used to calibrate the developed model (CLM-rubber) at the Harapan site.
The CLM-rubber predicted the net primary productivity and above ground biomass of rubber reasonably well and was able to capture the seasonal dynamics of LAI, yield and soil moisture. Further, the CLM-rubber was able to produce the 20% observed decline in soil carbon since clear-cut. The model was also able to successfully capture the magnitude of the low transpiration, which was likely due to enhanced sensitivity of stomatal conductance to soil water stress and increased nutrient limitation. All of the predicted water fluxes of the CLM-rubber were very similar to the site-specific calibrated hydrology model.

Despite more than 2-fold variability across 8 plots in measurements of carbon and water dynamics, CLM-rubber performed reasonably well. CLM-rubber could perform better if temporal variations in leaf-life span of rubber with litter-fall is studied together. CLM-rubber suggests that constraints from soil are more likely to limit transpiration than radiation and vapour pressure deficit. Because 85% of rubber plantations in Indonesia is owned by smallholders, our findings can be extrapolated at a larger-scale, and thus our results indicate that rubber plantations from Indonesia are less likely to have high carbon and water fluxes compared with rubber plantations from other tropical or subtropical regions.

Transpiration on the rebound in lowland Sumatra

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Following large-scale conversion of rainforest, rubber and oil palm plantations dominate lowland Sumatra (Indonesia) and other parts of South East Asia today, with potentially far-reaching ecohydrological consequences. We assessed how such land-use change affects plant transpiration by sap flux measurements at 42 sites in selectively logged rainforests, agroforests and rubber and oil palm monoculture plantations in the lowlands of Sumatra. Site-to-site variability in stand-scale transpiration and tree-level water use were explained by stand structure, productivity, soil properties and plantation age. Along a land-use change trajectory forest-rubber-oil palm, transpiration decreases by 43 ± 11% from forest to rubber, but rebounds with conversion to smallholder oil palm. We uncovered that particularly commercial, intensive oil palm cultivation leads

to high transpiration, even surpassing forest rates. Compared to small-holder oil palm, transpiration is 1.7-times higher in commercial plantations. Combined with severe soil degradation, the high transpiration may cause periodical water scarcity for humans in oil palm-dominated landscapes. As oil palm is projected to further expand, severe shifts in water cycling after land-cover change and water scarcity due to land-use intensification may become more widespread.

Improving the Community Land Model (CLM 4.5's) performance in simulating soil carbon in the tropics

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Soil stores three times as much carbon as the atmosphere and living biomass. Changes in land-use and climate can, therefore, contribute to important CO_2 emissions from soil carbon to the atmosphere. Observational studies provide information regarding the effects of land use change on C fluxes, but models are necessary to predict future changes and extrapolate results to larger areas. Most available soil models are developed and calibrated for temperate soils and often perform poorly for tropical soils. Our study aims to improve the performance of the Community Land Model (CLM 4.5) in simulating soil organic carbon and soil respiration in Jambi, Indonesia, by adapting the parameters in the model to the tropical conditions.
The key change made to the model was adjusting the parameters controlling the turnover time of soil C pools. Measured values of litter quality (C:N ratio, lignin, holocellulose concentration of litter) that control the decomposition rates of litter, were also modified by using observed values. By using the default parameter values, the model underestimated total soil organic carbon and overestimated soil respiration of forest, while underestimated the oil palm. The calibrated model showed a significant improvement: The simulated forest carbon stocks increased, showing a better agreement with observations (from an average of 6 kg C m^{-2} to ca. 23 kg C m^{-2}; compared to the observed value of 24 kg C m^{-2}). Simulated soil respiration went down, also approaching observed values and reduces the RMSE from 20 to ca. 16 mg C m^{-2} $hour^{-1}$. For oil palm, model calibration increased simulated soil C stocks from 5 kg C m^{-2} to ca. 13 kg C m^{-2} (observation is 18 kg C m^{-2}) and reduced the RMSE of soil respiration from 6 to ca. 5 mg C m^{-2} $hour^{-1}$.
Based on this, we will estimate the long-term effects of land use change compared to those of CO_2 fertilization. We will also estimate the regional short and long-term impact of land use on soil C stocks and fluxes.

Simulation of the impact of land use changes on climate parameters using regional climate model (RegCM) in Jambi Province, Indonesia

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The high and increasing demand for palm oil products leads to the conversion of forests into oil palm plantations. If this continues, the forest fraction becomes smaller than the land covered by oil palm. Land use change may have an impact on climate parameters. This research aims to study the impact of land use change from forest to oil palm on climate parameters. The Regional Climate Model (RegCM4.6.1) is used for a 1-year climate simulation in Jambi region. This model is configured at the domain of 101.15°-104.75° E and 2.6°-0.9 S with 5 km horizontal resolution. Two simulations using land cover of year 2010 (simulation I) with Biosphere-Atmosphere Transfer Scheme (BATS) and land cover modification of year 2010 (simulation II) where land cover of forest is replaced by oil palm, based on the assumption of no remaining forest land in the study area. The model is parameterized with cumulus convection scheme (Massachusetts Institute of Technology /MIT)) and the marine flux scheme (Zeng, Monin-Obukhov). The model simulation output are compared with BMKG observation data blending with Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) for rainfall and observation data from Climate Research Unit (CRU) for temperature. This study examines the effect of land use change on climate parameters such as surface radiation, air temperature, rainfall, humidity and soil moisture. The result shows the change of climate parameter, temperature of simulation I and simulation II have under values of observations with the lowest values found in Bukit Barisan (West Jambi), while simulation II has a higher temperature value of 1°C - 1.5°C than simulation I. The difference of rainfall is not significant and the humidity and soil moisture of simulation II have decreased than the simulation I. The reduction of forest cover in simulation II contributes to the variation of climatic parameters in Jambi Province.

Dissolved organic carbon under oil palm plantation in small catchment of PT Perkebunan Nusantara VI, Jambi

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The research aims to study DOC characteristics of stream water under oil palm plantation of a small catchment in PT Perkebunan Nusantara VI, Jambi. The research was carried out during June – December 2017 in the Bajubang catchment of 168 hectares. DOC was analysed by spectrophotometer with absorbance 254 nm, while concentration of Na, PO_4, Fe, Al, and Mn by emission, blue molibdate, and AAS respectively. DOC and other parameters were statistically correlated by considering hydrological characteristics of the catchment.
Concentration of Al, Fe, Mn, Na, and PO4 of the 60 water samples were analysed. DOC is highly positive correlated with Al and Fe (0.88 and 0.94), but slightly low with Mn (0.62) as well as with PO4 (0.73). There was no or low correlation of DOC and sodium cation (0.35).
DOC concentration is significantly high correlated with creek discharge ($r = 0.94$) while DOC is highly correlated with rainfall ($r = 0.87$) as well. The surface runoff and seepage will transport DOC down to the creek, and in turn will flow it to the main river. The highest rainfall does not indicate the highest DOC discharge, since DOC is influenced by soil organic carbon mineralization.
The average of transported DOC along five sampling points of the creek is 10.76 kg per day or 290.65 kg of 27 sampling days. The total DOC of daily sampling will be higher than 290.65 kg. Meaning, abundance of organic carbon that is dissolved in the water was washed out of the catchment, and in turn will be polluting water bodies in the downstream of watershed.

Soils under oil palm plantations and rainforest - preliminary results on silicon fractions and bulk density

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Given the rapid expansion of oil palm plantations in SE Asia, it is essential to ensure that soil functions in oil palm plantations are sustained on the long-term, including maintenance of well-balanced soil nutrient levels and prevention of compaction. With respect to nutrients, no studies on the influence of oil palm on soil silicon (Si) pools exist so far, although it is known that oil palms accumulate Si in their biomass.

In our project, we compare rainforest and oil palm plantations with respect to various soil Si pools. Si uptake of oil palms is expected to exceed that of rainforest trees. The Si in the oil palm biomass is partly removed from the system with the harvest, and partly returned to the soil through the palm fronds and empty bunches that are piled up in every second palm inter-row. We hypothesize that this practice results in an overall decrease in soil Si in oil palm plantations, and in marked differences between the soil under the palm fronds and the empty inter-rows. These hypotheses are currently tested for the loamy Acrisols in Jambi Province. In a preliminary study, top-soil samples (0–10 cm) from rainforests (n = 5) and oil palm plantations (n = 4) were subjected to sequential Si extraction. No clear trends were observed for mobile silicic acid and Si occluded in pedogenic oxides. The latter seems to be more strongly influenced by soil hydrology and associated redox processes than by land-use. Soils of oil palm plantations had lower contents of adsorbed silicic acid and biogenic amorphous silica than those of rainforests. At present, we systematically take top-soil samples within oil palm rows, in inter-rows, and under frond piles. Sequential Si extraction of these samples, together with analyses of bulk density, will provide further insight into the spatial patterns of soil Si dynamics and soil compaction under oil palm, both under well-drained conditions, and under the influence of temporarily perched water and groundwater at riparian sites.

Several enzyme activities in oil palm rhizosphere of drained peatland

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This research aims to study oil-palm root exudates, enzyme activities, and lignocellulose composition of peat. The research sites were selected in an oil palm plantation, degraded-forest, and shrub situated in Siak District, Riau. Observations and peat sampling were conducted in 16-observation points, representing the research sites. Peat samples from oil palm rhizosphere were taken from sub-observation point based on the distance from oil palm tree and peat depths. Enzyme activities such as: urease, phosphatase, β-glucosidase and laccase, and lignocelluloses, total nutrient contents, and root exudate were analysed by the related methods. The research results showed that lignin in peat had a significant positive correlation with laccase activity. Application of fertilizers decreased oil-palm root exudates and enzyme activities. Total content of the respective Fe and Cu in peat had significant negative correlations with analysed-enzyme activities. Low peat nutrients stimulated the release of oil-palm exudates. Enzyme activities in oil palm rhizosphere are not different with those in the degraded forest and shrubs.

The Effect of paraquat, difenoconazole, and butylphenylmethyl carbamate (BPMC) onto CO_2 emission and phenolic acids in peat soil

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Pesticdes are widely used in agriculture, including in peat soil. The objective of this study was to analyse the effect of paraquat, difenoconazole, and butylphenylmethyl carbamate (BPMC) on $C0_2$ emissions and concentration of phenolic acids in peat soil. Soil samples were taken in the district of Pulang Pisau, Central Kalimantan. Peat soil was treated with paraquat (1,89 mg kg^{-1}), Difenoconazole (1,72 mg kg^{-1}) and butylphenylmethyl carbamate (BPMC; 1,65 mg kg-1), then incubated for 1, 2, 4, 5, 7, 10, 14, 21, 26 and 30 days. The results showed that the application of pesticides which incubated up to 30 days increased $C0_2$ emissions, decreased CH_4 emission and decreased the phenolic acids concentration. CO_2 emissions were derived from C of degraded pesticides and from C of phenolic acid, although the oxidation reaction was not accompanied by change in pH of the soil.

Rainfall analysis and prediction for forecasting the rice production at the margin areas of Lore Lindu National Park-Sulawesi

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This study was conducted in the rice fields at the margin of Lore Lindu National Park (TNLL) in Central Sulawesi. The aim of this research was to investigate the relation between the rainfall patterns with the potential of rice availability status. This study contributes for better planning in rice production and distribution. Rainfall cluster arrangement will be done through monthly rainfall analysis and from STORMA AWS tower with *fuzzy* method, while the modelling of rain prediction will be done with *neural network analysis*. Rain prediction model was integrated with the ground water data set collected from field survey and the rice production data in the TNLL region. Ground water was determined with book keeping of water balance system. The result shows that rainfall in TNLL region has strong spatial variant due to the elevation as a result of orography. According to the error value of the rain prediction model, a good model was acquired from Palolo (Napu), Pakuli-Tuwa (Pandere) and Kulawi Gimpu. Generally when ENSO happened La Nina has stronger effect than El-Nino. This condition cause rainfall below or above normal, both caused harvesting area to be decreased with equation: Y= -3E-05x2 + 0.1065x – 80.721, R2: 0.62. Bariri, Napu and Kulawi regions their rice production was affected by rain anomaly. When there is rain anomaly, the rice production at these 3 regions will be reduced, and their food security status is altered from enough to moderate or less.

SESSION 3

Biodiversity

Chairs: **Holger Kreft**, University of Göttingen (holger.kreft@forst.uni-Göttingen.de) and **Damayanti Buchori**, Bogor Agricultural University (dami@indo.net.id)

Scope

Biodiversity changes dramatically with tropical forest transformation, thereby reducing genetic and species diversity as well as affecting community composition and associated ecosystem functioning. Tropical landscapes are dominated by different land- use systems, but their ecological functioning and contribution to biodiversity conservation is still poorly understood. The enormous magnitude of tropical biodiversity and the lack of solid taxonomic knowledge often sets limits to ecological studies. Since changes in biodiversity in response to human impact are known to differ widely among taxonomic groups and guilds, there is a need for multidisciplinary collaboration of plant, vertebrate, and invertebrate experts.

Scientific talks - Abstracts

Tropical ecosystem and plant diversity dynamics and the impact of climate, fire and humans during late Quaternary times

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The high number of different pollen and spore types (pollen richness) deposited in environmental archives such as lake, peat and swamp deposits can be used as an indicator of past plant diversity changes. Changes in pollen richness during late Quaternary times can provide important insights how plant diversity changed over time and how it reacts on past climate, fire and human impacts.

Several palaeoecological studies from different tropical ecosystems such as tropical lowland and mountain rainforest, semi-deciduous forests, savanna and subtropical forests and grasslands will be shown from South America (Brazil) and Southeast Asia (Indonesia). These studies provide important insights how ecosystems and its plant diversity responded to past environmental changes. These palaeoecological studies improve our understanding of vegetation and its diversity and provide important background information for conservation and management strategies of strongly affected tropical ecosystems.

The effect of volcanism on the submontane rainforest vegetation composition: palaeoecological evidence from Danau Njalau, Sumatra (Indonesia)

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Volcanic processes might have played an important role in the vegetation history of Sumatra, one of the largest and most tectonically active region in Southeast Asia. Palynological and macro-charcoal analyses results from Lake Njalau in the Kerinci Seblat National Park in Sumatra (Indonesia), provides an understanding of interactions between the volcanic deposition and vegetation in the past 5000 years. The deposition of volcanic material in the depression of the Lake Njalau (5100-4400 cal yr BP) led to the dominance of pioneer species of *Casuarina* and *Myrica*, which grow in deforested land and volcano slopes (volcanophile taxa). The formation of the modern forest composition took several centuries after the volcanic deposition in the soil ended (ca. 900 years at ca. 2400 cal yr BP). This suggests that the vegetation changes were not driven by a successional pattern and soil formation was the most important environmental factor explaining this slow change in composition. The palynological records show no evidence for prehistoric human-landscape interactions in the area despite the close proximity to known megalith sites. The local fire regime reconstructed using macro-charcoal analysis indicates that fire was rare for the last 5000 years and the average fire return interval was ca. 500 years. Phases of increased fire frequency could not be linked to either any of the vegetation phases or regional climatic changes, suggesting that fire occurrences were stochastic events. Our results overall suggest that volcanism have acted as one important driver of changes in the rainforests of the Kerinci Seblat National Park.

The impact of rainforest transformation in Sumatra on plant taxonomic, phylogenetic, and functional diversity

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Indonesia is known for its outstanding species richness and endemism. While being a global centre of biodiversity, it has also become the world's hotspot for deforestation, losing more forest each year than any other country worldwide due to land-use change and intensification. Deforestation and the conversion of forest into agricultural land has been shown to dramatically impact tropical plant communities. In addition to a usually pronounced loss in species diversity, community composition may also change, especially through the introduction of alien species favoured by altered microclimatic conditions. While the detrimental effects of land use change on taxonomic plant diversity in the tropics are relatively well-understood, a clear picture on how the loss of species translates into changes of phylogenetic and functional diversity is still lacking. Within the framework of the EFForTS project, we studied the impact of forest transformation on vascular plant diversity across the four transformation systems lowland rainforest, jungle rubber, rubber plantations, and oil palm plantations in Sumatra. We conducted extensive inventories of trees, epiphytes and understorey plants on 32 plots spread over the four land use systems in two lowland landscapes of Jambi Province, a hotspot of land use changes during the last decades.
We here present an overview of how land use dynamics in tropical lowlands of Indonesia affect different dimensions of plant diversity (taxonomic and phylogenetic; preliminary results of functional diversity) and how these effects vary between different ecological guilds (trees, epiphytes, and understorey plants).

Our results show that all three dimensions of plant diversity and composition are strongly affected by land use intensification.

Asytasia gangetica ssp. micranthea in the coming release of glyphosate resistance corn in Indonesia

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The Indonesian government is soon releasing glyphosate resistance corns for the easiness of farmers to control weeds in corn fields. During the discussion of possible problems in the field, it was suggested to identify the distribution of glyphosate resistance weeds in Indonesia to avoid ineffective weed control when farmers planted glyphosate resistance corn. A survey on the distribution of *Asystasia gangetica* subsp. *micrantha* in Sumatera was undertaken by BIOTROP to provide information on the status of Asystasia resistance to glyphosate. The survey started from North Sumatera province down to Lampung province by collecting mature fruits from standing *Asystasia cangetica* subsp. *micrantha,* brought to the laboratory, dried under the sun and seeds were collected and planted in pots under greenhouse condition at BIOTROP, Bogor. Indonesia. There were 133 different accessions of *A.gangetica* subsp.*micrantha* and they were subjected to spraying treatments of a range of glyphosate. The critical concentration of glyphosate considered fatal to the accession was done by calculating LD50 of each sucessions which varied considerably . The differential susceptibility of *A.gangetica* subsp. *micrantha* was suspected due to difference exposure to glyphosate. Although *A.gangetica* subsp. *micrantha* recorded in this paper were mainly taken from oilpalm plantations this species has been spreading very rapidly. The implication for the management of weeds in glyphosate resistance corn is discussed.

Status on the studies of invasive alien plant species in Sumatra

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Sumatra, with an area of 474,000 km^2 is the second largest island of Indonesia. Sumatra has already lost much of its natural forest cover- especially lowland forest which are threatened by deforestation, forest degradation and conversion into other land use system. Conversion of the forest into other land use type and forest conversion provide pathways for invasive alien plant species (IAPS) for instance open space of the forest can be easily occupied by IAPS. Weeds of agricultural ecosystems are well known by the public in Sumatra and Indonesia. However IAPS are relatively new for the public. IAPS are introduced species, few local species which could also become invasive in natural disturbed ecosystem. The issue of IAPS was raised during Convention on Biological Diversity (CBD) in 1992 which was ratified by the Indonesian Government in 1994. In 200 an effort to observe the IAPS problem, the Indonesian Ministry of Environment together with SEAMEO BIOTROP compiled a list of introduced species in Indonesia. It was found about 1936 species introduce plant species and 17.5% of them indicated as invasive plant species. The first training course on IAPS was conducted by SEAMEO BIOTROP in 2004 and followed by other training in 2010 –2016 and 2018. The last training course was conducted in Jambi in April 2018. After 2005, there were many information on Indonesian IAS and great sources of information are scattered in articles, publications and databases. In Sumatra, studies on IAPS were conducted in Taman Nasional Bukit Barisan Selatan, Bukit Duabelas, Tahura Sultan Thaha, and Bukit Harapan. Escaping large forest plantations for producing pulp in Sumatra, the introduced species *Acacia mangium* is increasingly becoming an ecological problem interfering with the forest. *A. mangium* is very difficult to control and is an important IAPS at Hutan Harapan (PT REKI) and Tahura Sultan Thaha. Furthermore, the climber *Meremmia peltata* is infesting large area of Taman Nasional Bukit Barisan Sela-

tan after the larger timber trees of the forest have been logged. IAPS in Jambi were also part of plant biodiversity studies under EFForTS project. Recently, people are more aware on the problem of IAPS in Sumatra.

Population genetics of endangered *Dipterocarps* in Indonesia: Implication for conservation strategy and sustainable utilization

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Indonesian's lowland rainforests are dominated by the emergent trees, dipterocarps, which are economically important as the timber and non-timber products can be used for many purposes. Unfortunately, the supply of Dipterocarps products still relies on natural forests, at the same time, the distribution area of the species is shrinking due to over-exploitation and changes in land use systems to agriculture causing many of these species to become endangered. However, the current existence, distribution and genetic information of the species in Indonesian's rainforest are not well studied. Therefore, this paper will discuss the results of previous studies on population genetics of the endangered Dipterocarps in Indonesia based on microsatellite markers such as *Dipterocarpus littoralis* and *Dryobalanops* spp. and its implication for conservation strategy and sustainable utilization. The two studies revealed that the levels of genetic diversity in *Dipterocarpus littoralis* and *Dryobalanops* spp. were lower than other common Dipterocarps indicated that this corresponds to a pattern often found in endangered endemic plants. The studies also showed that all populations in each species are genetically structured, which may be a consequence of limited gene flow and intensive genetic drift in the populations. These results have significant implications for conservation strategies. In situ conservation strategies should be adopted to protect and restore all existing populations of each species and when ex situ conservation is being carried out, germplasm resources should be established with seeds from multiple sources.

Xylem vulnerability to embolism in natural and intensively used tropical systems

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Drought-induced tree mortality has been reported by numerous studies over the past decades. Shifts in climate patterns are the major causes of massive tree diebacks in multiple biomes, including wet environments such as tropical forest. In those regions, the duration and intensity of drought events are predicted to increase. This might result in catastrophic hydraulic failure of the trees water transport system due to the increase in xylem embolism with rising drought stress.

To investigate plant sensitivity to drought, one way is to study functional traits related to water transport such as xylem safety against drought-induced hydraulic failure and especially its water potential at 50% loss of conductivity (P_{50}), extracted from xylem vulnerability curves. While embolism has been documented for non-tropical trees and related to several functional and structural parameters, little is known for tropical trees and palms. In this study, we measured the P_{50}-value as well as other tree structural traits (e.g., wood density, tree height) of ten canopy tree species in Sumatra, Indonesia, including valuable timber species. We also measured these parameters on rubber tree (*Hevea brasiliensis*) and oil palm (*Eleais guineensis*), growing in monocultures.

The selected forest species have a P_{50} ranging from -4.43 MPa to -1.86 MPa and significantly negatively correlated to tree height and maximum vessel length. No relation was observed between *P*50 and wood density. Oil palms showed a P_{50} range between -1.5 MPa and -3.5 MPa across different locations. Rubber trees showed an average P_{50} of -2.45 MPa across locations.

Our results give new evidences of lower drought resistance in tall rather than dense-wooded tropical trees and show a broad range of P_{50} in the forest. This higher diversity of tree hydraulic strategies in natural forest is most likely due

to its structural complexity leading to a resilient system with more abilities to face intense droughts. In opposition, we show for the first time that oil palm is highly vulnerable to cavitation and thus could be sensitive to long drought events, even if the high variability among plots suggests the importance of plantation management. Likewise rubber, oil palm plantation as a monoculture system with low embolism resistance will lack long term resilience facing climate variability.

Tropical land transformation shifts ecological functions of fungal communities

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Soil fungi are key players in nutrient cycles as decomposers, mutualists and pathogens, but the impact of tropical rain forest transformation into oil palm or rubber plantations on fungal community structures and their ecological functions are unknown. We hypothesized that (i) increasing management intensity and habitat loss due to the replacement of the diverse forest flora by intensively managed plantations drives a drastic loss of diversity of fungal taxa on roots because of the loss of host species and (ii) impairs ecological soil functions because of changes of fungal trophic structures. We found a decrease in root-associated fungal taxa. The strongest decline was observed for symbiotrophic taxa (ectomycorrhiza, arbuscular mycorrhiza). The decline in species of root-associated fungal richness was related to the decline in plant species richness. Root nutrient element contents were reduced and potentially toxic elements such as Al and Fe were increased in roots of oil palm compared with those of other land use systems. In contrast to root-associated fungi, rain forest conversion was not associated with diversity loss but with massive shifts in soil fungal community composition. The relative abundance of saprotrophic and pathotrophic fungi increased. Network analysis revealed characteristic fungal genera significantly associated with different land use systems. Among the indicator species in oil palm plantations, the potential plant pathogen *Fusarium oxysporum* was strongly enriched in soil and roots, whereas in rain forests ectomycorrhizal species of the genus Scleroderma were enriched. Conversion of rain forests and current plantation management restructure soil fungal communities towards enhanced pathogen pressure and, thus, threaten ecosystem health functions and nutrient provisioning.

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Land-use changes restructure fungal communities and alter their ecosystem functions

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Fungi are a key group linking soil microbiomes across all terrestrial habitats to the aboveground ecosystems by colonizing plant fine roots and the rhizosphere. Numerous symbiotrophic interactions as well as efficient decomposition of dead plant material contribute largely to nutrient and carbon cycling and facilitate the allocation of plant fixated carbon to the soils. Thus, fungal communities contribute largely towards the turn-over of soil carbon stocks. Conversion of hyper diverse lowland rainforest to monoculture plantations typically results in loss of associated taxa and changes in fungal community structures. We hypothesize that fungal community shifts are linked to reduced fine root and soil carbon content in plantation as the consequence of land

transformation. We investigated fungal communities in soil as well as those associated with plant fine roots. Further, we conducted analysis on fine root chemical properties in different land-use systems. We observed massive compositional shifts of soil-localized as well as root associated fungal communities driven by land-use changes. These changes were correlated with altered fine root chemical traits and abundance shifts of trophic fungal groups. Our study highlights strong restructuring of soil biota by land-use change and emphasizes the need to better understand their contribution to essential ecosystem services.

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Data source: B07

Correlation between biodiversity and carbon stock status on agroforestry practices of Berau, East Kalimantan, Indonesia

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Ecological dynamics related to environmental processes (e.g. carbon stock) and biodiversity (e.g. plant species diversity) in forests and agroforests are important factors to understand the fundamental ecosystem functions. Linking tree diversity to carbon stock can initiate further motivation to conserve tropical forests and to design carbon-enriched plantations. However, its relationship is still debatable due to the lack of convincing baseline data. The objective of this research was to develop the correlation between biodiversity and carbon stock status in agroforestry practices in Kampung Birang and Kampung Merabu, Berau, East Kalimantan. This research focused on tree level category. Measurement of the trees in a plot (medium trees of 10-20 cm, and large trees >20 cm) was estimated using the allometric equation. Tree biomass was converted into C which was further multiplied by 0.46. In this research, agroforestry system belongs to complex agroforestry (agroforest). Average biomass (205.25 Mg biomass/ha) and carbon stock (96.25 Mg C/ha) in Kampung Birang were higher than those in Kampung Merabu (biomass = 178.63 Mg biomass/ha, carbon = 82.17 Mg C/ha). Shannon-Wiener index did not significantly affect the total carbon stock. Total individuals per ha, total species per ha, and the basal area had positive correlation with the total carbon stock. Total individuals per ha significantly affected the carbon stock (p-val<0.1, r = 27.3%). Total species per ha very significantly affected the carbon stock (p-val<0.05, r = 28%). Basal area (m^2/ha) very significantly affected the carbon stock (p-val<0.05, r = 96.5%). Biodiversity and total carbon stock showed very weak correlation. The agroforest management, ecological site, socio-economic aspect, and market were identified as the main factors for species selection and maintenance indirectly affecting biodiversity and carbon stock status in the agroforest practices. Recently, agroforestry has not been directly targeted in REDD+ yet agroforestry still can be included in REDD+ strategies such as providing non-timber forest product which to avoid leakage in forest conservation efforts and to increase forest resilience.

Indirect effect of land-use change on species richness and abundance of braconid parasitoid wasps

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Land use change from rainforest to agricultural systems is known to cause biodiversity loss especially for parasitoid insects. As natural enemies, parasitoid insects suffer both from habitat change and host decline. We studied the effects of land-use types on species richness and abundance of braconid parasitoid wasps (Hymenoptera: Braconidae) and their potential lepidopteran host. We hypothesized that species richness and abundance of braconid parasitoids is related to their lepidopteran hosts rather than land-use type. Samples were taken in different land-use types both in Harapan and Bukit Duabelas landscape in Jambi province, Sumatra, Indonesia. Braconids and lepidopterans were collected by canopy fogging using a pyrethroid knockdown insecticide. In total, we found 309 species and 2753 individuals of braconid wasps and 256 species and 2060 individuals of lepidopterans. Braconid and lepidopteran diversity differed significantly between land-use systems ($P<0.05$). Braconid diversity was lowest in oil palm plantations, while lepidopteran diversity was lowest in rubber plantations. Species richness and abundance of braconid parasitoids was positively correlated with species richness and abundance of lepidopterans ($P<0.01$). While these results support our hypothesis, our findings also show that there might be an indirect effect of land-use on the diversity and abundance of braconid wasps. This study highlights the double jeopardy of land-use change on natural enemies.

Different region shapes dissimilar trophic interactions between pest and parasitoid in oil palm plantation

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Understanding trophic interactions between pests and parasitoids is key to the success of biological control in agroecosystem. Different regions of agroecosystem might have different diversity and trophic interactions between pests and parasitoids. The objective of this research was to compare the diversity and trophic interactions of pests and parasitoid in oil palm plantation in two different regions, i.e. Jambi and Central Kalimantan. Ecological research was conducted in oil palm plantation owned by PT. Humusindo in Jambi and PT. Astra Agrolestari in Central Kalimantan. Observation plots were 100 oil palms trees (10 trees x 10 trees) consisted of four-year old trees in both regions. Lepidopteran pests were handcollected and brought to the laboratory for rearing until parasitoids emerge. Our results found that the diversity of lepidopteran pests in Jambi (14 species and 104 individuals) was lower than Central Kalimantan (29 species and 3737 individuals). In contrast, the diversity of its parasitoids was higher in Jambi (17 species and 647 individuals) than Central Kalimantan (14 species and 124 individuals). The most abundant lepidopteran pest in Jambi was the Family Limacodidae, while in Central Kalimantan was the Family Psychidae (bag worm). In addition, eulophid wasp was the most abundant parasitoid in Jambi, while braconid wasp was dominant in Central Kalimantan. Using bipartite analysis, it is found that Shannon diversity and interaction evenness in Central Kalimantan were higher than in Jambi, indicating that the trophic interaction between pest and parasitoid was more complex in Central Kalimantan. In conclusion, different regions have different diversity of pests and their parasitoid, thus shaping dissimilar trophic interactions between pest and parasitoid in oil palm plantation.

Diversity of butterflies across rainforest transformation systems in Bukit Duabelas National Park and Harapan Forest Landscape, Jambi

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Habitat transformation in the rainforest can affect the biodiversity and community structure of butterflies. The habitat changes might alter ecosystem services, as most of the butterflies serve as pollinators. This research was about studying the effect of rainforest transformation on the diversity of butterflies. We studied seven land use types in Jambi Sumatra: forest, forest riparian, jungle rubber, rubber plantation, rubber plantation riparian, oil palm plantation, oil palm plantation riparian. The study was done by direct observation in the field and capturing the butterflies using insect net in two the periods of times, 08.00-12.00 and 3.00-17.00. Eight subplot samples with the size of 50 m x 50 m each were randomly assigned to each land use type, except in the riparian only 4 subplot samples. Total of collected butterflies in Jambi were 209 species consisted of 6,653 individuals. The highest number of butterfly species diversity was in jungle rubber and forest land uses, 127 and 126 species respectively, while the lowest was in riparian rubber plantation and rubber plantation, 61 and 63 species respectively. The species similarity among different types of land uses was in the range of 36% – 76%. It is concluded that habitat transformation caused changing in butterfly diversity. Many butterfly species were unique to certain habitat or land use type.

Community phylogenetics and trait dispersion of arboreal ants after rainforest conversion to monocultures in Sumatra

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The transformation of tropical rainforests to monoculture plantations is known to cause species richness decline and community change in many taxa, including arboreal ants. It is widely accepted that generalistic ant species thrive in anthropogenically altered environments, while specialist ant species do not. The details of which morphological, biological, and ecological traits differ between generalistic ants and specialist ants, however, are sometimes unclear. This is especially true in ant communities where many species are taxonomically undescribed. This is the case for almost all tropical ant communities, which are also the most species rich.
In our study, we use a collection of over 130.000 ant specimen, sampled in dry season 2013 and rainy season 2013/14 in a nested, eightfold replicated plot design in four land use systems in central Sumatra, i.e. rainforest, jungle rubber, rubber, oil palm. First, we sorted all individuals to ~240 morphologically distinct (morpho-)species, of which a few are unresolved species complexes. Using a ~1200bp fragment of 28S rDNA and a ~700bp fragment of CO1 mtDNA, we both verified the morphology-based sorting and estimated intra- and interspecific variance of the markers. For further analyses, we chose morphospecies that had an abundance of >10 individuals in all plots of both seasons, thus reducing the dataset to 155 morphospecies, which included >99% of all individuals. We then use a community phylogenetic approach to elucidate the relative contribution of habitat filtering versus competition to explain the ant community composition of the different land use systems. Knowing that two genes are usually not considered much, we will use >25 morphological traits (translated from dichotomous keys) and at least five biological trais such as nest building and recruitment behavior to show that habitat filtering is the dominant factor defining ant communities in an ecosystem derived from rainforest conversion.

Distribution of energy between basal and high trophic levels of belowground food webs under tropical land-use change

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Progressive deforestation coupled with land-use changes in tropical regions results in habitat loss and extinctions of species, which are not plastic enough to adapt. Extinctions of species occur non-randomly, leading to alterations in food-web structure and thus change ecosystem functioning. To date, very little is known about how belowground food webs respond to land-use change in tropical ecosystems and how this can affect ecosystem multifunctionality. In our study, we examined size spectrum, abundance, diversity and energy flux on different trophic levels of belowground food webs representing ecosystems functions of decomposition, herbivory and predation, along a land-use gradient from natural rainforest to jungle rubber, rubber and oil palm monocultures on Sumatra, Indonesia. Land-use change was associated with reduced abundance and taxonomic diversity of soil invertebrates, but strong increase in total biomass and moderate increase in total energy flux. These changes were due to increased biomass of large-sized decomposers in soil, in particular earthworms, with their share in community metabolism increasing from 11% in rainforest to 59-76% in jungle rubber, and rubber and oil palm plantations. The flux of energy through decomposers increased, but the flux of energy into litter and soil predators decreased by 84-94%, and the flux of energy into herbivores was reduced in litter but not in soil (except in rubber plantations). Our results suggest that the increase in large-sized primary consumers is sequestering energy from high trophic levels thereby decreasing abundance and diversity of predators and reducing top-down control. This was further supported by the detailed analysis of top predators (Araneae): cryptic soil-related spider species were tremendously affected by the land-use, while the changes in mobile ground communities were moderate. We found that soil systems with reduced biodiversity are able to sustain high flux of energy at the cost of reduced function of predation.

Composition of protist trophic groups changes with conversion of rainforest into rubber and oil palm plantations in tropical lowlands of Sumatra

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Large areas of lowland rainforests of Sumatra, Indonesia, are converted into agro-ecosystems, such as jungle rubber, intensive rubber and oil palm plantations. Land-use changes are connected with tremendous changes in biotic and abiotic factors that alter biodiversity and functioning of converted systems. Effects of land-use change on diversity and community composition of bacteria, fungi and different invertebrate groups has been investigated, but information on soil protists is lacking. To fill this gap of knowledge, we investigated the effects of land-use change on soil protist communities using state-of-the-art molecular methods. Protists are an abundant and diverse group of soil microbial eukaryotes, which belong to very different phylogenetic and trophic groups and are important players and indicators of ecosystem functioning.
Soil eukaryotic community composition and diversity were assessed by Illumina sequencing of environmental DNA targeting the hypervariable V4 region of 18S rRNA gene using universal eukaryotic primers. The overall dataset comprised 5,204 operational taxonomic units at species level (97% genetic identity). After subsampling of 2,300 sequences per sample, OTUs were categorized according to literature into five trophic groups: symbionts, photoautotrophs, phagotrophs, animal and plant parasites. Total protist richness was similar in rainforest, jungle rubber and oil palm plantation but significantly lower in intensive rubber plantations. In contrast, the relative abundance of protists did

not differ significantly between land-use systems. The most abundant trophic group was phagotrophic (52%), followed by animal parasites (29%), photoautotrophs (12%), plant parasites (1%) and symbionts (<1%). The relative abundance of photoautotrophs increased significantly with land-use intensity. This was similar but less pronounced for the relative abundance of symbionts. Animal and plant parasites decreased with increasing land-use intensity. The relative abundance of phagotrophs was lowest in rainforests and significantly higher in arable systems. Also community compositions and the factors affecting the structure of individual trophic groups differed between land-use systems. Overall, the results show that richness, relative abundance, and community composition of individual trophic groups of protists in tropical lowland rainforest significantly differ from that in converted ecosystems. This is likely associated with changes in ecosystem functioning.

Trophic plasticity in Oribatida (Acari) in transformation systems in Sumatra (Indonesia) investigated by stable isotopes (^{15}N, ^{13}C)

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The trophic structure of animal communities can be evaluated by analyzing the natural variation in $^{15}N/^{14}N$ and $^{13}C/^{12}C$ ratios. Oribatid mites are one of the most abundant soil animals, involved in decomposition processes and nutrient turnover. For our study we analyzed natural variations in $^{15}N/^{14}N$ and $^{13}C/^{12}C$ ratios of six soil living oribatid mite species (*Notophthiracarus* sp., *Protoribates paracapucinus*, *Scheloribates* cf *praeincisus* sp. 1, *Scheloribates* cf *praeincisus* sp. 2, *Trachyoribates shibai* and *Trachyoribates* nov. sp. 7) which occur in three lowland transformation system (jungle agroforest, rubber and oil palm monoculture plantation) and one secondary rainforest in two study regions (Harapan, Bukit Duabelas) located in the Jambi province of southwest Sumatra Indonesia. For the first time, we measured isotope signatures of single oribatid mite individuals. We aimed at understanding how species react to environmental changes in form of land use transformation and if there is a change in their feeding habits and if these animals differ trophically since they are all generalist species and since they manage to survive in all land use systems. The second aim of our study was to investigate if the trophic ecology of each of the six species (again by ^{15}N; ^{13}C) differs between the four land use systems.
Three of the six studied oribatid mite species differed significantly according to their ^{13}C and/or ^{15}N values (*Scheloribates* sp. 1, *Rostrozetes shibai* and *Rostrozetes* sp. 1) indicating that those species are trophically plastic allowing them to cope with future environmental changes.

Scientific Posters - Abstracts

The flight activities and diversity of pollen in honey of forest honey bee *Apis dorsata* in response to landuse changes

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Animals require habitat that meet their needs for feeding, mating, and nesting. With progressive changes in their habitat, certain animals have the ability to adapt while others are susceptible. The Asian giant bee *Apis dorsata* migrates annually to search nesting and foraging sites. Riau was home for thousands of colonies of these bees. However, land use changes have been very rapid causing the decrease in resources needed for the colonies such nesting trees, pollen and nectar. How do the bees respond to the land use change? Here, we explored the bees flight activities and pollen diversity in *A. dorsata* honey at two locations i.e. Kampar 1 and Kampar 2, Riau. The bee nesting tree at Kampar 1 is surrounded by thousand hectars of *Eucalyptus* and oil palm (*Elaeis guineensis*) plantations and a small remnant forest, whereas patchy oil palm plantations, and deforestation areas surrounds Kampar 2 bee nest. The Kampar 1 bees showed quite normal flight pattern, with moderate morning flight activities, low foraging behaviour during noon and slightly increased during afternoon. Interestingly, the honey of Kampar 1 colony contained 97% of oil palm pollen, suggesting an adaptation of the bees to oil palm for pollen foraging. However, the Kampar 2 bees showed high flight activities during noon (12 am -1 pm) but almost none of the bees flew back into the nest with pollen. Surprisingly, at the fourth day observations, all the bees left, leaving an empty nest; no bee pollen, larvae, and honey were found. We conclude that oil palm can be a good resource for pollen as shown in Kampar 1, however we need to preserve nectar plant species and nesting trees. The high noon flights without pollen into the nest of Kampar 2 bees were likely the behaviour of the scout bees searching for a new nesting site. The bees were forced to move in search for a new nesting and foraging habitat as land use have made the Kampar 2 location inhabitable.

Isolation and selection of actinomycetes isolates from Bukit Duabelas, Jambi to degrade sago (*Metroxylon sago*) frond

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The population of sago plant in Indonesia is very high. Stem of sago (*Metroxylan sago*) is widely used in Indonesia due to its high content of starch. Sago frond is one part of sago plants that are not utilized and become waste. Sago frond consists among others are hemicellulose 10.39% and cellulose 36,00%. The product of cellulosic degradation may be sello-oligosaccharide or glucose as a monomer which can be used for the production of bioethanol. Cellulase activity to degrade cellulose is mostly owned by microorganism especially actinomycetes. In this study were isolated and selected actinomycetes that have cellulase activity to degrade sago frond. Isolation of actinomycetes were using humic acid vitamin agar (HV agar) and and ISP4 medium. Qualitative analysis of cellulase activity were done by forming of clear zone in CMC medium. Three kind of sago frond was used: (1) milled (2) treated with alfa-amylase (3) treated with delignification. From 99 isolates, 61 isolates has cellulase activity, which 8 isolated were selected for further characterization. Four isolate were selected for the degradation of 3 kind of sago frond. Thin layer Chromatography were used to see the degradation product from sago frond using P4(3) isolate as the best isolate for degrading sago frond.

Technique for monitoring deforestation and forest degradation using vegetation indices: A practical perspective

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The increasing quality of satellite sensors, especially the increase of spatial, spectral and temporal resolutions, has increased the probability on the use of satellite imagery being used for forest monitoring. This paper discusses the development of practical techniques of monitoring deforestation and forest degradation using remote sensing, particularly in the mangrove and swamp forest. The main objective of the study is to develop a practical technique for monitoring deforestation and forest degradation, particularly within the mangrove and swamp forest ecosystem. The multi-temporal of SPOT 5 and SPOT 7 imageries acquired in 2007, 2012 and 2014 were examined to develop the general forest and land cover classes. The raw images were transformed into three vegetation indices, i.e., Normalized Difference Vegetation Index (*NDVI*), Green-Normalized Difference Vegetation index (*GNDVI*) *dan Normalized* Green-Red Vegetation index (*NRGI*). The study found that deforestation was well detected and identified using the NDVI and GNDVI, however the forest degradation could be well detected using NRGI, better than NDVI and GNDVI. The study concludes that the strategy for monitoring deforestation, biomass-based forest degradation as well as forest growth could be done by combining the use of NDVI, GNDVI and NRGI respectively.

Diversity of Parasitic Hymenoptera in Dry and Wet Sites across Indonesian Oil Palm and Rubber Plantation

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Indonesia is the great producer of oil palm and exporter of rubber worldwide. Habitat transformation from natural forest to monoculture agroecosystem affected the diversity of beneficial insect. Parasitic hymenoptera is beneficial insect that play important role as natural enemies to control pest population and prevent pest outbreak in agroecosystem. We studied the species richness and abundance of parasitic hymenoptera in oil palm and rubber plantation, then compared their community composition in upland and riparian site. The research was conducted in in Jambi Province, Sumatra, Indonesia which consists of two different land-use, oil palm and rubber plantation. Sampling plot was sized 20 m x 20 m with four replications of each land-use type. *Asystasia gangetica* was planted in every sampling plots to attract the parasitic hymenoptera. Parasitic Hymenoptera were collected by direct sampling using insect net and traps using yellow pan and malaise traps. We found 188 parasitic Hymenoptera species in total. Parasitic Hymenoptera species abundance was significantly different among land-use type but not in species richness. Both species richness and abundance of parasitic Hymenoptera were not significantly different between in dry and wet site. Parasitic Hymenoptera species richness and abundance were higher on rubber than oil palm plantation. Riparian wet site had higher number of parasitic Hymenoptera richness and abundance than upland dry site. Community composition in rubber was different with oil palm plantation but similar in each dry and wet site. Scelionidae was the dominant family that found on all land-use types. Megaspilidae and Mymarommatidae were only found in wet rubber plantation site, however Eucharitidae was only found in dry oil palm plantation site. We conclude that parasitic Hymenoptera abundance and community composition were different in rubber and oil palm plantation but not in species richness.

Bird and arthropod diversity in an oil palm plantation in Central Kalimantan

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Expansion of oil palm plantation has been recognized as one of the threats to biodiversity. The implementation of high conservation value area in oil palm plantation provides forest patches in the plantation, which are supposed to be potential to increase or maintain the biodiversity in the plantation. The study was aimed to examine whether bird and arthropod diversity differed between locations closer and farther to forest patches, and between two different age classes of plantation (under and above 10 years old). Data were collected from an oil palm plantation in Desa Runtu, Sub District Arut Selatan, District of Kotawaringin Barat, Central Kalimantan in June 2014 and February 2015. Birds were observed along 1 km transects, while arthropods were sampled using sweep nets, pitfall trap and malaise trap. A correlation analysis was used to examine the relationship between bird and arthropod diversity. A total of 78 bird species of 37 families were recorded, most of them were insectivores. Bird species richness varied according to time of sampling, age class, and distance from forest edge, with highest diversity in June and in location closer to forest edge. Younger plantation also held higher bird diversity. Similar result was also recorded for arthropods: higher abundance and richness were found in locations closer to forest edge. Pit fall trap collected the highest number and diversity (1375 individuals comprised of 78 morphospecies). However, correlation analysis did not show significant relationships between bird and arthropods diversity. This study suggests the importance of forest patches in maintaining the biodiversity in oil palm plantation.

The effect of tree enrichment planting in an oil palm plantation on the abundance and diversity of arbuscular mycorrhizal fungi (AMF)

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Arbuscular mycorrhizal fungi (AMF) play an important roles in a sustainable soil-plant system. The presence and functionality of arbuscular mycorrhizal symbiosis in agroecosystems is affected by several factors such as vegetation structure, agricultural practices, soil properties and application of fertilizer. We studied the presences of arbuscular mycorrhizal fungi in Oil Palm plantation enriched by several forest tress species. 168 soil samples were collected from core plots of enrichment planting area in Jambi Province. Spores from soil samples were isolated following the method of Gerdemann and Nicolson. AMF identification were carried out according to INVAM method. Data were analysed using t-student and correlation tests. The results showed that Oil Palm enriched by forest trees species had positive impact to AMF population (number and spore density), especially when Oil Palm enriched by tree species from Leguminous family (*Parkia speciosa* and *Archidendron pauchiflorum*). However, enrichment planting on Oil Palm plantation didn't show a significant difference to the AMF diversity. The number of spores from each plots were found in range 89 to 486 spores per 20 grams. The AMF genera found in enrichment area were Glomus, Acaulospora, Gigaspora, Entrophospora, and Scutellospora.

Seedling distribution and genetic variation in three species of Shorea (*Dipterocarpaceae*) assessed by microsatellite markers

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The genus *Shorea* (Dipterocarpaceae) includes timber species that are ecologically and commercially important in the Indonesian region. Genetic variation is a fundamental requirement for the maintenance and long-term stability of forest ecosystems, where these species are abundant and is related to the flowering system and the method of seed dispersal. Therefore, in this study, seedling distribution, genetic variation, and genetic relationship among three *Shorea* species (*S. accuminata*, *S. guiso*, and *S. leprosula*) growing in PT Restorasi Ekosistem Indonesia were assessed using 10 microsatellite markers. It was found that all three species had gyration-type seed dispersal. However, *S. leprosula* had the highest density of seedlings and a slightly higher genetic variation than the other species. Genetic relationship analysis revealed three distinct groups, wherein *S. leprosula* and *S. accuminata* were closely related and formed a distinct group from *S. guiso*. This information will be invaluable for developing management strategies for these species.

Isolation and amplification 16S rRNA gene for metagenomic analysis from oil palm rhizosphere in different locations (based on soil textures)

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Soil environment is the most complex habitat on earth. This complexity manages soil biodiversity, which is estimated to contain one third of all living organisms and regulates the activity of the organisms responsible for ecosystem functioning and evolution. It is known that most of them are soil bacteria. Soil microbes, especially bacteria, play key roles in ecosystems and influence a large number of important ecosystem processes such as nutrient acquisition cycling, driving plant productivity and soil formation, biocontrol of some diseases, and fertilizer. Rhizosphere (root zone) is an important habitat for bacteria to play their functions as plant growth promoter and plant protector from pathogen infection. Large area of oil palm tree plantation in Jambi Province will be good habitat for soil bacteria. Oil palm plantations in Jambi have different soil textures. There is an assumption that differrent soil texture lead to different diversity of soil bacteria in palm tree root zone. This study aimed to investigate the diversity of soil bacteria in oil palm rhizosphere from different soil textures. This research was started from collecting soil samples, followed by DNA extraction and amplification using 16S rRNA gene. The result indicated that there were eight classes of soil textures, i.e sandy loam, sandy clay, loamy sandy, salty clay, salty clay loam, sandy clay loam, sandy and clay. Genomic DNA purity were 1.2 –1.7. However we did not obtain 16S rRNA genes yet, and therefore more optimization procedure to continue the study should be required.

Unraveling the impact of rainforest transformation on microbial functionality by metagenome analysis

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Palm oil production in Indonesia increased constantly over the last decades, which led to massive deforestation, especially on Sumatra Island. The ongoing conversion of rainforest to agricultural systems results in high biodiversity loss, while the entirety of effects on the biosphere is still not completely understood. Prokaryotic communities and their functionality, however, are crucial factors for plant growth due to their involvement in almost all nutrient cycling pathways. Recent studies on rainforest transformation regarding Prokaryotes showed that bacterial communities are indeed affected. The groups which were most abundant in secondary rainforest, jungle rubber, rubber and oil palm samples (*Frankiales* of the *Actinobacteria*, Subgroup 2 of the *Acidobacteria* and *Rhizobiales* and *Rhodospirillales* of the *Alphaproteobacteria*) were also affected in the highest degree by rainforest transformation.
These studies were based on 16S rRNA sequence analysis and while giving a reliable overview of the bacterial community composition, the effect on bacterial community functionality cannot be fully investigated. Shotgun metagenomic sequencing allows the analysis of all microorganisms and their functions in a sample and is therefore a powerful tool to analyse the effect of agricultural land use on bacterial functionality. In order to investigate these effects in detail, we sequenced 32 metagenomes from rainforest, jungle rubber, rubber and oil palm soils which enables highly detailed analyses on how bacterial functions are affected by rainforest transformation.

Root hydraulic conductivity of rubber and oil palm in riparian and non-riparian sites in Jambi Province

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The water transport rate through the xylem is determined by the hydraulic efficiency of the conductive cells. Therefore, xylem hydraulic properties play essential role in supporting growth and photosynthesis and influence sensitivity to environmental conditions such as drought. Xylem conductivity is determined by the structure and size of the vessels and by their efficiency. However, information on diameter variation in root xylem anatomical and hydraulic properties is yet very limited, especially in tropical agroforestry systems seasonally differing in water availability.
We have taken root samples at oil palm and rubber plantation plots , riparian and non-riparian sites. The root samples taken was determined the diameter (1-2 mm, 2-5 mm, and 5-10 mm in diameter). All root samples were cut using a sliding microtome (G.S.L.1, WSL Birmensdorf Switzerland) and stained with mixture of safranin-alcian blue 1%. Root anatomy was analyse images with a stereo-microscope equipped with a digital camera (SteREOV20, Carl Zeiss MicroImaging GmbH, Göttingen, Germany) using Adobe Photoshop CS6 (version 13.0 x 64, Adobe Systems Incorporated, United States) and the particle analysis function from ImageJ (version 1.49 v). Furthermore, we calculate the total root hydraulic conductance for all root samples . The results showed that the hydraulic conductivity of rubber and oil palm in riparian and non- riparian sites in Jambi Province were different each other.

Effect of rainforest conversion on food resources of soil animals (case study in Sumatra, Indonesia)

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Rainforest conversion and expansion of plantation systems is a common land-use change issue, particularly in Sumatra, Indonesia. However, how land-use change affects soil communities is poorly understood due to the limited knowledge on trophic interactions in tropical soil food webs. Our research is aimed to investigate how the food resources of soil animals respond to conversion of rainforest into rubber and oil palm plantations. Neutral lipid fatty acids (NLFAs) were used to track energy channels based on plant, bacterial and fungal resources in different groups of soil. Oleic acid (18:1w9) as relative biomarker for plant and linoleic acid (18:2w6,9) as relative biomarker for fungi were the most common fatty acids in animals across the ecosystems and taxa analysed. Araneae, Chilopoda, Diplopoda, and Lumbricina contained higher amount of relative fungal and plant biomarkers (18:2w6,9 and 18:1w9, respectively) than other groups, while Collembola and Oribatida contained the highest amount of algal biomarker (16:3w3). The concentration of Gram-positive bacteria biomarkers (NLFAs i15:0, i16:0, i17:0) and Gram-negative bacteria biomarker (NLFA cy17:0) were most abundant in rainforest and significantly less abundant in plantation systems. In contrast, fungal biomarker (18:2w6,9) and algal biomarker (16:3w3) did not differ significantly between land-use systems. Abundance of plant biomarker 18:1w9 was significantly higher in oil palm plantation in comparison to rubber plantation and rainforest. Our findings show that land-use change reduce bacterial energy channel of soil food web, increase plant energy channel and has only little effect on fungal energy channel. We also demonstrate, that despite the shift in resource use of soil animals with land use, the differences between macrofauna (linked more to plant and fungal resources) and mesofauna (linked more to algae) were retained across the studied ecosystems.

Diversity of Central Sulawesi local mangosteen (*Garcinia mangostana* L.) based on morphological anatomy and genetics analysis

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Mangosteen *(Garcinia mangostana* L.) is Indonesia›s main export commodities of high value. Central Sulawesi has promising prospect because based on agro-ecological aspect is very suitable so geographical location is very strategic because it has potential accessibility because it is located near the centre of economic growth, but on the other side there are some weaknesses that need to be improved such as cultivation, production, harvest and post harvest. Maximal plant growth, low fruit quality due to yellow sap and dotted become an obstacle to the achievement of Indonesian mangosteen fruit standard. Providing quality planting materials sourced from quality mother trees is an important step in improving mangosteen cultivation in Central Sulawesi. Determination of mangosteen parent tree candidate was taken through identification of mother tree in the form of a series of tests including morphological test, anatomy and DNA isolation on a number of mangosteen accessions from five districts in Central Sulawesi. The research was conducted at the mangosteen plantation center in Donggala, Sigi, Poso, North Morowali and Banggai Laut. Testing of morphology, anatomy and DNA isolation was carried out in Agrotechnology Laboratory of Tadulako University of Palu. The study was conducted from April 2015 to May 2016. Materials and tools used were 320 accession mangosteen, meter, microscopes, cameras, knives, paper labels, plastic samples, *cool box,* ruler, vernier caliper, chemicals and modified *Descriptors for Mangoosten* DNA isolation (IPGRI, 2003). Descriptive methods study, data were analyzed using *cluster analysis* using SYSTAT program is displayed in the form of dendogram. The results showed at a distance of 0.707 There are 20 different groups of accessions of morphology and anatomy and DNA analysis at 0.503 range There are four different accession groups represented by TB08, RM01, LB02 and BI11 accessions.

Seasonal diversity and identification keys of canopy ants in Harapan Rainforest

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Forest ecosystem restoration can help reverse biodiversity loss and still has rich in biodiversity, also as a major importance for biodiversity on a global scale. Ants are highly abundant, important element in the canopies of tropical forest, often used as indicators of ecological change, and have been extensively used to assess a range of restored habitat types. The study site was located in Harapan Rainforest area, Jambi Province, Sumatra. We used canopy fogging method to collect ants from tree crowns between dry season and rainy season. Ants canopy were collected from four plots in each 50m * 50m, with 3 replicate, resulting in 24 core plots in total. The general sampling design follows a nested, standardized plot design by the EFForTS project. A total of 17471 individuals were collected belong to 123 morphospecies from 44 genera. The most species richness genera were Crematogaster (16 species) and Polyrhachis (12 species). General patterns of ant community show important seasonal variations which increase of ant species richness and decrease of their abundance during rainy season, with 82 ant morphospecies from 10581 individuals occurred in the dry season and 99 ant morphospecies from 6899 individuals occurred in the rainy season. The most dominant ant species in the community were *Crematogaster* rogenhoferii-complex and *Dolichoderus thoracicus*-complex. *Monomorium* floricola is an invasive ant which also common in both seasons. The most common native ant species in rainy season e.g. *Crematogaster fraxatrix, C. modiglianii* and *C. reticulata* did not occur in the dry season. Identification key was done by using software LUCID v3.5 . Morphological characters used are petiole, number of antenna, sting and several other characters. The taxonomic information available in this study is expected to assist in the identification process of canopy ants in Jambi Province, Sumatra.

Distribution pattern of soil surface Collembola and its association with Acari in different ecosystems

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Forest is one of the ecosystems with different habitat characteristic of its inhabiting species. Deforestation and land-use transformation (e.g. from forest to oil palm plantations) will impact the ecosystem and its species. Here, we investigated the abundance of soil surface Collembola and Acari in forest and oil palm systems, to explain the influence of environmental factors on soil animal communities and to identify the type of association between the soil surface Collembola and Acari. The field activities consisted of litter trap making, litter harvesting, soil surface Collembola and Acari extraction using Berlese-Tullgren, and measurement of environmental factors. The highest abundance of soil surface Collembola occurred in the oil palm plantation. The total number of individuals of soil surface Collembolain all ecosystems was 1 618. It included 13 genera, 6 families (Cyphoderidae, Entomobryidae, Isotomidae, Oncopoduridae, Paronellidae, Dicyrtomidae) and 2 orders (Entomobyromorpha and Symphypleona). The densities of soil Collembola per square meter about 28-72 individual. The existence of soil surface Collembola depended on biotic (vegetation, litter, canopy cover) and abiotic factors (temperature, relative humidity, soil acidity).

Diversity of butterflies (*Lepidoptera*) caught using by fruit traps in Bukit Duabelas and Harapan Forest Landscape, Jambi.

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The presence of butterflies within an ecosystem is influenced by the availability of plants as food and host plants. Butterflies have specific host plants to lay eggs and food for the larvae. One method for butterfly sampling is to use fruit traps. The purpose of this research was to know the diversity of butterflies by using fruit trap in Bukit Duabelas landscape and Harapan Forest Jambi. Butterfly sampling was conducted on seven land uses: forest, forest riparian, jungle rubber, rubber plantation, riparian rubber plantation, oil palm plantation and riparian oil palm plantation. Traps in pairs of 4 pieces using bananas (2 traps) and fruit pineapple (2 trap). Traps mounted in the morning 08.00 - 17.00. At 17:00 the trap was opened and counted the number of species and the number of individual butterflies caught in the trap and then the butterfly was released again. The total number of butterflies caught using traps were 52 species and 417 individuals from Nymphalidae. The number of butterflies caught with banana bait were 37 species and 190 individuals, while the butterflies caught with pineapple bait were 44 species and 227 individuals. Number of species of butterflies caught highest in the forest using pineapple traps of 19 species and the lowest in riparian rubber plantation 1 species. The highest number of individuals caught in the oil palm plantation were 58 individuals and the fewest in riparian rubber plantation 1 individuals.

Rot disease caused by Ganoderma in land use change of Sumatra

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Ganoderma spp.*,* has been reported as the most devastating plant pathogen, causing root and stem rots and killing most of the economically important trees and perennial crops including forest, oil palm and rubber trees. This study aims were to investigate the distribution and disease incidence of stem-rot disease in Jambi, collect fungal samples from infected trees, analyse the identity of fungal isolates, and determine the diversity of *Ganoderma*s pp. This study conducted at the transformation systems of Bukit Duabelas and Harapan in Jambi. Observations of disease incidence was based on symptom diagnostics. We collected the basidiocarp of Ganoderma and identify the morphological and molecular phylogeny. We found that all of the land uses at the transformation systems showed the incidence of the rot disease caused by Ganoderma. The forest trees showed the higher incidence compared to rubber and oil palm plantations. A total of 828 basidiocarps of Ganoderma were obtained from infected forest, oil palm, and rubber trees Of that amount, we found 47 different morphotyping of basidiocarps. All the basidiocarps collected had different morphological characteristics Basidiomes. They were sessile and bracket shaped with a vary of colour (light brown until black) and laccate pileus. The margins of the basidiomes also show different shape, colour, and thickness. To determine the molecular characters, each different morphotyping of Ganoderma is being identify by DNA sequencing.

Acknowledgments

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Data source: B07

SESSION 4

Interdisciplinary socioecological approaches

Chairs: **Meike Wollni**, University of Göttingen (mwollni1@gwdg.de) and **Zulkifli Alamsyah,** University of Jambi (zulkifli_alamsyah@yahoo.com or Zalamsyah@unja.ac.id)

Scope

Driven by profitability considerations, tropical lowland regions are rapidly converting into intensively used agricultural plantation systems. In many cases, this involves poor smallholder farmers, who benefit from higher incomes, reduced poverty and increased food security. Unfortunately, the intensification of land use systems in tropical lowland regions is associated with adverse effects on biodiversity and ecosystem functioning. This is particularly concerning as agricultural expansion is taking place in unique biodiversity hotspots. Scientific evidence on how to design and induce sustainable land-use systems that reconcile socio-economic and ecological functions is urgently needed. In this session, we highlight interdisciplinary research that analyzes socio-ecological synergies and trade-offs in tropical lowland land-use systems. We invite cutting-edge research that applies interdisciplinary approaches using a wide range of methods, which may include qualitative and quantitative field studies, integrative experiments, as well as modelling approaches.

Scientific talks - Abstracts

Widespread trade-offs between multifunctionality and profit in smallholder agricultural landscapes

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While the transition from tropical forest to intensively cultivated land can enhance the livelihoods of farming households, the resulting economic-ecological trade-offs remain poorly understood. Here, we present a multidisciplinary study of an Indonesian smallholder landscape under ongoing transition dynamics. We present evidence that land-use transition from forest and agroforestry to intensive monocultures creates widespread biodiversity-profit trade-offs. These trade-offs are consistently observed for aboveground and belowground taxa and using multi-biodiversity indices. Despite variation across different types of ecosystem functions, profit increases also come at the expense of ecosystem multifunctionality, suggesting profound ecosystem deterioration. Using a genetic algorithm, we identify landscape compositions that

can partially mitigate some of the trade-offs under optimal land-use allocation. However, if higher profits solely follow from transitions to intensive monocultures, further losses in biodiversity and ecosystem functioning may be unavoidable, unless the economic incentive structures are changed through well-designed policies. Our findings can inform stakeholders for long-term sustainability of current land-use dynamics in tropical smallholder landscapes.

Land-use change in oil palm dominated tropical landscapes - An agent-based model to explore ecological and socio-economic trade-offs

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Land-use changes have dramatically transformed many tropical landscapes from forest-dominated to agricultural landscapes. Agricultural land-uses, such as rubber and oil palm plantations, increase economic benefit at the cost of reduced ecological functions. Our research aims to investigate the spatio-temporal interactions, feedbacks and trade-offs between economic and ecological functions of the landscape mosaic. Based on field data from the EFForTS project, we developed the agent-based model EFForTS-ABM. EFForTS-ABM serves as an integrated, exploratory tool to analyse how tropical land-use change affects ecosystem functions. The economic module simulates smallholder land-use management decisions based on a profit maximization assumption. Heterogeneous farming efficiencies and learning dynamics incorporate the heterogeneity of households in knowledge and experience. The ecological module currently includes a simple account of carbon sequestration in above- and below-ground vegetation. For different output price and farming efficiency scenarios, we demonstrate model capabilities with results on household consumption and carbon sequestration.

Land-use change towards the more profitable crop was mainly driven by the output prices for rubber and palm oil. However, heterogeneity of farming efficiency created inertia of land-use change and asynchronous behaviour of smallholder households. In contrast, optimal farming scenarios with all households fixed to 100 % efficiency showed less inertia. In general, model scenarios with higher inertia resulted in more stable landscape mosaics and carbon stock dynamics. The overall model results proved that the interactions between economic and ecological functions were not trivially straightforward, underlining the need of exploratory tools like EFForTS-ABM, which help to gain an understanding of such complex dynamics. Future research will focus more deeply on the effects of the spatial configuration of the landscape mosaic.

Which degree of diversification to achieve truly multifunctional landscapes? Using land-use optimization as a basis for participatory research

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What should landscapes look like to provide multiple ecological and economic functions? This is one of the key questions of land-use science. While the debate on land-sharing vs. land-sparing approaches is on-going, the conditions under which each strategy may be applicable (considering all gradients between these extremes) remains unclear.
Simulation and optimization methods have been suggested to achieve a better understanding of synergies and trade-offs between different ecosystem functions. This presentation demonstrates a land-use optimization approach which allows for simultaneous consideration of multiple ecosystem functions of different land-use options and their uncertainties. The approach aims at answering the question of "what is the ideal degree of landscape diversification (monocultures, combinations of monocultures in a mosaic or diversified land uses) to achieve high and stable levels of various ecological and economic functions". For this purpose a variant of goal-programming following robust optimization strategies is applied using normalized indicator values for each land-use option. Uncertainty of each indicator and each land-use option is represented by the error of sampling or simulation. The method is presented using an example for restoration options in Ecuador, an agricultural landscape including agroforestry systems in Panama and a first approach for Indonesia. The results offer insights into ideal landscape compositions for different conditions which avoid underperformance of single ecosystem functions (e.g. compensatory effects).
It is demonstrated, how this approach could serve as an objective basis for participatory research methods, during which political decision-makers, stakeholder and shareholder agree upon "desirable future landscapes". More complex models (e.g. Agent-based models) could then help to understand how these landscape compositions could be achieved.

The effect of information and sapling provision on smallholder tree planting in oil palm plantations

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Palm oil expansion in Indonesia is associated with both a reduction in biodiversity and ecosystem services, and livelihood improvements for smallholder farmers. While this dichotomy highlights the importance of sustainable management options, empirical evidence on which policies are effective in stimulating biodiversity-friendly plantation management is relatively scarce. This paper addresses this gap by presenting results from a Randomized Controlled Trial implemented in Jambi province, Sumatra, in 2016. We focus on tree nuclei planting in oil palm plantations as one sustainable management option to support biodiversity. To test whether information and input provision affect smallholders' tree enrichment activities, two treatments were designed: the first provided information about tree planting in oil palm plantations, while the second combined information and sapling delivery. We model adoption in a double-hurdle framework where farmers first decide whether to adopt or not and then how many trees they plant per hectare. Our results suggest that both interventions are effective in stimulating tree planting in oil palm. While input provision in combination with information leads to a higher probability of adoption, farmers plant on average relatively few trees per hectare. In contrast, in the informational treatment, few farmers enrich but they plant more trees per hectare than farmers who received saplings. However, we observe that the survival rate of trees planted is lower for farmers who received saplings. While we cannot fully explain the difference in survival rate, experience with tree planting and species choice might be one of the reasons.

Land use transformation and changing flooding regimes

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Global land use cover change (LUCC) towards cash crop cultivation is often considered a main cause of ecosystem service loss. Multiple studies have shown that LUCC can decrease flood regulation control. But such LUCC is also accompanied by large-scale socio-economic and political transformation processes which may interact with biophysical drivers towards a loss of flood regulation control. In Jambi province in Sumatra, Indonesia, villagers perceive an increase of flood events since vast forest areas have been converted into rubber and oil palm plantations. Our integrated analysis aims to disentangle the complex causalities underlying increasing flood occurrence in Jambi province by testing different hypotheses based on existing studies and applying a variety of methods from social sciences, soil science, remote sensing, climatology and land use modelling.

First, we use measurements of precipitation, river discharge, groundwater table, and surface run-off to investigate changes in flood regimes. Preliminary results show that alterations in rainfall patterns cannot explain the observed increase in flood events. But management practices in monocultures change bio-geophysical soil properties, leading to soil compaction and lower water infiltration rates. Further, we find that recent population growth and rising financial investments in land increase the demand for land for plantation development. Consequently, an increasing encroachment of formerly considered marginal soils such as wetlands has been observed which likely reduces water storage capacities of these ecosystems. Finally, qualitative interview data and land use mapping reveal that non-compliance with environmental legislation further decreases ecosystem flood retention capacity. Our findings indicate that thorough land use planning, strict monitoring of legal compliance and application of best management practices is needed to maintain flood regulation capacities of Jambi's tropical lowland ecosystems.

Scientific posters - Abstracts

The effect of soil conservation practices on soil carbon and yields in oil palm plantations

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The transformation of rainforest into oil palm plantations is associated with significant reductions in soil organic carbon (SOC) contents and a decrease in other soil fertility indicators. While the related climatic consequences have received considerable attention in the literature, the agronomic effects of SOC on oil palm yields are poorly studied as most studies focus on the effect of SOC on annual crops. However, a reduction in SOC levels is also linked to a decrease in many important soil ecosystem services as water and nutrient regulation which are both relevant factors for sustaining yields. In order to sustain and enhance SOC contents, soil conservation practices such as mulching or applying cover crops have been proposed. Most of the scarce literature on the effect of these practices on soil quality indicators stem from big industrial plantations. Despite their growing importance, smallholdings have yet been neglected. The present study tries to close these detected gaps by presenting results from Jambi province, Indonesia. We focus on the application of empty fruit bunch mulching and cover crops as soil conservation practices and analyse their effect on SOC contents and oil palm yields, and the different pathways through which soil carbon affects yields. Our study was conducted in 2017. With help of a stratified random sampling procedure, we selected 146 oil palm growing independent smallholders. Per household, one plantation was selected. Our dataset covers three different soil types, two different management practices and one control group. Soil samples were collected for SOC content and bulk density measurements. In addition, on 36 plantations a more detailed analysis (pH value, C from density fractionation) was conducted that allows for a better understanding of soil fertility effects. Our first results hint to a positive effect of empty fruit bunch application on soil carbon. While the direct effect of soil carbon on per hectare oil palm yields is insignificant, application of empty fruit bunches is associated with statistically higher oil palm yields in comparison to ground cover application and the control group.

Rubber-based agroforestry in peat swamp land

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Agroforestry is an optimal method of land use that combines woody and agricultural crops based on the principle of sustainability in forest areas or comunity land to achieve the welfare of the people. Economically, agroforestry in peatlands provides food and diversify other products of timber as a long-term investment for farmers. In addition to local economic interests, agroforestry is also able to improve the quality of peatlands in the environmental sustainability. Agroforestry as a cropping pattern on fragile land due to trees growing under unfavourable soil conditions and climate. One of the role of agroforestry is maintaining peat soil fertility. The management and utilization of rubber plants can have a real positive impact for society and economy in Meranti Regency, Riau Province. The development of agroforestry systems in peatlands is largely determined by combinations and cropping patterns so that their sustainability is ecologically, socially and economically sound. Agroforestry technical information is indispensable for the development of sustainable agroforestry practices. This study aims to assess the quality of peatlands from rubber-based agroforestry systems.

Exploring the current socioeconomic status and forest utilization of local people in Vietnam's Bu Gia Map National Park

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Social-Ecological Interdisciplinary has been used by forest managers to deal with the degradation of natural forests caused by human activities. This study delves into the relationship between socioeconomic status of people nearby Vietnam's Bu Gia Map National Park and their utilization of products extracted from woodlands. Structural equation modelling has been used to examine the effects of socioeconomic status of local people including ethnicity, education, demographics, and economic status on the utilization of timber and non-timber forest products in the buffer zones of Vietnam's Bu Gia Map National Park. Interviews with 121 local people residing in the buffer zones of Vietnam's Bu Gia Map National Park illustrate the relationship between socioeconomic profiles and the consumption of forest products. On the one hand, poor socioeconomic status encourages local people to extract non-timber forest products for their survival, and the improvement of their socioeconomic status can contribute to the reduction of the extraction of these products from natural forests within the park. On the other hand, there is an increase of consumption of timber harvested from natural forests when their socioeconomic status is enhanced. This result shows a dilemma between economic development and biodiversity conservation in natural forests. The structural equation model provides local managers with a vivid picture explaining the roots of forest extraction within the park. This model also shows local managers where they can intervene to balance local needs and biodiversity conservation. An interdisciplinary methodology must be applied to help local managers to balance forest protection and food security for the poor people in the buffer zones of the Bu Gia Map National Park.

Using Google's high resolution images for large-scale assessment of land cover/land cover change and spatially explicit auxiliary data

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The rapid development of monitoring land cover via remote sensing comes along with a rapid increase of the masses of spatial data that can be processed to answer questions arising over large spatial areas and relatively short time periods.
Using the possibilities of remote sensing and the capabilities of next-generation tools like FAO's openforis Collect Earth for data collection via virtual globes like Google Earth, various tasks are possible with increasing efficiency, including land use/land cover and land use change assessment, validation of existing maps, collection of spatially explicit socio-economic data, quantification/estimation of deforestation and reforestation, …. Using freely available and georeferenced imagery provided by virtual globes like Google Earth has the advantage to work on big image data with very high spatial resolution. The data provided by their application programming interface (API) is collecting images over time and their derivatives and show therefore comprehensive information about the location.
We developed a workflow to use these tools in a study area Jambi Province, Sumatra, Indonesia, known for very high dynamics of land cover and land use. As a basis, a classification key was produced based on the land cover/land use classification published by the Indonesian ministry of environment and forestry as well as additional information on ecology and socio-economy extracted from existing data. Using this classification key, 1009 points were analysed concerning land cover and land use and describing attributes like vertical structure in forests or proximities to infrastructure, water, and land cover changes.
Amongst others, the data indicates a strong relationship between decreasing forest area and increasing oil palm plantations and their predecessor stages as well as a high possibility of changes at forest boundaries due to fire. Com-

bining this information with a classification of high-risk areas (e.g. for fire or flooding), this information can be used for supporting decision processes and management planning. While we are still not using the full potential of a possible complete spatial auxiliary dataset, our approach already up-scales to a more solid understanding of the land cover changes in our study region.

Remote sensing and WebGIS tools for spatial data analysis and management in the CRC 990

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Spatial analysis is an integrated part of ecological and socio-economic research and plays a vital role in the CRC 990. Two primary sources of spatial data are used: i) field observations, and ii) external data. Field observations are collected by the projects in the study areas. Even though the 'spatial' components of the data collection are often not in the focus of the projects, they collect spatial information as the observations are made at certain locations or in spatial entities.
Collecting, analysing and communicating spatial data requires expert knowledge and specialized IT platforms. This will enable spatial analysis to support research into the mechanism of land used transformation and its ecological and economic consequences.
The INF Project is responsible for the management of the research data within the CRC 990. As spatial data is highly relevant within the research setting of the CRC 990 INF is providing three specialized services:

- The EFForTS-webgis which is a web platform for spatial data. The system allows researchers to upload, store, share and visualize their spatial data. Furthermore, it can be used to create custom made maps to communicate specific research findings
- INF is providing consultancy services and technical support for remote sensing and spatial data analysis to individual projects in 1:1 meetings and to large groups in form of workshops.
- INF is acquiring and preparing spatial data demanded by projects such as administrative boundaries, elevation models or maps of vegetation indices.

To conclude, the INF project is providing support for spatial data analysis at different levels and intensities with the goal of supporting the researchers and to promote the use of spatial technologies. We consider this a key technology for analysing heterogeneity at the landscape as influencing factor of land use change which is one of the main topics in the second phase of the CRC 990.

INF - Information Infrastructure Research Data Management and Integrative Statistical Analysis

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Talk about the INF as a whole (especially EfforTS-IS, WebGIS, statistical consultancy, research data management). Overview of past, current and future research topics in INF including

- EFForTS-IS and the WebGIS system
- Migration of EFForTS-IS to BExIS 2
- Connection of WebGIS
- Statistical consultancy and support
- Sustainable research data
- Data reuse and publication
- Embedded research data management
- Research data lifecycle support and support of the IT systems

Then we go into detail about the EFForTS-IS system, Migration from BeXIS 1 to 2, WebGIS, statistical consultancy and the goals for Phase 3.

SESSION 5

Conservation

Chairs: **Dirk Hölscher**, University of Göttingen (dhoelsc@gwdg.de) and **Bambang Irawan**, University of Jambi (irawanbam@yahoo.com)

Scope

Conserving biodiversity in tropical lowland regions is a great challenge. Large expanses of tropical rainforest have been converted to landscapes dominated by land-use systems, in which fragments of forests are surrounded by a mix of settlements, monocultures and agroforests. While smallholder-dominated mosaic landscapes often retain natural resources and combine land uses that support complementary ecosystem functions, services and benefits, these are subject to trade-offs and synergies. Further, land-use intensification, conversion of semi-natural habitat remnants and specialization on a few cash crops remain pervasive. Studies on how biodiversity and ecological functions are affected by land-use dynamics and socio-economic benefits in smallholder systems are essential to better understand adapted conservation management.

Scientific talks - Abstracts

Improving conservation design using palaeoecology

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The success of conservation nowadays relies on the support of local community that is often lacking due to the neglect to socioeconomic aspects. Thus, the socioeconomic of local people, especially those whose livelihood depends entirely on the natural resources, needs to be accommodated. To ensure ecosystem sustainability, the socioeconomic activities certainly need to be compatible with conservation and should not undermine the ecosystem's resilience. The ecosystem's ability to maintain it structure and function despite perturbations and to return to its pre-disturbance state, is often a slow process that might take decades or centuries. Thus, understanding ecosystem resilience is often hindered by a lack of long-term information that can be obtained using palaeoecology. Aiming to assess the ecosystem resilience, particularly to human disturbance, a palaeoecological study, including the analyses of pollen and spore, charcoal and carbon (C) content, is conducted on the Sungai Buluh peatland in Sumatra, Indonesia. Its vicinity to the Muara Jambi temple complex, remains of the former Malayu Empire, provides a unique opportunity to understand ecosystem response to human activity. The palaeoecological record from the Sungai Buluh suggests that the Malayu Empire people conducted activities on the peatland such as logging, grazing/cut-and-carry, and wild-harvesting. Although such activities altered vegetation composition of the peatland and slightly reduced the peatland's C sequestration capacity,

they give little impact to peatland hydrology, one of the key prerequisites for peatland resilience that allowed the peatland to recover after the cessation of human disturbance. Those activities or others that will not significantly impact the key resilience of the peatland i.e. maintained hydrological condition, thus can be defined as "resilience-friendly" and may be permitted to be conducted on the conserved peatland.

Spider community response to oil palm riparian buffers

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The expansion of the Southeast Asian oil palm industry is threatening regional biodiversity; however, expansion is not the only concern. It is equally important to sustainably manage existing oil palm. The effects of many management strategies have not yet been studied. One such strategy is maintaining mature oil palm around plantation rivers. These riparian buffers, which act as the interface between terrestrial and aquatic ecosystems, have a high conservation potential to improve oil palm biodiversity, ecosystem services and yield.
University of Cambridge researchers and Sinar Mas Agro Resources and Technology Research Institute (SMARTRI) are currently managing two riparian buffer-focussed projects. The RERTA Project is experimentally restoring riparian buffers to assess their contributions to replanted oil palm. The rAGE Project is observing biodiversity response to riparian buffers across an oil palm chronosequence. Both RERTA and rAGE are occurring in SMARTRI estates located in Riau Province, Sumatra, Indonesia.
Here, we consider the effects of oil palm riparian buffers on an abundant invertebrate predator – spiders. Spiders are present in all tropical agroecosystems and play an important role in integrated pest management. Sustaining robust spider communities in tropical agroecosystems may therefore mitigate pest populations and enable higher agricultural yields.

To contextualise our research, we present results from a systematic review and meta-analysis that concluded land use change across the tropics has adversely affected spider communities. We will then outline RERTA and rAGE Project experimental designs and present preliminary spider-focussed results. Results suggest that oil palm replanting significantly reduces understory spider abundance, but populations recover as palms mature. Riparian buffers may provide a habitat refuge for spiders while oil palm replanting occurs.

Integrating carbon and species conservation - making a case for Borneo ironwood as a conservation flagship

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Tropical forests play a crucial role in taking up CO_2 from the atmosphere. In Borneo, although structurally intact forests have been shown to be a long-term carbon sink, fragmentation and drought are posing progressive and periodically severe threats to this carbon sink. Different tree species respond differently to these changes, and in turn may modulate the carbon dynamics in the forest community they are part of. Here I report recent findings on the long-term above-ground biomass carbon dynamics in Borneo's forests, and shine a spotlight on the IUCN vulnerable Borneo ironwood (*Eusideroxylon zwageri*). I review our knowledge of the carbon value of this species and challenges to its long-term survival, using my recent study on its seedling survival to point to the species' regeneration bottleneck. I will also use the opportunity of this symposium to explore the case for making Borneo ironwood a conservation flagship in Borneo and Sumatra, which can potentially integrate carbon and species conservation with local community agroforestry.

Exploring strategies applied in promoting community agreements on conservation in Lore Lindu National Park, Indonesia

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The community agreements on conservation which aims to balance the conservation and the livelihood of community surrounding the park are promoted by NGOs that differ in their objectives and value orientations. The objective of this article was to explore the strategies applied by different NGOs and the contents of the agreements. Descriptive analysis had been used to analyse both the negotiation process and the contents of the agreement. Interviews with stakeholders were conducted in these 10 villages as basis for the selection of research locations. In view of the comparatively small number of villages to choose from the large variation among them, a purposive sampling method was applied. The criteria included the coverage of the three districts where agreements had been signed and coverage of the three NGOs promoting agreements that were already signed. The result shows that these the three NGOs that played a pioneering role in establishing the agreements: (1) Yayasan Tanah Merdeka (Free Earth foundation – YTM), an NGO which concentrates on advocacy for indigenous rights and strengthening of indigenous institutions (2) The Nature Conservancy (TNC), an international NGO which deal with conservation in supporting to the Park Management, and (3) CARE, an international NGO which concerns on rural development/agricultural extension and infrastructure provision.

Soil macroporosity and its related physical properties after forest conversion to rubber and oilpalm plantation in Jambi, Indonesia

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Soil properties and soil processes in relation to landuse change were mostly connected to the soil porosity. Total soil porosity is commonly predicted based on bulk density and particle density, which are measured using undisturbed soil sampling using ring samples. This method unfortunately excludes large pores and root channels during the sampling, which are actually closely related to nutrient leaching and soil erosion. Therefore we attempt to study macroporosity in rubber and oil palm plantation, in comparison to secondary forest. *T*he research was conducted in Bukit Duabelas landscape of Sarolangun District, Jambi Province. We selected four landuse systems (SF = secondary forest, JR = jungle rubber, RP = rubber monoculture, and OP = oil palm plantations), and each repeated three times. In each land use we measured root distribution and dye infiltration in soil profile as indicator of soil macroporosity, and took soil samples from 5 depth (0-20, 20-40, 40-60, 60-80, and 80-100 cm) for soil physical analysis (bulk density, particle density, pFo, pF 2.54, aggregate stability) and organic C content. They were taken in the middle of the adjacent trees (in forest, jungle rubber and rubber plantation), and in 3 different zones in oil palm plantation (fertilized zone, inter row, and frond piles). For comparison between 4 landuses, we used weighted average of 3 zones in oil palm plantation based on the coverage area of each zones.

Forest conversion to jungle rubber, rubber and oil palm plantation in Jambi lead to a decrease or macroporosity in the soil profile as well as in the soil matrix, especially in the upper 50 cm. Macropores both at vertical and horizontal plane in the secondary forest was significantly higher than other landuses. Macropores at horizontal plane in jungle rubber was higher than rubber and oil palm plantation. However the vertical macroporosity tend to be insignificant different in jungle rubber, rubber and oil palm plantation. This pattern was in

accordance to soil organic C content, aggregate stability, total and macropores in soil matrix, and litter thickness. However, macroporosity in soil profile was apparently unsignificantly correlated to soil bulk density. Among the soil properties measured, litter thickness, coarse root dry mass, organic carbon, and aggregate stability were the most determining factors for soil macroporosity.

Scientific posters – Abstracts

Effects of fertilizer regimes and time of planting in a Biodiversity Enrichment Experiment in an oil palm landscape

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Some initial conclusions can be made after four years of Biodiversity Enrichment Experiment (BEE) of CRC 990 / EFForTS Project. In the initial phase, EFForTS-BEE significantly increased yields per oil palm, which at the plot scale even compensated for the yield losses from oil-palm removal. An overall neutral effect on yields for small plots, but overall significantly positive effect for large plots was reported by Gerard, *et al*., (2017). Moreover, Teuscher *et al*., (2016) concluded that the positive responses of birds and invertebrates to the biodiversity enrichment treatments. However, some questions still required to be answered: (1) in which oil palm age, the enriching trees should be planted in the landscape? (2) When the number of oil palm trees and the planting space still in the same as the regular manner, is the BEE still feasible? (3) In which level of fertilizer to the trees that managed in the landscape may provide better growth of trees and production of oil palm trees? The research had been conducted in PT. Mekar Agro Sawit, Jambi. The experimental design that applied is Split Plot Randomized. The first factors were a1 (one year old oil palm); a3 (three year old oil palm) and a5 (five year old oil palm); while the second factor consist of two levels namely f0: no additional fertilizer and f1 additional fertilizer that calculated based on soil nutrient content. The treatments combination is six with five replications. Four tree species were selected for enriching the landscape namely petai (*Parkia speciosa*), jengkol (*Archidendron pauciflorum*),sungkai (*Peronema canescens*) and bulian (*Eusideroxlyon zwageri*). The trees were planted on December 12, 2017 with the total number is 600 trees. The preliminary results revealed that jengkol had the highest deviation standar both on height and diameter with the value of 13,29 cm and 0,93 mm while pe-

tai had the lowest deviation standard both on height and diameter. Based on the mean height and diameter, bulian was the highest and the biggest seedling compared to other species while the smallest seedlings were petai.

Exploring peat thickness and resistivity using the VLF Method

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This poster would present the study on the relationship between peat thickness and its resistivity explored using geophysical method, called VLF (very low frequency). The method equipped the VLF receiver to measure VLF properties emitted by the ground from study area. The study was done in Jambi Province of Indonesia in three different depth of peat area, i.e.; very deep (8–5 m), deep (3–8 m) and shallow (0–3 m) peat. The depth was confirmed by direct measurement. The VLF measurement was done along transects on each areas. The data was processed using *NAMEMD* (*Noise Assisted Multivariate Empirical Mode Decomposition*) method and converted into value and depth of resistivity using *Inv2DVLF* software.

From the study, it is known that the resistivity, shows significantly difference ($F(2,637) = 4.525$, $p = 0.0$) between area of very deep peat and the shallow peat. The resistivity exhibits to vary according to peat thickness. In the area of very deep, it tends to be statistically similar until 7.32 meter depth and starts to differ significantly at .46 meter depth. While in the area of deep peat, it is statistically similar until 4.72 meter and start to be different at 7.32 m depth. However, in shallow area, it does not exhibits as in the area of deep peat. This proved that the VLF method work properly in deep and very deep peat and is able to indicate peat thickness

Factors affecting people's acceptance in peatland restoration in Jambi

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The conversion of peatlands into agriculture and plantation occurs due to encroachment of communities in the area of protected peat forest (HLG) of the Bram Itam River, Jambi. This causes degradation of the ecological function. Peat restoration is pivotally important to improve the ecological function of the protected area, by replanting the area with appropriate plants, particularly local species. It is important to understand the influencing factors of people's acceptance in peat restoration. This study evaluates correlation of the variables of age, education level, knowledge about peatland, land ownership in and outside the HLG area and household income with the acceptance in peatland's restoration. The research indicates that the age as well as land ownership within and outside HLG area are the factors that influence the public acceptance in the effort to restate peatland in HLG Sungai Bram Itam. These three variables are related to livelihood systems and economic needs of farmers' families live around the HLG area of Bram Itam River. Appropriate strategies are required to increase households' income and prosperity parallel with the activities of the peat restoration's program.

Understorey vegetation with *Clidemia hirta* and *Boreria alata* for improvement of the water infiltration rate at an undulating oil palm plantation

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Field experiment was conducted at people's oil palm plantation in Jambi 2015-2016 in order to assess the role of understorey vegetation to improve water infiltration status. Concerning ecological sustainability of oil palm production system, a respectable consideration is to pay more attention to water balance status. A higher runoff and lower infiltration rate at present oil palm plantation area originated from forest stands implicates a reduction of ecosystem service quality. Until recently understorey vegetation *Clidemia hirta* (L.) D. Don and *Boreria alata* (Aubl.) DC at oil palm plantation, have been being considered as reluctant vegetation and controlled intensively as weeds. *Clidemia hirta* had more intensive primary, secondary and tertiary root distribution in the soil than *Boreria alata* and *Boreria leavis*. *Clidemia hirta* had also more value of water infiltration capability. At three cathegories of gradient slope, i.e. slight, moderate and heavy slope, *Clidemia hirta* showed the best performance for improvement of water infiltration with the K_s value of 14.2, 10.6 and 18,4 cm h^{-1} respectively, compared to soil surface without lower strata of vegetation as control with Ks value only reached to 2.1, 1.8 and 3.7 cm h^{-1} respectively. It was also found, that the ratio of female and male flower was associated with the previous soil moisture status.

Pollination: A missing link to sustainable oil palm agroecology?

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Despite extensive agroecological research in pollination services and conservation for many crop systems, the role of pollination is largely overlooked for the highly productive oil palm (*Elaeis guineensis*), which produces 29% of world vegetable oil on just 6% of the area cultivated for vegetable oils. In order to identify knowledge gaps, we conducted a review of the original literature and found that yield has improved in many regions from the introduction of the African weevil species *Elaidobious kamerunicus*, replacing hand pollination and the poor performance of the pollinator *Thrips hawaiinensis*. However, more recent papers indicate that reliance on this species as the only pollinator in introduced regions may eventually become problematic, as weevil populations have fluctuated and declined. We therefore present a more comprehensive overview of known and likely pollinators described in the literature, as well as their interactions relevant to pollination complementarity.
We also identify important controls of pollinator populations and services, which fall within the categories of biotic, climate, and management drivers, and discuss future research needs for each driver. For biotic drivers, avenues of research include potential temporal and spatial complementarity of pollinators, eventually reduced genetic diversity of introduced weevil populations, and the regionally different impacts of parasitic nematodes. For management drivers, this includes optimizing spatio-temporal distribution of inflorescences and sex ratio, as the weevils reproduce in male inflorescences, identifying regional landscape effects, and supporting pollinator coexistence to maintain more stable pollination services. Finally, a critical climate research need is identifying the impacts of climate change on pollinator communities and pollination services, as precipitation and temperature shapes pollinator availability already now.
In conclusion, oil palm is an economically important crop with significant impacts on biodiversity, but yield appears to be limited by the service provided

by pollinators. A stronger understanding of the role of its pollinator species and their nonlinear relationship to yield as well as the complexity of biotic, management and climate drivers of successful pollination is needed. Optimizing pollination may contribute to a more sustainable agricultural model that values ecosystem services gained from biodiversity, while also improving producer livelihoods.

SESSION 6

Socioeconomics dimensions

Chairs: **Heiko Faust**, University of Göttingen (hfaust@gwdg.de) and **Nunung Nuryartono**, Bogor Agricultural University (nuryartono@yahoo.com)

Scope

Social organisations and traditional smallholder land use systems have often co-evolved as a result of human interactions with the natural environment in tropical lowland regions. However, there is currently a rapid shift towards more commercialized land use systems because of growth in demand and increased market integration promoted by infrastructure development, technology and globalizing value chains. Analysing the drivers and impacts of these changes is key to understanding their broader implications for land use systems and the potential trade-offs that may occur. Economic factors are clearly the main drivers of both land use intensification and substantive land use change in tropical lowlands. Nevertheless, social, cultural and political processes, the natural setting, and the historical context also matter substantially for human welfare. Therefore, this session focuses on these socioeconomic aspects to obtain a comprehensive understanding and ramifications of land use changes at different spatial and institutional scales. We aim at highlighting the major contribution empirical socioeconomic studies in tropical lowlands can provide for an improved understanding of the nexus between land use and society to prepare policy recommendations. The session asks for trendsetting investigations, research innovations, and the use of a mixture of methods from a broad range of social sciences (e.g. economics, sociology, politics).

Scientific talks - Abstracts

An analysis of land use transitions in Jambi Province, Sumatra, Indonesia from 1990 to 2013

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The pattern of land use and in particular of the dynamics of land use changes is relevant information to understand the development of a landscape and to potentially identify drivers of changes and devise future land use scenarios. We used the official land use map of the Government of Indonesia (stemming from the President´s „one map policy“) that distinguishes 22 land use classes and produced land classifications for the years 1990, 2000 and 2013 from Landsat satellite imagery. We aggregated the 22 detail classes into 9 broader classes for more straightforward interpretation, namely primary forest, secondary forest, plantation forest, jungle rubber, rubber plantation, oil palm, agriculture, shrub/bush, and other land uses. Reliable reference information was only available for the year 2013, where the accuracy assessment yielded an overall accuracy of 78.2 %, obtained from 298 ground truth points. The three dimensional change matrix for these 3 points in time illustrates the dynamics of land use changes in Jambi Province where a considerable share of the land underwent more than one change within that 23 years period. Our change map allows assessing the changes for each polygon in Jambi: here, we analyse in particular the land use history of the 2013 oil palm plantations to quantify from which former land uses they come and to test the hypothesis that predominantly primary forest had been converted. It will also be possible to determine such changes for any administrative boundaries or specific research plots. Of course, all results are

to be understood and interpreted with the determined classification accuracy in mind.

Socioeconomic effects of oil palm cultivation for rural farm and non-farm households in Indonesia

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Oil palm is one of the most rapidly expanding crops throughout the humid tropics. While the environmental effects of the oil palm boom have received considerable attention, studies on the socioeconomic effects remain limited. This paper provides an overview of the quantitative research on socioeconomic effects of oil palm cultivation in the EFForTS Project. The research builds on survey data from rural Jambi (Sumatra), including farm and non-farm households.

The farm survey includes 700 randomly selected households with and without own oil palm cultivation. Using regression models to control for confounding factors, we show that oil palm cultivation increases farm household income and living standards. Richer farm households benefit more than poorer ones, suggesting that further oil palm expansion may lead to rising inequality among farmers.

The survey of non-farm households includes 430 randomly selected households. On average, employment in rubber and oil palm accounts for 70% of these households' total incomes. Land-use changes towards oil palm may influence labour-market opportunities and thus non-farm households' livelihoods. Our data show that non-farm households living in villages with larger oil palm areas and being employed in the palm oil sector are better off than households working as labourers or sharecroppers on rubber farms. The data further suggest that oil palm expansion reduces income inequality among non-farm households.

We also pool the data from farm and non-farm households to analyse combined rural development effects. On average, farm households are better off than non-farm households. Poverty rates are significantly lower in villages with more oil palm cultivation. Inequality decomposition analysis suggests that oil palm does not affect overall income inequality: the inequality-increasing effect among farmers is offset by the inequality-reducing effect among non-farm households. Broader implications for sustainable development are discussed.

The analysis of inequality using carbon footprint approach in Indonesia

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Sustainable development is an interesting issue in the 21st century. The main pillar of sustainable development is economic sustainability, social and environment. Based on the fact that carbon dioxide emissions comes from economic sector which leads to global warming, We further separate measures on emission inequality based on household sector. The objectives of the study are 1) Determine the characteristic of Carbon consumption differ in terms of expenditure of households in Indonesia, 2) Which factors affect the household carbon footprint in Indonesia, 3) Study on CO_2 emission inequality at the household-sector and its link to expenditure inequality. This research using Indonesian Input-Output (IO) table data, Global Trade Analysis Project Environmental Account (GTAP-E) and National Socio-Economic Survey (SUSENAS) 2016. to analyse the factors affecting the carbon footprint in household use the linear regression method, for measuring basic in emission equity using in approach Gini Coefficient. The result shows that fuel and electricity consumption is the biggest carbon footprint formers. we also find many household

characteristics (age, married status, education, poverty level) influence emissions, total expenditure is by far the most important determinant of household emissions. Consequently, emissions inequality is very similar to expenditure inequality across households.

Financial feasibility study of smallholder palm oil in Muaro Jambi district, Jambi province

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The purpose of this study was to identify the amount of production cost spent by smallholder palm oil farmers, to identify the annual income level of the smallholder palm oil farmers, and to analyse the financial feasibility level of smallholder palm oil plantations in Sungai Bahar Sub-District, Muaro Jambi District, Jambi Province. Research was done in Sungai Bahar sub-District, Muaro Jambi District. The samples for this study that collected in September 2017 were 86 farmers selected through accidental sampling technique. The data used in this study were the primary and secondary data. The formula of TC = FC + VC was used to identify the amount of production cost spent by smallholder palm oil farmers. The formula of I = TR – TC was used to identify the annual income level of the smallholder palm oil farmers. The NPV, IRR, and B/C analysis was used to analyze the financial feasibility level of smallholder palm oil plantations. The result of this study showed that the average annual production cost per hectare of smallholder palm oil plantation business in research area was IDR 9.961.585.- The cost production facility of IDR 5.488.161.- was the biggest, the cost of manpower of IDR 4.316.511.- was second highest, and the lowest was the depreciation cost of IDR 156.911.- only. The average annual income per hectare of the sample farmer was IDR 19.118.532.- the average annual income per farmer of the sample farmer (area of 2.5 ha) was IDR 25.412.602.-Financially, the smallholder palm oil plantation business in research area was feasible with the values of NPV was IDR 30.113.603,- IRR was 24.498% and B/C was 2,934.

Risk attitude and time preference: crucial factors for planting oil palm by smallholders?

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Indonesia as the largest palm oil producers receives international spotlights concerning rainforest deforestation for oil palm expansion. The earliest oil palm productions in Indonesia were carried out by the government and private companies, and later, smallholder farmers also established oil palm plantation in a substantial number. This state is interesting because oil palm is relatively new crop compared to other Indonesian traditional cash crops such as rubber, rice, and sugarcane. It seems that Indonesian smallholders did not perform the common premise that smallholders are reluctant to adopt new technology.
Our research identifies smallholders' preferences using their risk and time preferences simultaneously. The identification of smallholders' preferences and motive about crop choice will be necessary knowledge for future policies regarding environment preservation and maintaining economic benefit of palm oil for smallholders. The identification of time preference, which is created by comprehensive internal conflicts containing different-timing consequences, is relevant to the investment decision such as crop choice. However, estimation should incorporate risk preference because an assumption that individuals are indifferent toward risk is not accurate. Thus, there is a particular reason to estimate the risk and time preference simultaneously. This objective addresses the absent literature of Indonesian smallholders' preferences using simultaneous estimation.
To do so, we gathered risk and time preferences of 756 smallholders in Jambi Province. Based on these data, we followed simultaneous estimation method by Andersen *et al.* (2008) by using maximum likelihood estimation. We researched in the lowland areas where transformation of rainforest into agriculture farm occurred. We involved three types of smallholders: oil palm, rubber, and smallholders who cultivate both crops. Both-crops smallholders were those who cultivated rubber in the beginning and then cultivated oil palm as

the second crop. We involved rubber smallholders, as rubber was the main cash crop in Jambi Province before the oil palm boom. Oil palm and rubber have different waiting time for the first yield as well as productive periods.
We found that palm oil smallholders were more risk-averse compared to rubber smallholders. Besides, we revealed that both-crops smallholders were the most risk-averse farmers. Nevertheless, the discount rates were not different among farmers realizing various types of crops. This result implied that the Indonesian farmers did not have crop preference regarding the unequal harvest period between two crops.

Green territorialization, rural development and peasants and indigenous groups rights to land. Insights from Guaviare, Colombia

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In 2008, the Colombian government started initial steps towards REDD+ readiness and announced the goal to achieve zero net deforestation in the Amazon by 2020. Within this context, the Colombian government started to implement the Amazon Vision. A spatial planning initiative that seeks to achieve zero net deforestation, to promote green growth and alternative income sources for peasants and indigenous groups (Gobierno de Colombia 2015: iv).
Guaviare is considered as a highly biodiverse region in the transition zone between tropical rainforest and tropical savanna. However, Guaviare is not only a testing ground for the new 'green territorialization' strategies of the Amazon Vision. The cattle and coca frontier is still expanding while land speculators just wait to further expand the frontier (Castiblanco et al., 2015; Potter, 2015). The recent peace agreement with the FARC-EP might induce far-reaching societal and state transformations including agrarian reforms with implications for access and property relations.
Based on multi-sited qualitative research conducted in Guaviare and Bogota and building on political ecology and socio-spatial theory we seek to contribute to an improved understanding of social and environmental consequences of conservation interventions. We show how development and conservation interventions have changed access and property relations and identify differences between de-facto and de-jure rights to land. Our multi-scalar analysis reveals contradictions and limitations in the way in which conservation policies are designed from a central government point of view, disregarding the nuances of property dynamics on regional and local scales. The procedure imposes a legal rationale that accentuates problems in frontier areas, such as Guaviare, where the state has had a weak presence and its legitimacy is continuously challenged by different private and illegal actors.

Beyond the sum of its parts: A counterfactual simulation of Brazil's forest conservation recipe

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An innovative mix of policy instruments for conservation has reportedly played a key role in the unprecedented decline of deforestation in the Brazilian Amazon. So far, impact evaluations have focused on measuring the effect of individual policy instruments in that mix. Identifying valid counterfactuals for all relevant policy instruments in a single rigorous quasi-experimental design is a major challenge. Alternatively, we estimate a comprehensive spatially-explicit econometric model of deforestation that separately controls for multiple key elements of the Brazilian strategy to combat deforestation. The model allows us to construct counterfactual scenarios by selectively removing individual policy effects from the full set of policy predictors. We also quantify GHG emission savings from alternative counterfactual scenarios. Our measures of individual policy effects account for much less than the drop in annual defor-

estation rates from 2004 to 2012. We thus discuss the role of selection bias and alternative explanations for this finding.

Political deforestation cycles in Indonesia

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Forest loss due to agricultural expansion is the largest contributor to GHG emissions after coal and fuel consumption (12\% - 30\% of total emissions). Annual deforestation rates in Indonesia have been continuously increasing during the 2000s. Migration and agricultural extensification has brought significant improvements to local livelihoods at the expense of forest and biodiversity loss. The process is accompanied by Indonesia's political reforms of democratization and decentralization of environmental management. This paper focuses on political incentives of local administrations to foster forest conversion. We assemble a district level panel data set across Indonesian regencies, accounting for remotely sensed forest loss, forest degradation and fires. The data is linked to election cycles and fluctuations of global world market prices. We expect an increase in deforestation permits before elections in order to satisfy the interests of small land holders and agricultural companies who favour expansion. These effects are expected to be more pronounced where re-election incentives exist, where agricultural dependencies are high, and in time periods of increasing crop prices. In addition, we expect the detrimental effects to decrease in districts with stronger institutional settings, e.g. a longer democratic history, fewer corruption incidences and fewer property rights disputes.

Land control under two different regimes of forest governance

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The *Hutan Harapan* Ecosystem Restoration (ER) and the *Sultan Thaha Saifuddin* Grand Forest Park (FP) are two different forest functions located at Bungku village, Jambi, Indonesia. The first is a production forest dedicated for ecosystem restoration, while the last is protected type of forest devoted for research, science, education, tourism and nature recreation. This paper analyses how different nature of governance of ER and FP and its historical access can generate different path and intensity of control over land. A political ecology of struggle over forest is carried out as framework of study. We argue that struggle for access, control, and conflict over land within the area of ER are more forceful, organized, and severe rather than FP due to different nature of governance, knowledge contestation, bundle of power and networks of actors across scale. Further, different history of access and control, population complexity, weak community rights, overlapping authorities, and inconsistent regulations are robust independent factors that colour the complexity and contentious of land control in Indonesia.

Acceptance, implications, and perspectives of palm oil certification in Indonesia

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While a further expansion of palm oil production is likely, increased awareness of adverse consequences of indirect land use change (ILUC), such as high greenhouse gas emissions and loss of biodiversity, has highlighted the need to make palm oil production more sustainable. Both official regulations such as the EU sustainability criteria for biofuels and voluntary measures such as the Roundtable for Sustainable Palm Oil (RSPO) pursue this objective, yet the few existing empirical studies suggest little positive impact of certification on reduced deforestation, biodiversity and household income. The objective of this paper is two-fold: to shed light on the reasons why few positive impacts are found, and to spell out potential future directions for more effective sustainability certification. Our micro-level data from smallholders in Jambi, Indonesia show that under RSPO there are no significant differences in yields, management practices, or price premiums and only 45% of certified smallholders are aware of their certification. Case studies illustrate that adoption seems to be driven mainly by the fear not to be able to sell uncertified palm oil in the future rather than by the strive of producing a more sustainable product. Three policy measures addressing low adoption are tested in framed field experiments, namely a price premium, an environmental information intervention, and invoking group norms to increase the social acceptance of forest preservation. Both price premiums and environmental information resulted in significant reductions in plantation expansion. Taken together, these results suggest potential for enhancing the design and impact of certification schemes. In a final step, we simulate a stylized certification scheme with more ambitious impacts on biodiversity and household incomes while determining the premium price necessary to achieve these improvements.

International rubber price transmission and policy

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The prices of natural rubber were exposed to great volatility during the last three decades. While many policies have been implemented by rubber producing countries (at the national level, multilateral cooperation, and international scale) to stabilize prices of natural rubber, their success is disputable. The spatial price transmission analysis presented in this paper investigates price dynamics between international and domestic markets. Natural rubber prices are spatially interconnected both domestically (Jambi and Palembang) and internationally (Singapore and Malaysia). The study employs the spot prices (for the domestic market) and futures (international markets). In particular, this leads to the emergence of a new challenge for the development of market integration and price transmission research.
The objectives of the study are threefold: (1) measuring the degree of price transmission and integration; (2) measuring the rubber price transmission elasticity; and (3) reviewing and evaluating the success of policies which have been implemented during the period observed in the study. Econometrically the study is based upon the Vector Error Correction Model (VECM), augmented with qualitative analysis of rubber policies based upon stakeholder interviews. Conducting VECM modelling gives a picture for short and long run interlinkages both of domestic and international rubber markets. The in-depth interviews enable a superior contextualization of the results from quantitative results, especially regarding policy responses to the price changes internationally which would be transmitted into domestic markets. It is not only the responses for a negative but also a positive price change which would be a different policy implemented.

Economic feasibility of the peat restoration in Sungai Bram Itam forest area, Jambi

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Peat restoration in protected forest area, namely Hutan Lindung Gambut (HLG) of "Sungai Bram Itam" has been and is conducted not only in the degraded peat forest areas and bare lands, but also in farmlands and plantations, since people cultivated agricultural crops and oil palm in some locations of the protected peat area. This study indicates that the household's income generated from unmanaged (less intensive manage) of monoculture oil palm plantations is usually very low. The peat restoration program will success if and only if it considers not only the ecological aspects, but also the social needs and economic feasibility. This study evaluates different schemes of peat restoration strategies, and overall confirms that the peat restoration scheme of the enrichment planting with some multipurpose tree species (MPTS) in oil palm plantation will increase the Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Rate of Return (IRR) of lands. It means that these restoration schemes will make a better ecological function and simultaneously also improves the economic value of those lands, and therefore will increase the households' income and then prosperity of villagers. In long-term, the enrichment planting will transform monoculture oil palm into an agroforestry system with multi layers of multipurpose trees.

Scientific posters – Abstracts

The social costs of air travel in academia: A case study on a German-Indonesian research project

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Air travel is ubiquitous in academia and contributes to climate change via its carbon emissions. Different approaches exist to assess the social costs of carbon, i.e. the monetized damages associated with an incremental increase in carbon emissions. However, little work has been done to quantify the magnitude and the social costs of air travel in academia. Efforts to transparently communicate such data and to reduce flights are also rare, even though especially scientists warn against climate change and global warming. In this work, we exemplarily analyse flight data over several years from a German-Indonesian research project funded by the German Research Foundation. We calculate the social costs associated by air travel and propose solutions to mitigate these costs for this project. Moreover, we develop concepts and incentives for all academic institutions and funding agencies to reduce air travel in academia.

Translocality: Explaining for spatio-temporal heterogeneity in Jambi's agricultural landscape

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Sumatra is well known for an outstanding oil palm expansion, which has taken place for the last decades and is related to a globally increasing demand for palm oils. This development mirrors a broader „engagement of rural regions in the global economy" (Woods 2013, 11) or contrastingly framed capitalism's geographical expansion (Harvey 2003). However, local impacts are variegated and within our research region in Sumatra a heterogeneous landscape mosaic has evolved. Initial investigations across the region showed that neither the agricultural transformation process was uniform nor the concomitant societal change was balanced. In some areas, oil palm cultivation is dominant, others are characterised by rubber forests, and in between, places of paddy farming, horticulture, or fruit cultivation persist.

During data collection it became apparent that in all research villages, actor-networks took a crucial role, and in line with findings from Murdoch & Marsden (1995, 369) „local actors are tied into sets of relations both with other local actors *and* those located elsewhere." Thus, we wondered if networking practices in the research villages have been decisive for the heterogeneous transformations. To answer this question we apply the concept of translocality. „Translocality deliberately confuses the boundaries of the local in an effort to capture the increasingly complicated nature of spatial processes and identities, yet it insists on viewing such processes and identities as place-based" (Oakes & Schein 2006, 10).

We can conclude, that there are certain influences that have a transformative potential, e.g. the demand for agricultural land. This demand for land may finally become a visible imprint in the landscape. However, such potentials are not always realized, the influences are contested. In translocal spaces „multi-scalar engagements [...] of actors are formed by ‚localized context and everyday practices'" (Greiner & Sakdapolrak 2013, citing Brickell & Datta 2011, 13).

The Impact of the rubber auction market on the transmission price for farmers in Jambi Province

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Jambi province depends crucially on its agricultural sector and, in particular, products like rubber. Much rubber production in Jambi, however, is produced in small plantations cultivated by smallholders. Nevertheless, rubber has the potential of being key to economic and social development in rural areas and so of improving the socioeconomic situation of millions of farmers in Jambi Province. There are unfortunately major obstacles to this process. Most importantly, rural farmers do not have sufficient bargaining power to ensure a good price for their slab rubber from traders. One distribution channel for smallholder bokar (preprocessed) rubber is through the auction market (in Indonesian, Pasar Lelang Karet, PLK). This market attempts to help farmers get a higher price from traders. The objectives of our study were therefore to give an overview of the rubber auction market process in Jambi Province and to analyse the impact of the PLK on the transmission price for farmers. We also described the changes in prices received by farmer at auction, assessed the vertical price transmission elasticity through simple regression and determined the farmer share. The results showed that the rubber auction market (PLK) is an alternative distribution route that allows smallholder farmers to obtain a better price for their good quality bokar. The price transmission elasticity is 2.85. Farmers who use the auction market obtain a share of 4060%. Price changes at the export level are transmitted very little to farmers and their effect on farmers is very low.

Transforming exploitative land-based economy for sustainability: What options do we have?

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Large-scale land exploitation to jumpstart backward economies is often accompanied by massive environmental impacts. The broad concepts of productivity-oriented 'bio-economy' and conservation-oriented 'eco-economy' were proposed to transform exploitative land-based economies. Taking cases in Borneo as examples, this paper explores 10 transformative options for more sustainable economic growths: boosting productivity of cash crops on upstream, activating under-utilised low carbon (ULC) land for production, upgrading and diversifying downstream activities, branding for more values (industrial), establishing new domestic demand for bio-resources, creating values for carbon and ecosystem services, enhancing agro-ecological resilience, establishing eco-based tertiary sectors, branding for more values (smallholders), and encouraging self-sufficient lifestyles. It was revealed that utility-based development options with wealth creation as the centre of policymaking are inadequate to repair the previous environmental damage. Likewise, options that prioritise restoration have shown limited contribution to economic growth as observed in the case of Borneo. The interconnected nature of economic productivity and conservation means that no single option is a perfect solution but a combination of them may produce a better outcome. However, the existence of multiple stakeholders with different interests and values means that an 'optimal' combination would be a result of political negotiations rather than scientific investigations. Reconciling economic development and conservation requires serious thinking of the suitability of the options in a wider canvas of reality – the perspectives, attitude and influencing power of the various actors.

Correlation analisys between rubber raw materials (Bokar) and price received by farmer in Jambi Provice

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Some research showed that the quality of natural rubber produced by smallholder in Jambi Province is getting worst, while the international rubber market on the other hand needs higher quality. This research is to find out whether the natural rubber price received by farmer is linked to the rubber quality marketed in Jambi Province. The research was undertaken in four regency main rubber producing samples. Data was collected in survey method and analysed by using correlation method. The research found that the natural rubber was marketed in monopolistic manner, in which the natural rubber price was mainly controlled by trader. Majority (81,33 %) smallholder farmer sold their natural rubber to certain local trader. The natural rubber quality was range from low (50.09 %) to medium (76,14 %) grade, with the average grade was 62,27 %. Furthermore, the research was also showed that the price received by farmer ranged from Rp. 5000/Kg to Rp. 10.800/Kg and the average price was Rp. 7.499,02/Kg. The research was also found that there is a weak correlation between price paid to the farmer and the natural rubber quality sold by the farmer in Jambi Province.

Independent smallholder strategies to sustain RSPO certification in Jambi Province, Sumatra, Indonesia

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The Round Table on Sustainable Palm Oil (RSPO) is a voluntary certification scheme for sustainable palm oil production for both companies and small-

holders. In Indonesia, 112 companies have obtained RSPO certification, very few smallholders have obtained RSPO certification. Nevertheless, in Jambi Province, two Gapoktan (Smallholder Group Associations) have obtained RSPO certification. These two are Gapoktan Tanjung Sehati Merangin District (RSPO certification in 2012) and Forum Petani Swadaya Merlung Renah Mendalu (FPS-MRM) in Tanjung Jabung Barat District (RSPO certification in 2017). Given the above mentioned problems, it is important to understand how independent smallholders can sustain RSPO Certification. This study investigated Gapoktan Tanjung Sehati consisting of 214 households, of which 45 households represented the population. Focus group discussions were conducted to collect important data from the key informants. Data were analyzed using Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis. The SWOT analysis indicated that the position for development is in Quadrant 1 (aggressive strategies). Aggressive strategies indicate benefit because they have opportunities and strengths. These strategies use strengths and utilize opportunities to sustain RSPO certification and to implement principles and criteria for the production of sustainable palm oil. The development of the Gapoktan Tanjung Sehati involves cooperation between stakeholders: 1) financial administration and transparency are well recorded, 2) Gapoktan organization is structured, 3) advanced information and technology are accessible, 4) marketing results coordinated by Gapoktan, 5) a trained internal supervisor already exists, 6) most members have implemented RSPO certification Principles and Criteria, 7) profit gain is not only from financial (Premium Price), 8) most members have understood the benefits of environmentally sound plantation management, 9) and then the strengths are supported for the opportunities (S-O), after that strength and opportunities factors can overcome weaknesses and threats. Conclusion (1) the motivations for independent smallholders are mutual strength, supported by the Setara Foundation for the provision of empowerment and environmental knowledge to smallholders so that they can be independent, and also supported by researchers and others, (2) the various factors supported the sustainability of RSPO certification remembering that strong factors must be guaranteed and improved and the weak factors must be anticipated and fixed, and (3) the strategy for maintaining RSPO certification found in the first quadrant is and aggressive one.

Economic and social iImportance of Jernang as a prominent NTFP from Hutan Harapan-Indonesia

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In Sumatra-Indonesia forest areas are continuously shrinking and the forest quality deteriorating leading to a reduction in the medicinal plant, including dragon's blood, resin obtained from the exudate of the fruits of *Daemonorops draco*, locally known as Jernang. *D. draco* is strongly correlates with the floral diversity of the surround forest. Its diverse application leads this species into overexploitation and therefore Jernang was identified as potentially threatened in the Workshop of Specialist Ethnobotany and Economic Botany and as vulnerable species in IUCN Red List. It has internationally market demand yet it has not been listed under NTFPs commercialized in Asia under resin/dyes category presented in the most recent global study. Jernang has been collected in the wild for at least 70 years for its high commercial value and it was ranked as the most valuable NTFPs in Hutan Harapan. Official statistics on Jernang trade and consumption are scant as it is part of the informal economy. This study is the first to investigate Jernang potential contribution to poverty reduction. It also identifies whether Jernang is only attractive to resource-poor households or particular ethnic group. This study was designated to focus on specialized extraction group (Batin Sembilan and Immigrants) and specialized cultivation group (Malayan). The absolute importance of Jernang in the context of annual household economies varies from 255 USD/aeu (Malayan) to 384 USD/aeu (Immigrant), while its relative contribution to annual household income ranges from 17% (Immigrant) to 37% (Batin Sembilan). Social benefits are derived through both maintenance of health and treatment of illnesses especially for indigenous Batin Sembilan, and also provision of employment in 3 investigated market chains, from middleman to exporters.

EXCURSIONS

Kintamani Tour – Socio-cultural and Scenic Attractions of Bali

The one-day excursion will highlight scenic attractions and socio-cultural characteristics of Bali.
The tour starts with the visit of a traditional Barong and Keris Dance Performance. Balinese dances are famous and the Balinese themselves take them very seriously in the daily life. Afterwards, the tour will lead you to Celuk Village, known for its traditional gold and silver art.
We will then continue to the Pura Tirta Empul Temple *(Holy Spring Temple)*, a Hindu-Balinese water temple at Tampak Siring, which was built more than 1.000 years ago to worship Indra (a Vedic Deity in Hinduism).
Lunch will be offered near Kintamani, a scenic location with view of the active volcano Batur Mount and the Lake Batur View.
The program is rounded off by the visit of Penglipuran, a unique traditional Balinese village where you will get to know local people and their cultural habits and customs.

TOUR ITINERARY

08.00: Pick up at the hotel
09.30: Experiencing Barong and Keris Dance Performance (Trance Dance)
11.00: Visiting Celuk Village for traditional gold and silver art
12.00: Visiting Pura Tirta Empul Temple (Holy Spring Temple)
13.30: Lunch at Kintamani village with view of Mount Batur Volcano and Lake Batur View
15.30: Visiting Penglipuran, a unique traditional Balinese village
17.30: Arriving at the hotel

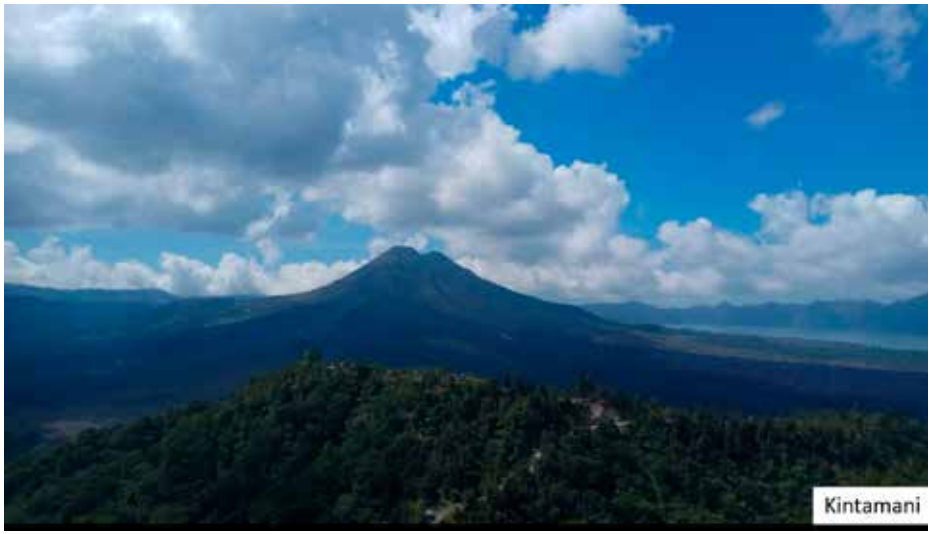

Photo 1. Batur Mount Volcano near Kintamani (Photo: Dwi Java)

Photo 2. Pura Tirta Empul Temple (Photo: Dwi Java)

Bedugul Tanah Lot Tour –
Hindu temples & agronomic characteristics of Bali

The one-day excursion will highlight traditional Hindu temples and specific agronomic characteristics of Bali.
The program includes visiting the temples of Pura Taman Ayun, of Pura Ulun Danu Bratan, and of Pura Tanah Lot. The Taman Ayun (means temple of the floating garden, UNESCO Heritage) is considered one of the most beautiful temples of Bali. It was built in 1634 on a river island.
The Ulun Danu Bratan is an important water temple of Bali, dedicated to the Lord Shiva. The temple complex was built in 1663 and is situated on the western banks of the volcanic Lake Bratan in the Bedugul highlands at an altitude of 1239 m.
The Tanah Lot ("Land in the Sea" in the Balinese language) is an ancient Hindu pilgrimage temple. It sits on a large offshore rock which has been shaped continuously over the years by the ocean tide. Tanah Lot was built in the 16th-century and has been a part of Balinese mythology for centuries. The temple is one of seven sea temples around the Balinese coast and very scenic during sunset.
Further highlights include visiting the Jatiluwih Rice Terrace, the largest rice field on Bali and appointed as one of the world heritage sites by the UNESCO.
Also, a Bali Coffee Plantation will be visited where you can witness several coffees types including the Bali Kopi Luwak Coffee, digested by an Asian palm civet.

TOUR ITINERARY
08.00: Pick up at hotel
09.00: Visiting Pura Taman Ayun Temple
11.00: Visiting Pura Ulun Danu Bratan Temple
12.00: Lunch at Local Restaurant
14.30: Visiting Jatiluwih Rice Terrace
15.30: Visiting Bali Coffee Plantation
17.30: Visiting Pura Tanah Lot Temple (Sunset)
18.30: Back to hotel

Photo 3. The Pura Ulun Danu Temple at Lake Bratan (Photo: Dwi Java)
Photo 4. The Jatiluwih Rice Terrace (Photo: Dwi Java)

The Bali Botanical Garden and Hindu Temples

The one-day excursion will highlight the Botanical Garden and two traditional Hindu temples of Bali. The Bali Botanical Garden is the largest botanical garden in Indonesia. It is located in the mountainous region of Bedugul, central Bali. The Garden was established in July 1959 and is situated around 1300 meters above the sea level overlooking Bratan Lake and the Pura Ulun Danu Temple on the slopes of Tapak Hill. The Garden contains more than 2.400 species, representing various species from mountainous areas of eastern Indonesia. Attractions include a large orchid display, a bamboo garden, a cactus greenhouse, a fern garden, traditional Balinese medicinal and ceremonial plants, and one of the world's largest begonia collections.

From the Botanical Garden, the tour continues to the Pura Ulun Danu Bratan temple. It is an important water temple on Bali, dedicated to the Lord Shiva. The temple complex was built in 1663 and is situated on the western banks of the volcanic Lake Bratan in the Bedugul highlands at an altitude of 1239 m.

The excursion is rounded off by the visit of the Pura Tanah Lot temple. The Tanah Lot ("Land in the Sea" in the Balinese language) is an ancient Hindu pilgrimage temple. It sits on a large offshore rock which has been shaped continuously over the years by the ocean tide. Tanah Lot was built in the 16th-century and has been a part of Balinese mythology for centuries. The temple is one of seven sea temples around the Balinese coast and very scenic during sunset.

TOUR ITINERARY

08.00: Pick up at hotel
10.00: Visiting Bedugul Botanical Garden
13.00: Lunch at Local Restaurant
14.30: Visiting Lake Bratan with is floating temple Pura Ulun Danu
17.30: Visiting Pura Tanah Lot Temple
18.30: Back to hotel

Photo 5. The Ulun Danu Temple at Lake Bratan (Photo: Dwi Java)

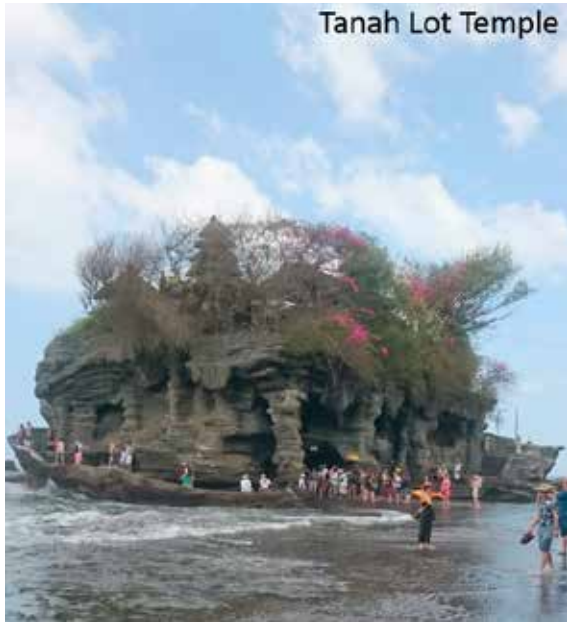

Photo 6. The Tanah Lot Temple (Photo: Dwi Java)

West Bali National Park

The West Bali National Park (Taman Nasional Bali Barat in Bahasa Indonesia) is the most north-westerly point of Bali. The official area inside the park boundaries is 190 square kilometers, with a further 580 square kilometers of protected reserve in the highlands to the east. In total this accounts for some ten percent of Bali's total land area. The Park was established as an Indonesian National Park in 1941.

Landscape

The park covers a large variety of landscapes including rainforest, dry savanna, acacia scrub and lowland forests, as well as more montane forests in the higher center. There are also some pockets of dense mangrove forest. There are several long extinct volcanoes in the protected reserve area to the east, with Mount Patas (1.412 m) and Mount Merbuk (1.388 m) being the highest points. These peaks are dominant visual landscape features from within every area of the park.

Flora and fauna

One hundred and sixty species of birds have been recorded in the park, including the near extinct Bali Starling, Bali's only endemic vertebrate species.

TOUR ITINERARY

07.00: Pick up at hotel
11.00: Visiting West Bali National Park
13.30: Lunch (lunch box)
16.00: Visiting Pura Pulaki Temple
21.00: Arriving at hotel

Mammals found inside the park include Banteng (*Bos javanicus*), a wild cattle from which the domestic cattle of Bali cows descend. Both Javan rusa (*Rusa timorensis*), a deer native to the islands of Indonesia and East Timor and Indian Muntjac (*Muntiacus muntjak*), also called red muntjac or barking deer - a common muntjac deer species in South and Southeast Asia - are quite widespread. Wild boar and leopard cats (*Prionailurus bengalensis*) are both quite common but seldom encountered.

The excursion is rounded off by the visit of the Pura Pulaki Temple, a sacred Balinese Hindu temple. The Pura Pulaki is part of a group of sea temples, set around the island to form a chain of temples which protect the island.

Photo 7. Pura Pulaki Temple (@ https://balijungletrekking.files.wordpress.com/2016/10/achitecture-of-pulaki-temple.png?w=885&h=591)

Photo 8. West Bali National Park (@ http://www.bali-individually.com/sites/default/files/styles/villa_hotel_thumbnail/public/news/West-Bali-National-Park-Jungle.jpg?itok=7ELOav-Y)

Jambi – EFForTS Experimental Sites

The two-day excursion (three days including the transfer from Bali to Jambi) will highlight the integrative experiments of EFForTS.
On Friday the excursion will visit the Biodiversity Enrichment Experiment in oil palm plantations (EFForTS-BEE, http://www.uni-goettingen.de/de/412084.html) at PT Humusindo. This long-term experiment was set up in December 2013 to evaluate the role of tree diversity and habitat size on biodiversity and ecosystem services.
On Saturday, the excursion will focus on the Oil palm management experiment at PTPN VI, a state-owned company, where also the meteorological tower is established (http://www.uni-goettingen.de/de/oil+palm+management+experiment+%28at+ptpn+vi%29/584053.html). The experiment started in 2017. The overall goal is to evaluate whether alternatives to current oil palm nutrient and weed management can contribute to reducing the negative impact of this land-use system on ecosystem services while maintaining current production levels.

TOUR ITINERARY

Thursday, October 10, 2018: Arrival in Jambi

Friday, October 11, 2018
08.00: Pick up from hotel
11.00: Welcome at PT Humusindo
12.00: Lunch at PT Humusindo
13.00: Visiting of B11 experimental sites
16.00: Back to hotel
18.30: Arrival at hotel

Saturday, October 12, 2018
08.00: Pick up from hotel
09.30: Welcome at PTPN VI
10.00: Visiting the climate tower
11.00: Visiting the oil palm management experiment
12.00: Visiting a riparian rubber plot (HRr5)
13.00: Lunch
15.30: Arrival at hotel and / or departure to Jakarta International Airport

Photo 9. The Oil palm management experiment at PTPN VI, Jambi, Indonesia (Photo: Kevin Darras)

Photo 10. The B11 enrichment experiment at PT Humusindo, Jambi, Indonesia (Photo: Watit Khokthong)

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