CRC 990 - EFForTS

NEWSLETTER

Mid-Term Project &
Research Progress
PHASE 2
Oct 2017–Sep 2018

Issue 6 / Sep 2018

Cover:
Water use in oil palm – a joint research collaboration between A02, A03 and IPB & UNJA. The research activity focuses on the quantification of internal and external oil palm stem water flow to quantify the plant's overall water use and contribution to evapotranspiration. A02 conducts sap flux measurements whereas A03 measures stem water flow, throughfall and above-canopy precipitation.

Figures 1 and 2. Stem flow measurement on oil palm tree. In total, three oil palm trees with similar tree height and stem diameter are equipped with a metal ring at 3.5 m height to measure stem flow. (Photo: Christian Stiegler)

Figure 3. Throughfall measurements. In total, five throughfall measurements have been installed near the A03 microclimate tower at PTPN VI. The installation collects precipitation, which is not intercepted by the oil palm trees. (Photo: Christian Stiegler).

Content

Acknowledgement from the Management

Z01 – Central tasks

MANAGEMENT

The Joint Management Board Indonesia, at its meeting on 14 March 2018, designated new members:

- Speaker of the Indonesian University Consortium is Prof. Dr. Dodik Ridho Nurrochmat. On February 2, 2018, Prof. Dodik was inaugurated as new vice-rector for partnership at IPB, succeeding Prof. Anas M. Fauzi. Pak Dodik is an alumnus of the University of Göttingen.
- Prof. Fauzi continues his work as member of the Board with focus on Scientific Affairs. At IPB, as of March 2018, he is Dean of the Graduate School.

COORDINATION OFFICES AT IPB AND UNJA:

- IPB: As of July 2018 Prio Nugroho took over the position as financial assistant from Mira who left the project the end of June. Satriyo Hutomo (permit management) left the office the end of June 2018. His successor is Ms. Jeane Siswitasari who started her work on 1 August 2018.
- UNJA: Starting July 2018 Nobon works as driver for EFForTS, he succeeds Epriansyah who resigned from his job the end of June 2018.

FOCI REPRESENTATIVES:

- Focus 2: Meike Wollni (PI C08, co-speaker group C) joined the group in January 2018. Her focus will be on heterogeneity and economy.

Figure 1. Signing ceremony of the MoU between the University Consortium and PT. REKI at UNJA on 4 December 2017. From left to right: Aprilitza, Abdul Azis, Sutan Adil Hendra, Johni Najwan, Tonny Soehartono, Lisman Sumardjani and Bambang Irawan.

Figure 2. Signing of the MoA between the University Consortium and PT. REKI on 13 February 2018. From left to right: Zulkifli Alamsyah, Lisman Sumardjani and Bambang Irawan.

- Focus 4: Tom Kopp (associated postdoctoral researcher C01) became a team member in May 2018.

REPRESENTATIVES OF DOCTORAL / POSTDOCTORAL RESEARCHERS:

- Group B: Fabian Brambach (postdoctoral researcher B06) joined Kira Urban as the group's spokesperson in May 2018.
- Group C: Nadjia Mehraban (doctoral researcher C07) succeeded Christoph Kubitza (C07) who completed his dissertation in May 2018.

AGREEMENTS

Apart from the agreements already concluded in 2016 + 2017 (see newsletter no. 5, October 2017) the following memoranda of understanding (MoA, MoU) have been signed:

- The MoU between UNJA on behalf of the Indonesian University Consortium and PT. REKI has been signed on 4 December 2017 by Johni Najwan (Rector of UNJA) and Tonny Soehartono (PT. REKI) (figure 1). On 13 February 2018, the MoA between the two parties has been extended. It has been signed by Prof. Dr. Zulkifli Alamsyah, Vice rector of UNJA and by Pak Lisman Sumardjani, Director Operational Management of REKI (figure 2).
- The Technical Agreement on Housing Facilities between UNJA on behalf of the Indonesian University Consortium and PT. REKI was signed on 4 July 2018. On the side of PT. REKI Pak Lisman Sumardjani (Director of Operational Management) signed the agreement, and on the side of UNJA Prof. Zulkifli Alamsyah (Vice rector for Planning, Collaboration Affairs and Information Systems). The construction of *The Guest House Göttingen – Hutan Harapan* (four

Figure 3. Annual compensation payment of plot owners at Pompa Air, Harapan landscape. From left to right: Yuking Linatra, Aiyen Tjoa, Bapak Julius (plot owner HOr1).

Figure 4. Annual compensation payment of plot owners at Lubuk Kepayang, Bukit Duabelas landscape. Front row from left to right: Muhammad Fahrozi, plot owner, Yuking Linatra, Aiyen Tjoa, daughter of plot owner. Back row from left to right: Village head - Bapak Y. Hadi and plot owners.

Figure 5: Damaged rubber tree at HRr1.

bedrooms, one office room) will start in the second half of 2018. Funding is provided by EFForTS. REKI will cover expenditures for electricity & water, and EFForTS will pay accommodation fees for the researchers staying in the house. EFForTS researchers have preferential access to the guesthouse.

FURTHERMORE, PLOT COMPENSATION PAYMENTS WERE COMPLETED FOR 2017 AND 2018:

- The annual compensation payments of plot owners took place on 9 and 13 February 2018 in the Bukit Duabelas landscape and the Harapan landscape, respectively (figures 3 and 4).

RESEARCH INFRASTRUCTURE – PLOTS

Replacement of plot HRr1 with HRr5 – riparian rubber plot, Harapan Landscape

- Due to the very poor management and maintenance of the rubber plot HRr1 by the owner (bad and irregular tapping followed by die-back of trees, significant tree damages and poor yield – tapping is done for only 60% of the trees at irregular intervals; figure 5) an alternative site nearby was installed in March 2018. HRr1 will be kept for continuation of measurements as needed by scientific projects, however yield and litter data will be recorded at the new HRr5 site. The size of the plantation is 1.5 ha and the age of the trees is 12 years old. The plot is surrounded by other smallholder rubber fields. The terrain is flat and located close to a stream. The soil characteristics are similar compared to the other sites (figure 6). The density of the rubber trees is somewhat lower (4m x 7m) compared to the common practice in the area (4m x 4m or 4m x 5m). The contract with the owner (Pak Abdul) was signed in April 2018.

Litter sampling in rubber and forest plots - Harapan Landscape

- In November 2017, 256 litter traps (16 traps per plot) have been installed by the plot management team of Z01-Jambi (figure 7). Litter samples are collected once a month (starting December 2017) for one year. For the rubber plots, the dry weight of rubber leaves, non-rubber leaves, bark/branches and for seeds/flowers/fruits is recorded. For the for-

Figure 6. Rubber plantation at HRr5.

Figure 7. Litter traps set up in a rubber plantation.

Figure 8. Graphic recording of keynote of Dr. Aiyen Tjoa presented at the DAAD workshop "Sharing best practices: doing research together" on 8 May 2018 in Jakarta.

est plots, the dry weight of leaves, bark/branches, fruits and of seeds/flowers/fruits is documented. The data are collected and recorded by Z01 (Aiyen Tjoa) and B04 and will be uploaded to the platform EFForTS-IS.

Topography mapping of the riparian plots – Harapan Landscape

- A05 created topography maps of the riparian plots to outline the areas that become flooded/non-flooded during the rainy season. Elevation and slope of the terrain surface were measured by Z01-Jambi in 5m x 5m grids using a Vertex tree height-measuring device.

Tree mapping

- B06 (Katja Rembold & Holger Kreft) documented the position of all trees > 10 cm DBH (diameter at breath height) of EFForTS core plots. The maps are deposited on the SharePoint under Core Plots – Tree maps (https://sharepoint.uni-goettingen.de/projects/sfbindo2/CRC990Documents/Forms/Core%20Plots.aspx). The size of the circlets is enlarged to make small trees more visible, but the size is in relation to their DBH.

Tree tags - replacement:

- About 300 missing and / or broken tree tags will be replaced in mid-August by B06 (Florian Brambach, Edo Mauliarta, M. Ihsan). Funding is provided by Z01.

Staff – Z01 plot management team:

- Starting February 2018, Yohannes Toni is the new field supervisor of the plot management team, succeeding Yohannes Bayu. New team members are Darus (Ahmad Darussalam) and Leonarda Simanjuntak.

SCIENTIFIC NETWORKING AND COLLABORATION WITH PARTNERS AND STAKEHOLDERS

DAAD Workshop – sharing best practices: doing research together

- The workshop was held on 8 May 2018 at the German Embassy in Jakarta. Dr. Aiyen Tjoa, Svenn Langguth (Head of Division Science & Technology, German Embassy Jakarta) and Dr. Christian Rable (Deputy Director DAAD, Jakarta) jointly organized the workshop. The workshop addressed challenges of conducting science at an international level, especially when the team members of collaborative scientific projects have different levels of scientific achievements, when the countries involved possess a different richness of biological diversity or different cultural backgrounds. Oftentimes, the partners are called upon to deal with situations beyond their control (e.g. permits, visa regulation); often they have to improvise to find solutions on a case-by-case basis.
- Aiyen gave a keynote on "CRC 990 / EFForTS: Best Practices in Research Collaboration Management" (figure 8); Iskandar Siregar (IPB) chaired the working group on "Tackling global challenges", and Suria Tarigan (IPB) was chair of the working group "Managing international research projects". Further participants from EFForTS were Sunny Reetz (Z01 Bogor) and Bambang Irawan (UNJA representative of EFForTS).
- The working group findings and recommendations can be downloaded from the EFForTS' website (https://www.uni-goettingen.de/de/daad+workshop+%22sharing+best+practices%22+on+may+8%2c+2018+in+jakarta/588489.html)

EFForTS seminar and handing over of invertebrate animal collection to LIPI

- On 22 March 2018, Stefan Scheu (speaker of EFForTS, PI B08 & Z02) presented the project's strategic objective to analyze and monitor diversity in rainforest transformation systems in Jambi, Sumatra.
- He handed over a collection of holotypes of invertebrate animals (oribatid mites and centipedes) to Ms. Dhian Dwibadra, Manager of the Zoological Collection at LIPI (figure 9). The list and scientific description of the holotypes are published on the website of EFForTS (http://www.uni-goettingen.de/de/indonesian+institute+of+science+%28lipi%29/412126.html).

Biodiversity species lists for PT. REKI and the National Park Bukit Duabelas (TNBD)

- Lists of plant and animal species identified at both the Harapan Rainforest and TNBD were handed over to official representatives. The species comprise:
  - B06: Plants (trees, understory)
  - B08: Mites (mesostigmata, oribatida), springtail (collembola), spiders (araneae)
  - B08: Living testate amoeba in litter and soil

Figure 9. Handing over of holotypes of invertebrate animals (Stefan Scheu / EFForTS and Dhian Dwibadra / Manager of the Zoological Collection at LIPI).

  - B09: Bats and birds
  - Z02: Beetles, ants, butterflies, parasitic wasps.
- The lists are deposited on the EFForTS' website (http://www.uni-goettingen.de/de/partners/580468.html).

SOCIAL NETWORKING WITH LOCAL PARTNERS AND STAKEHOLDERS

Workshop with local governmental institutions in Jambi Province

- A one-day social event workshop was organized by the EFForTS management - UNJA on 16 July 2018 for governmental institutions in Jambi to outline the status-quo of the collaborative project activities (research work, field activities, capacity building measures, joint publications, involvement of students). Presentations were given by Aiyen Tjoa (overall outline), by Damris Muhammad (focus on group A activities), by Bambang Irawan (focus on group B activities) and by Rosyani (focus on group C activities). The workshop was hosted by Bapak Harlik, head of the Bappeda Provinsi (Provincial Development Agency) and chaired by Zulkifli Alamsyah, vice rector for collaboration, information and communication, University of Jambi. About 35 officers attended the workshop (figure 10):
  - BAPPEDA (Development Planning Agency at sub-national level)
  - KESBANGPOL (Office for National Unity and Politics)
  - Dinas Perkebunan (Estate Plantation Office)
  - Dinas Pertanian (Agricultural Office)
  - Dinas Kehutanan (Forestry Office)
  - BALITBANGDA (Province Research Body)
  - Badan Lingkungan Hidup Daerah (BLHD) (Environmental Agency)
  - Badan Pengkajian Teknologi Pertanian (BPTP) (Agricultural Technology Body)

Figure 10. Social event with local governmental institutions in Jambi on 16 July 2018. Front row sitting from left to right: Zamerli, Husni Yarnis, Zulkifli Alamsyah, Harlik, Aiyen Tjoa, Rosyani, Damris. Back row standing from left to right: Septu Haswindi, Wasnan, Didit Wahyu, Ervina Aprianti, Dien Novita, Sri Kusumawati, Yitno Yuwono, Riswari, Bambang Irawan.

  - BMKG (Meteorology, Climatology, and Geophysics Agency)
  - Imigrasi (Immigration Office)
  - Balai Pemanfaatan Hutan Produksi (BPHP) (Forest Utilization Production Agency)
  - BPDAS (Watershed Management Agency)
  - BKSDA (Natural Resources Conservation Agency)
  - Badan Karantina Pertanian (Quarantine Office)
  - Sekber Kehutanan (Joint Secretariat of Forestry).

Exchange meeting with the indonesian palm oil board (Dewan Minyak Sawit Indonesia, DMSI)

- On 9 May 2018 representatives of EFForTS – Indonesia met with delegates from DMSI (http://dmsi.or.id/index.php/public/profil/detail/1) to introduce the Collaborative Research Center 990. Aiyen Tjoa, Bambang Irawan and Suria Tarigan presented research highlights of groups A, B and C and gave an overview of the partners involved. Further, they emphasized the role of EFForTS / DFG as independent non-profit basic science project with strong focus on scholarly research and education including publications of own data.

Guest Visits of EFForTS field sites

- The Indonesian Oil Palm Estate Fund (BPDPKS) together with The Ministry of Foreign Affairs of the Republic of Indonesia, the Jambi Government and the University of Jambi (UNJA), held the Executive Oil Palm Program for Ambassadors of European Union Member States in Jambi from 16 to 18 April 2018 to showcase the practice of palm oil manage-

ment in Indonesia. As part of the cooperation of UNJA with both BPDPKS and EFForTS, on 17 April 2018, the delegation visited the climate tower at PTPN VI and one plot of the B11 Biodiversity Enrichment Experiment at PT. Humusindo. The trip was hosted by Zulkifli Alamsyah (Vice Rector for Planning, Collaboration Affairs and Information Systems, UNJA) and by Bambang Irawan (Dean Faculty of Forestry & UNJA Representative of EFForTS). Further sites visited in Jambi were PT. REKI (forest restoration) and PT. Inti Indosawit (oil palm plantation).

PUBLIC RELATION AND SOCIAL MEDIA IN EFForTS

Social media group and contact person

- To disseminate research results and raise the profile of EFForTS to a broader audience, EFForTS launched a social media group in July 2018. Tasks of the group are knowledge transfer, improved visibility and networking at national & international level via social media. Group representatives are Fabian Brambach (B06), Jörg Christiansen (A01), Ivonne Hein (Z01), Joost Koks (A05), Fenna Otten (C02), Christian Stiegler (A03), and Clara Zemp (B11).
- Editorial contributions (posting, linking, commenting) for Facebook, Twitter, Instagram or ResearchGate can be directed via email to one of the group representatives. The official hashtag is *#CRC990*:
  - Facebook - https://www.facebook.com/Efforts-CRC-990-761206753931084/. The site is managed by Ivonne & Jörg.
  - Twitter-https://twitter.com/efforts_crc990. The account is managed by Fabian.
  - Instagram - https://www.instagram.com/efforts.crc990/. The account is managed by Joost.
  - ResearchGate: it is planned to have one official EFForTS group which is managed by Fenna.

Module public relations (Ö-Projekt)

- For the planned Phase 3 of EFForTS (2020 to 2023) it is panned to integrate a separate / own module *Public Relations*. PI and counterpart are Susanne Bögeholz (Professor Didactics of Biology, UGoe) and Damayanti Buchori (Professor Department of Pest and Plant Disease, IPB).
- In Göttingen, the main focus is on education of pupils and the training of student teachers – Education for Sustainable Development (ESD) – building on EFForTS research findings. Similarly, at IPB (Indonesia) it is proposed to develop and integrate an additional ESD-module into existing curricula for student teachers. In October 2018 a two-day workshop on Natural Resources, Biodiversity and Sustainable Education will be held at IPB from the 15th to the 17th with stakeholders from university and non-university institutions to explore the local conditions and to develop a possible concept.

MISCELLANEOUS

Training workshop "weed and invasive plant management" at UNJA

- Dr. Sri S. Tjitrosoedirdjo, counterpart of B06 at SEAMEO BIOTROP and the Faculty of Forestry, UNJA conducted a five-day workshop on "Training on weed and invasive plant management" (Pelatihan Pengelolaan Gulma dan Tanaman Invasif) from 23 to 28 April 2018 at the Research Center of UNJA laboratory. Twenty participants from UNJA, PT. REKI, Quarantine Office Jambi, the universities of Padang, Palembang & North Sumatra as well as from EFForTS (Mr. Ihsan, field assistant of B06) took part in the workshop.

BEFTA workshop - participation of EFForTS counterparts

- Tania June and Damayanti Buchori were invited by Edgar Turner (University of Cambridge, BEFTA) to participate in an one-day workshop entitled "Impacts of climate shock in SE Asia – measuring and adapting on 5 March 2018 in Palembang". Tania June (more specifically representative) gave a talk on "Change in sensible and latent heat fluxes of oil palm as affected by water availability".

Educational film production about palm oil production for german school classes - taking Indonesia as example

- Mr. Höpfinger (Emeritus Professor at the Faculty of Human Geography, Catholic University of Eichstätt-Ingoldstadt) & Heckl Entertainment

and Media Productions, Ingoldstadt on behalf of FWU (Institut für Film und Bild in Wissenschaft und Unterricht gGmbH) visited two of the experimental sites of EFForTS as showcase for the educational film. From 19 to 23 June 2018 the film team went to the climate tower at PTPN VI and the Biodiversity Enrichment Experiment at PT. Humusindo (figure 11). Further sites filmed in Jambi were smallholder sites in Merlung and a palm oil factory of PTPN VI in Bunut (production of crude palm oil). Thereafter they continued to Medan, Northern Sumatra.

FUNDING OF DFG PROJECT

- Dr. Kartika Anggi Hapsari (former doctoral researcher of A01) has been granted a three-years postdoctoral DFG project entitled "Putting the carbon back into peat: Palaeoecological contribution to the enhancement of natural carbon sequestration of Indonesian peatland". Research focus is in Riau (Sumatra) and Kalimantan.

ATBC HONORARY FELLOW AWARD

- Prof. Damayanti Buchori received the ATBC Honorary Fellow award 2018. Honorary fellow is the highest award given by the Association for Tropical Biology and Conservation.

Figure 11. Film team visiting the climate tower at PTPN VI. From left to right: Harald Heckl, Johann Höpfinger, Aiyen Tjoa, Franz Heckl, Bambang Irawan.

Enjoy reading!

Prof. Stefan Scheu
(Speaker of EFForTS)

Prof. Dr. Dodik Ridho Nurrochmat
(Speaker of the Indonesian University Consortium)

I. Mid-term project and research progress of Phase 2 (2018)

1. Research acivities of groups A, B, C, Z02 and INF

Group A

FIELDS OF RESEARCH
- Environmental processes

GROUP COORDINATORS
- Dirk Hölscher, Marife Core (University of Göttingen, UGoe);
- Suria Darma Tarigan (Bogor Agricultural University, IPB);
- Muhammad Damris (University of Jambi, UNJA)

REPRESENTATIVES OF DOCTORAL/ POSTDOCTORAL RESEARCHERS
- Florian Ellsäßer (A02)
- Joost Koks (A05)

A02

TITLE: **Tree and palm water use**

TEAM: Principal Investigators: Dirk Hölscher (UGoe); Herdhata Agusta, Hendrayanto (IPB).
Scientific Staff: Florian Ellsäßer (Doctoral Researcher).
Associated Scientists: Alexander Röll (Postdoctoral Researcher), Joyson Ahongshangbam (Doctoral Researcher).

RESEARCH SUMMARY:

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. Photogrammetric methods were applied in an oil palm agroforest (B11), 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 (Ahongshangbam et al., unpublished data). Vegetation and land surface temperatures were measured with thermal imagery in a commercial oil palm plantation, where evapotranspiration was assessed by the eddy covariance technique (A03). Energy balance models based on surface temperatures supplemented by net radiation measurements yielded high temporal agreement with eddy covariance measurements (up to $R^2 = 0.86$), even under different weather conditions (figure 12) (Ellsäßer et al., unpublished data). 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. We are now going to work in the oil palm management experiment, the biodiversity enrichment experiment, and the Harapan rainforest.

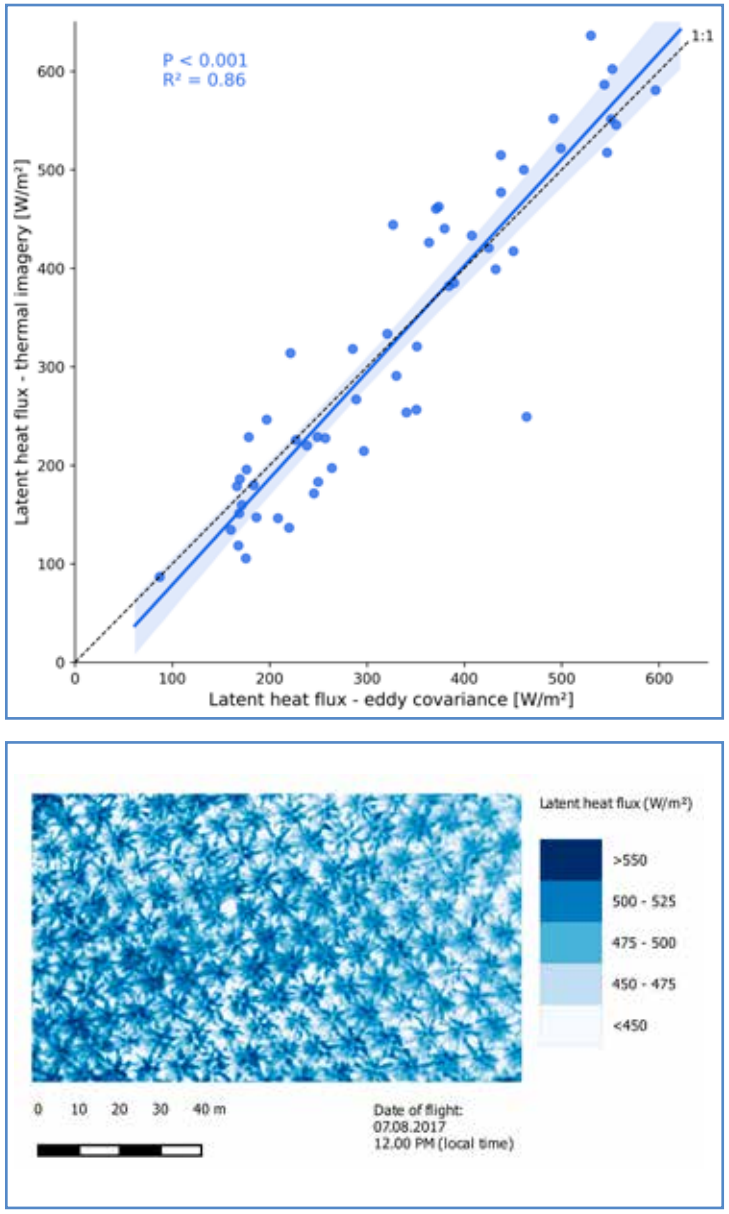

Figure 12. Evapotranspiration, expressed as latent heat flux, over a commercial oil palm plantation. (A) Comparison with eddy covariance measurements (n = 56 flight missions), and (B) spatial distribution at a given flight mission (resolution 15 cm x 15 cm) (Ellsäßer et al., unpublished data).

A03

TITLE: **Ecosystem-scale assessment of the full greenhouse gas and energy balance of an oil palm plantation in Sumatra (Indonesia)**

TEAM: Principal Investigators: Alexander Knohl (UGoe); Tania June (IPB); Dodo Gunawan (Badan Meteorologi Klimatologi dan Geofisika, BMKG); Abdul Rauf (University of Tadulako, UNTAD).
Scientific Staff: Christian Stiegler (Postdoctoral Researcher).
Associated Scientists: Fernando Moyano, Ana Meijide (Postdoctoral Researchers), Mattia Bonazza (Doctoral Researcher).
Technical Staff: Marek Peksa, Edgar Tunsch (UGoe), Basri Hatake, Bayu Puja Kesuma, Darwis (UNJA).

RESEARCH SUMMARY:

We investigated nitrous oxide (N_2O) greenhouse gas fluxes at the PTPN VI oil palm plantation using the eddy covariance technique. N_2O is a powerful greenhouse gas, with an atmospheric life span of approx. 100 years and a global warming potential of 265 molecules of CO_2 over a 100-year time horizon (IPCC, 2013). Chamber-based measurements of soil N_2O fluxes in col-

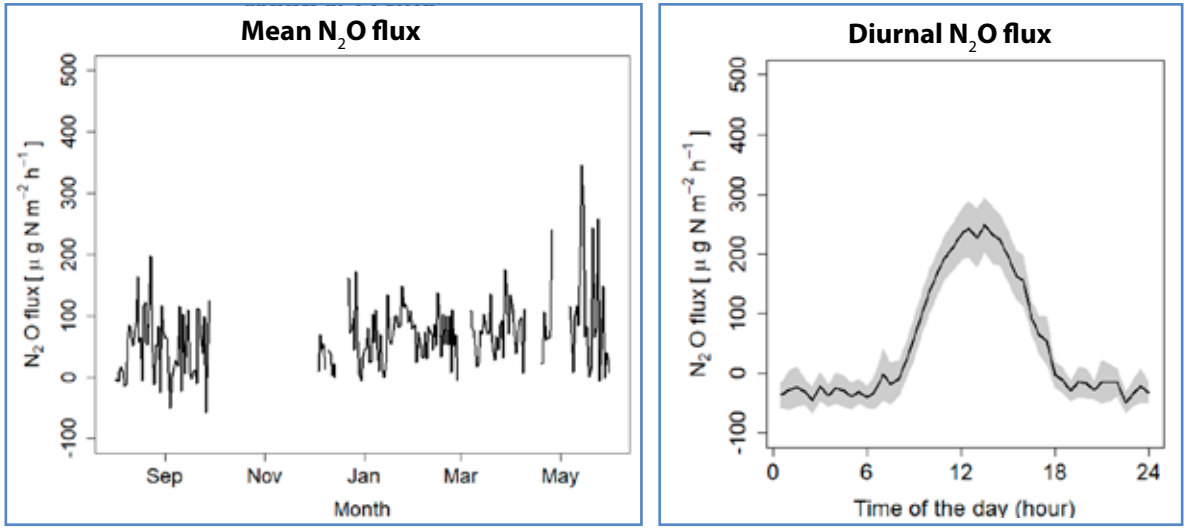

Figure 13. Mean daily N_2O flux (left) and mean diurnal N_2O flux (right) during the study period 1 August 2017–31 May 2018.

laboration with A05 have shown that the soil at the PTPN VI oil palm plantation is a source of N_2O (0.3 g N-N_2O m^{-2} yr^{-1}). In this study, we investigate the overall ecosystem N_2O fluxes and elaborate the driving atmospheric and soil parameters influencing N_2O fluxes.

Mean daily ecosystem N_2O fluxes during the period 1 August 2017 to 31 May 2018 show pronounced day-to-day variation and range between -58.0 µg N-N_2O m^{-2} h^{-1} and 345.5 µg N-N_2O m^{-2} h^{-1}, with average flux of 66.2 µ g N-N_2O m^{-2} h^{-1} (figure 13). The observed N_2O flux based on 30-minute average values equals to 5.6 kg ha^{-1} yr^{-1} of N_2O emission and a global warming potential of 232 g CO_2-equivalent m^{-2} (63.3 g Carbon-equivalent m^{-2}). The relatively high eddy covariance-based N_2O emissions compared to chamber-based measurements indicate that chamber measurements might underestimate the true N_2O flux due to possible N_2O root assimilation and leaf efflux, possible N_2O production in the plants, and canopy soil N_2O emissions. Diurnal N_2O fluxes are negative (N_2O uptake) during the night, with average night time N_2O flux of -27.9 ±10.0 µg N-N_2O m^{-2} h^{-1}, and positive (N_2O emission) during the day, with average day time fluxes of 123.7 ±96.7 µg N-N_2O m^{-2} h^{-1} and peak fluxes in the early afternoon (figure 13). N_2O fluxes show no correlation with soil temperature and soil moisture (R^2=0, respectively), indicating that the two soil parameters might not be key factors affecting N_2O emissions. However, N_2O generally increases with increasing air temperature (R^2=0.37) and increasing atmospheric vapour pressure deficit (R^2=0.38). A similar trend, with higher R^2 is observed for N_2O fluxes and incoming solar radiation (R^2=0.44) and photosynthetically active radiation (R^2=0.51). Negative N_2O fluxes (N_2O uptake) during the night might be related to microbial activity and anaerobic denitrification or possible sensor detection limits. The increase in N_2O flux during the day might be related to light-dependent plant internal gas transport through N_2O-root assimilation and leaf transpiration and light-dependent plant internal N_2O production as well as due to enhanced plant transpiration and related N_2O assimilation through plant roots.

Figure 14. The eddy covariance flux tower of A03 at a 12-year old oil palm plantation at PTPN VI, Batang Hari Unit, Jambi, Sumatra, Indonesia (Photo: Christian Stiegler).

A04

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

TEAM: Principal Investigators: Michaela Dippold, Yakov Kuzyakov (UGoe); Kukuh Murtilaksono (IPB); Damris Muhammad (UNJA).
Scientific Staff: Nina Hennings (Doctoral Researcher).
Asscociated Scientists: Thomas Guillaume (Postdoctoral Researcher).

RESEARCH SUMMARY:

In the context of the Oil Palm Management Experiment at PTPN VI the team of A04 conducted a laboratory experiment in order to determine the ongoing field experiment under controlled conditions.

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 in agricultural soil in the tropics, especially in the rhizosphere (C excess and N limitation), is still incomplete. The effects of fertilization and herbicide use on CO_2 emissions and microbial biomass in the interrow and the weeding circle of an oil palm plantation rhizosphere were investigated in a 30-days incubation experiment.

The soil was amended with the fertilizer composition used in the field, consisting of Urea, Triplesuperphospate (TSP), Potassium chloride (KCl) and dolomite in a conventional (9.8 mg^{-1} soil) and reduced fertilization level mixture (5.7 mg^{-1} soil) in the weeding circles and as well as with or without herbicide treatment (glyphosate, 2.2 μl^{-1} soil) in the plantation's interrows. Microbial biomass and CO_2 emissions were measured in order to analyze 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 group, which indicates a nutrient limited ecosystem, where microbial activation occurs and soil organic matter (SOM) is destabilized and emitted as CO_2 to the atmosphere. Furthermore, the effect of herbicide use on SOM stabilization in interrows is investigated. Here, we challenge the question whether herbicides hamper the microbial activity and lead to lower CO_2 emissions and consequently support carbon storage.

Figure 15. The team of A04 after field sampling in May 2017. From left to right: Winda Januarista, Irham, Nurman, daily helper, Nina Hennings.

A05

TITLE: **Soil and tree-stem N_2O fluxes from a large-scale oil palm plantation on well drained, loam Acrisol soil**

TEAM: Principal Investigators: Marife D. Corre, Edzo Veldkamp (UGoe); Muhammad Damris (UNJA); Sri Rahayu Utami (University of Brawijaya, UB); Aiyen Tjoa (UNTAD).
Scientific Staff: Greta Formaglio, Joost Koks (Doctoral Researchers, UGoe); Amanda L. Matson (Postdoctoral Researcher in 2015-2016).
Asscociated Scientists: Syaruhl Kurniawan (Postdoctoral Researcher, University of Brawijaya).

RESEARCH SUMMARY:

We have completed in March 2018 the one year field measurements of our four goals in

the second phase. 1) Assessment of whether lower-intensity management practices in a large-scale oil palm plantation 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}, equal to harvest export) with herbicide spraying, and reduced fertilization with mechanical weeding. Each of the 4 treatments has 4 replicate plots (50m x 50m each). Measurements were conducted in two subplots per plot with 3 sampling locations in each subplot: fertilized area around palms, unfertilized inter-rows and frond-stacked area. We quantified nutrient response efficiency (yield ÷ plant-available nutrients in soil), nutrient retention efficiency (leaching losses ÷ nutrient available in soil), and free-living N_2 fixation in soil. The latter will be presented by G. Formaglio at the conference in Bali. 2) In a large-scale oil palm plantation, where an eddy covariance flux tower measurements are conducted, soil greenhouse gas (GHG) fluxes were quantified for two years to complement to ecosystem-scale GHG budget and to characterize inter-annual variability. 3) Soil GHG fluxes were quantified in the reference land-use systems (forest or jungle rubber) and

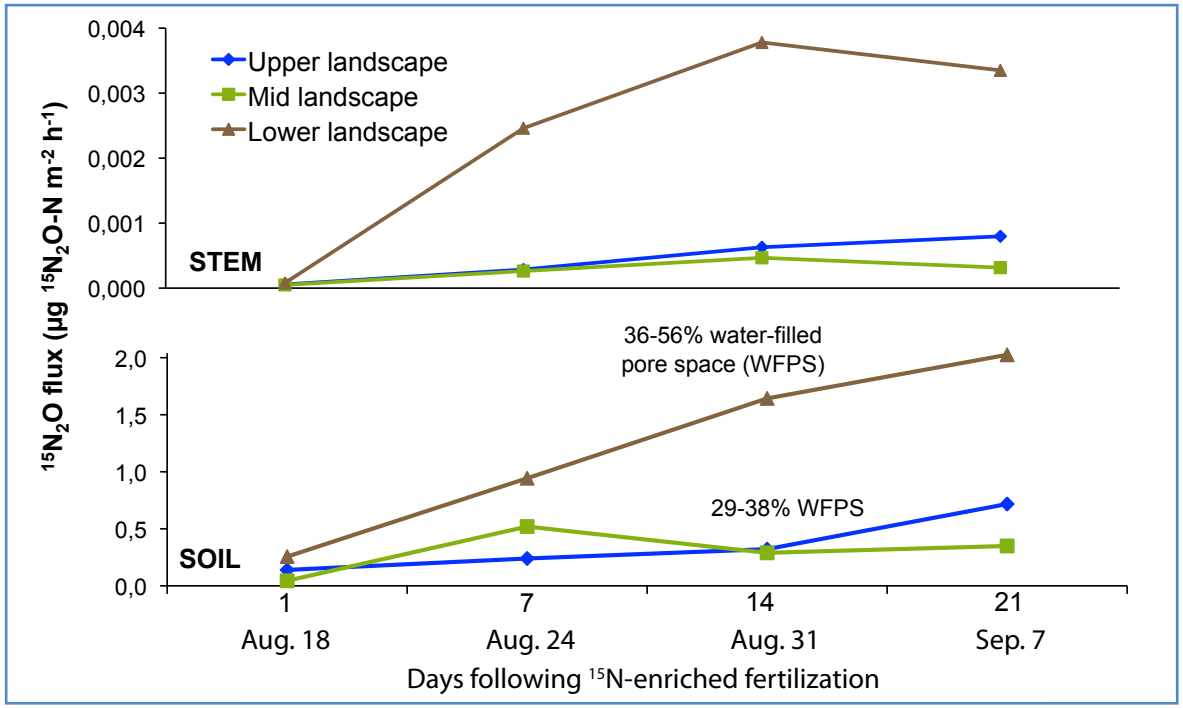

Figure 16. ^{15}N-tracing from the applied fertilizer in the soil to the soil- and stem-emitted $^{15}N_2O$. Application rate per tree was 1 kg urea-N mixed with 53 g $(^{15}NH_4)_2SO_4$ (99% ^{15}N) to get an initial enrichment of 2.8% ^{15}N-mineral N, considering the extant mineral N in the top 5 cm soil of 11 mg N kg^{-1}. This was applied within a band at 0.8-1-m distance from the stem base on Aug. 17, 2015.

the smallholder rubber and oil palm plantations on well-drained and riparian areas, and tree-stem GHG fluxes in the riparian areas. The latter will be presented by J. Koks at the conference in Bali. 4) The mechanism of tree-stem GHG (N_2O) emission was investigated and its contribution to the total (soil + stem) N_2O emissions was quantified from a large-scale oil palm plantation.

We found that in a large-scale oil palm plantation on a well-drained, loam Acrisol soil (which had two to five times N fertilization rate than the smallholder plantations) annual N_2O fluxes were five times larger than the smallholders, 4.88-5.27 kg N_2O-N ha^{-1} yr^{-1}, and oil palm stem emissions contributed 2-9% of these annual fluxes. Tree-stem N_2O fluxes originated from the soil as supported by the: 1) ^{15}N-tracing from the applied fertilizer in the soil to the stem-emitted N_2O (figures 16, 17) decreases in N_2O emissions with stem height (figure 17b), and

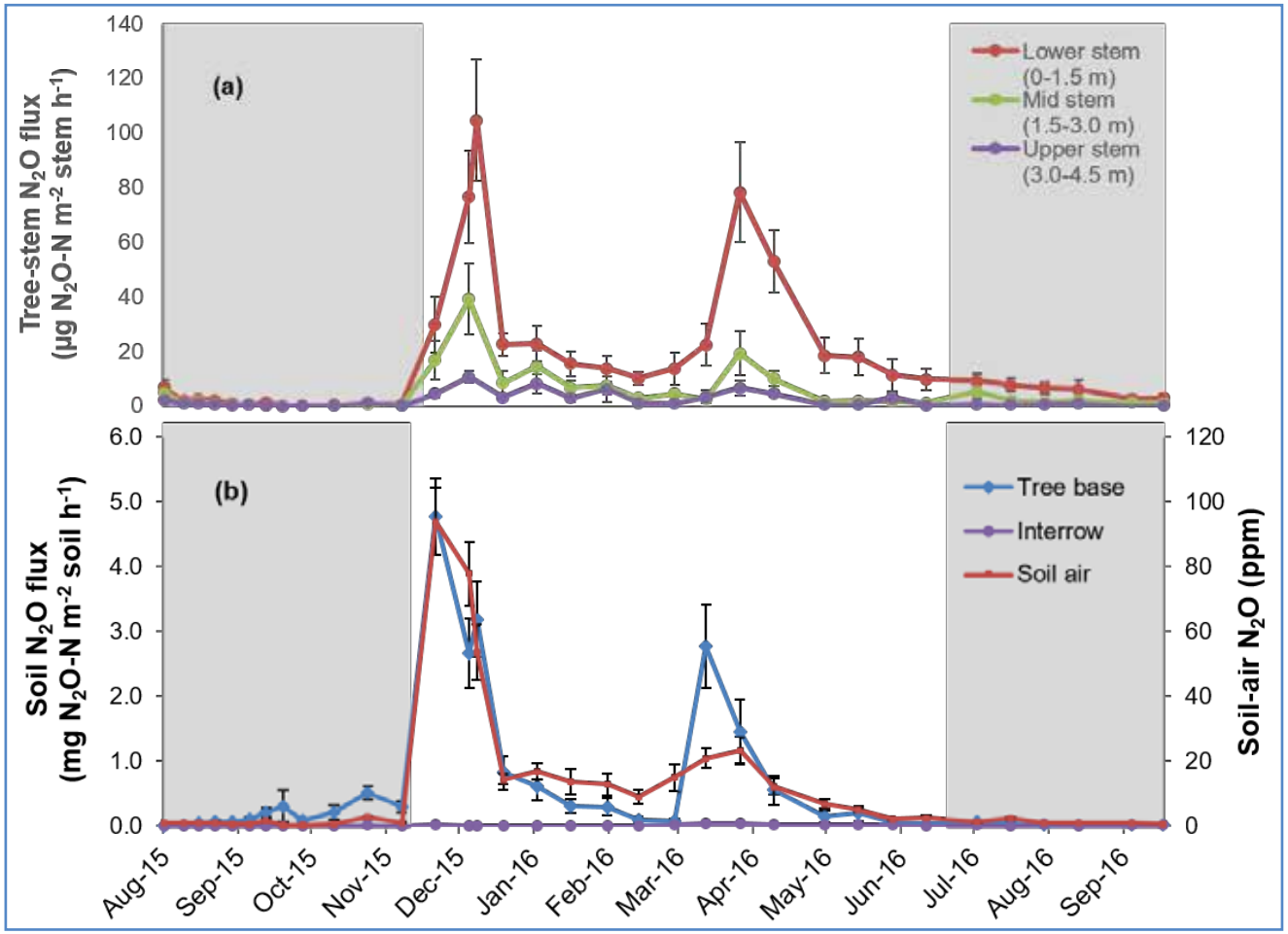

Figure 17. Tree-stem emissions (a) and soil emissions and concentrations (b) of N_2O between Aug 2015 and Sept 2016 from a large-scale oil palm plantation in Jambi, Indonesia. All values are the average (SE bars) of 12 trees on each date, except for inter-rows, which are the average of 3 trees. Gray shading is the dry season.

3) parallel patterns of N_2O fluxes from the stem and soil as well as the soil N_2O concentrations (figure 17b). Details will be presented by A. Matson at the conference in Bali.

Figure 18. The team of A05 in the field. Top left: Joost Koks, Middle left: Amanda L. Matson, Top and middle right: Greta Formaglio & Happy Chandra, Bottom: Edzo Veldkamp, Joost Koks, Somad, Nando Gafar.

A07

TITLE: **Modelling biogeochemical processes in rainforest transformation systems in Sumatra (Indonesia)**

TEAM: Principal Investigators: Alexander Knohl, Edzo Veldkamp (UGoe); Tania June, Surya Tarigan (IPB).
Scientific Staff: Ashehad Ali (Postdoctoral Researcher).
Asscociated Scientists: Yuanchao Fan, Fernando Moyano (Postdoctoral Researchers); Rahmi Ariani (Doctoral Researcher).

RESEARCH SUMMARY:

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 leaf 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 was able to capture the seasonal dynamics of leaf litter-fall (figure 19a), soil respiration (figure 19b), soil moisture (figure 19c) and leaf area index (figure 19d). Further, the CLM-rubber was able to produce the 16% decline in soil carbon since clear-cut, which is close to the observation. Finally, the model was also able to successfully capture the magnitude of the low transpiration. CLM-rubber suggests that constraints from soil are more likely to limit transpiration and productivity than radiation and vapor pressure deficit. Because 99% of rubber plantations in the Jambi Province is owned by smallholders, our findings from the plot-level can be extrapolated at a larger-scale, and thus our results indicate that rubber plantations from Jambi are less likely to have high carbon and water fluxes compared with rubber plantations from other tropical regions.

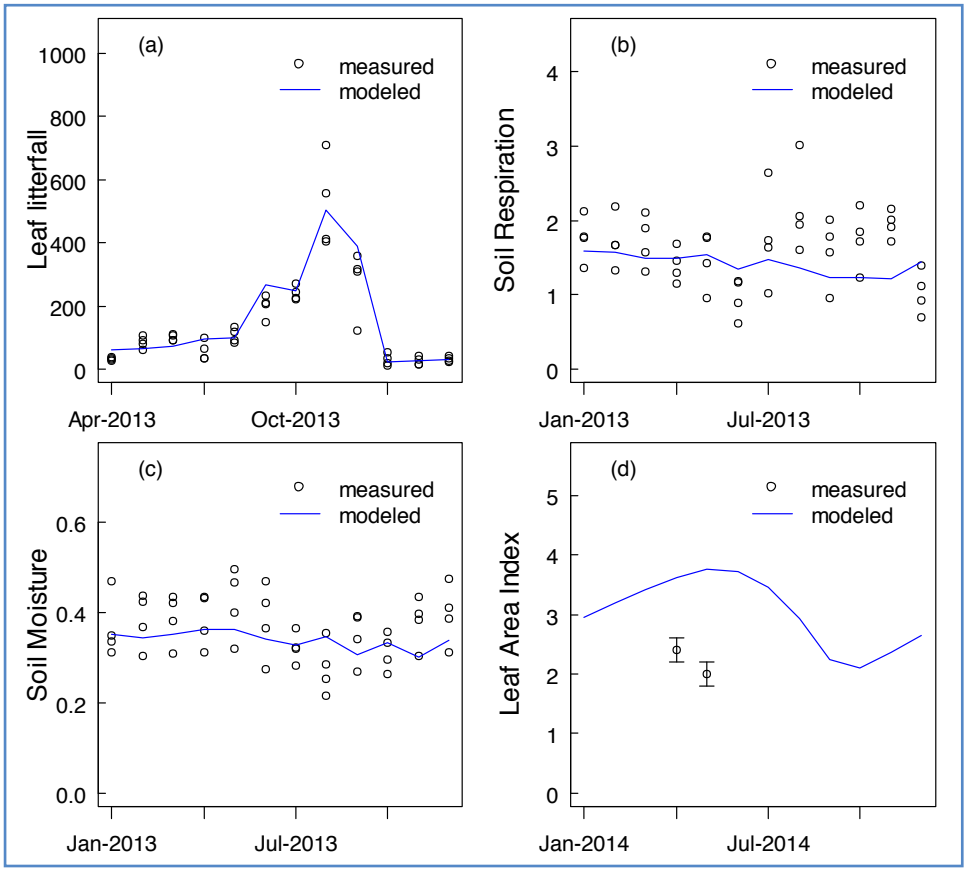

Figure 19. Monthly trends of leaf litter fall ((a); g C m^{-2} yr^{-1}), soil respiration ((b); kg C m^{-2} yr^{-1}), soil moisture ((c); m^3 m^{-3}) and leaf area index ((d); m^2 m^{-2}) of rubber plantation simulated by CLM-rubber (blue line) and observed values (open circles) during the mature phase of growth of rubber. The leaf area index was measured in 2018.

Sauer - assoziiert

TITLE: **Impact of transformation of rainforests into oil-palm plantations on silicon pools in soils – start: 1 march 2018**

TEAM: Principal Investigators: Daniela Sauer, Barbara von der Lühe (UGoe); Suria Tarigan, Arief Hartono (IPB); Aiyen Tjoa (UNTAD).
Scientific Staff: Britta Greenshields (Doctoral Researcher).

RESEARCH SUMMARY:

Our associated project started in March 2018 and the doctoral student Britta Greenshields is in Jambi for field work since the beginning of April. In this study, we aim to quantify the impact of transformation of tropical rainforest to oil palm plantations on the soils Silicon (Si) pools. Oil palms are Si-accumulating plants and thus have a considerable impact on soil-plant Si cycle and plant-available Si in heavily desilificated tropical soils. The currently ongoing fieldwork campaign (April 8th to August 8th 2018) includes the following work in the destruction sites of the plots HO1-4, HOr1-4, HF1-4 and HFr1-4:

1) Classification according to World Reference Base for Soil Resources, horizon-wise sampling of the soil profiles for sequential extraction of silicon (Si).
2) Sampling of top-soils in HO1-4 and HOr1-4 (a) in the weeding circle (b) within oil palm rows (c) under frond piles (d) in the middle of the inter-rows for mobile Si and biogenic Si extraction.
3) installation of surface runoff and erosion traps on HO1-4. The eroded sediment will be analyzed for its phytolith (silica bodies from plant tissues) content.

During our field work, we found that the oil palm plantations at the riparian sites (HOr1-4) are considerably influenced by perched water, as indicated by a strongly developed stagnic color pattern (soil type: Stagnosol) of their sub-soil horizons. In contrast to the slightly sloping land of the plots HO1-4, which prevents strong water stagnation above the clay-illuviated, dense sub-soil horizons of the Acrisols of these plots, the flat topography of alluvial plains and river terraces at the riparian sites results in perched water for some time of the year, especially immediately after flooding. Gleyic color patterns indicate additional influence of groundwater at some depth. After Britta Greenshields retuns from fieldwork, she will conduct Si sequential extractions in the laboratory of the Physical Geography department.

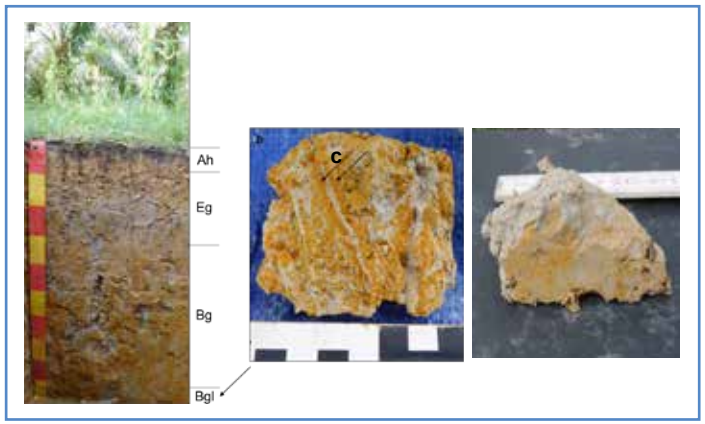

Figure 20. Soil at HOr2: Acric Endogleyic Stagnosols (Loamic, Ochric). (b) Precipitation of iron oxides (ferrihydrite, goethite) preferably along root channels, indicating groundwater influence. (c) Ped with gray, iron oxide depleted surface and mottled inner part (by the iron oxide lepidocrocite), indicating strong influence of perched water for some time of the year.

Figure 21. After field work in HO3 from left: Sofyan, Arif, Nando, Daniela Sauer, Somad, Britta Greenshields.

Group B

FIELDS OF RESEARCH
- Biota and ecosystem services

GROUP COORDINATORS
- Teja Tscharntke, Holger Kreft (UGoe);
- Leti Sundawati (IPB);
- Upik Yelianti (UNJA)

REPRESENTATIVES OF DOCTORAL/ POSTDOCTORAL RESEARCHERS
- Kira Urban (B05)
- Florian Brambach (B06)

B02

TITLE: **How rainforest conversion to agricultural systems on Sumatra (Indonesia) affects active bacterial communities in soil**

TEAM: Principal Investigators: Rolf Daniel (UGoe); Anja Meryandini, Iman Rusmana (IPB); Zulkarnain (UNJA).
Scientific Staff: Dirk Berkelmann (Doctoral Researcher).

RESEARCH SUMMARY:

Prokaryotes are the most abundant and diverse group of microorganisms in soil and mediate virtually all biogeochemical cycles in terrestrial ecosystems. In phase 2 of the project, we aim to analyse entire and active prokaryotic communities regarding rainforest conversion, enrichment of biodiversity and different management systems in oil palm cultures. Sampling took place in May 2017 on all available plots and will be repeated in August 2018 on oil palm management and biodiversity enrichment experiment plots. We analysed the effect of rainforest conversion on active bacterial communities in a RNA based study using 16S rRNA transcripts. Active communities were dominated by *Frankiales (Actinobacteria)*, Subgroup 2 of the *Acidobacteria* and *Alphaproteobacteria* (mainly *Rhizobiales* and *Rhodospirillales*) and showed significant differences in community composition between

Figure 22. ABS - EFForTS scholarship recipient Mazidah Noer Inayah, a doctoral researcher of Prof. Anja Meryandini at IPB, is introduced to the inner city during her stay in Göttingen. Left: Dirk Berkelmann, right: Mazidah Noer Inayah.

agricultural sites compared to rainforest reference sites (see figure 11, newsletter no. 5). Most important abiotic drivers for community formation were pH, Ca, base saturation and C to N ratio. We could also show that rainforest transformation has effects on microbial metabolisms, e.g. nitrogen metabolism and interspecific interactions. We therefore concluded, that rainforest transformation and agricultural management in form of fertilizer application and liming led to a less dynamic active bacterial community, in which less competition for nutrients (due to higher availability by fertilization and liming) occurs and consequently antagonistic behaviour seems to be reduced.

Samples from riparian plots from 2017 are currently used for analysis of endophytic *Actinobacteria* in soils (formerly known as *Actinomycetes*). We successfully extracted and sequenced specific 16S rRNA sequences for these groups with our counterpart from Bogor. Besides analysis based on 16S rRNA transcripts, we also started analysis on full metagenomes extracted from all plots of the land use experiment. We obtained several million sequences in each sample and can confirm that the most abundant taxa are similar to the previous detected taxonomic profile in 16s rRNA transcript analysis (see figure 23). More importantly, it is possible to analyse prokaryotic functionality, which will enable us to further test our hypothesis regarding the impact of rainforest conversion on bacterial functionality.

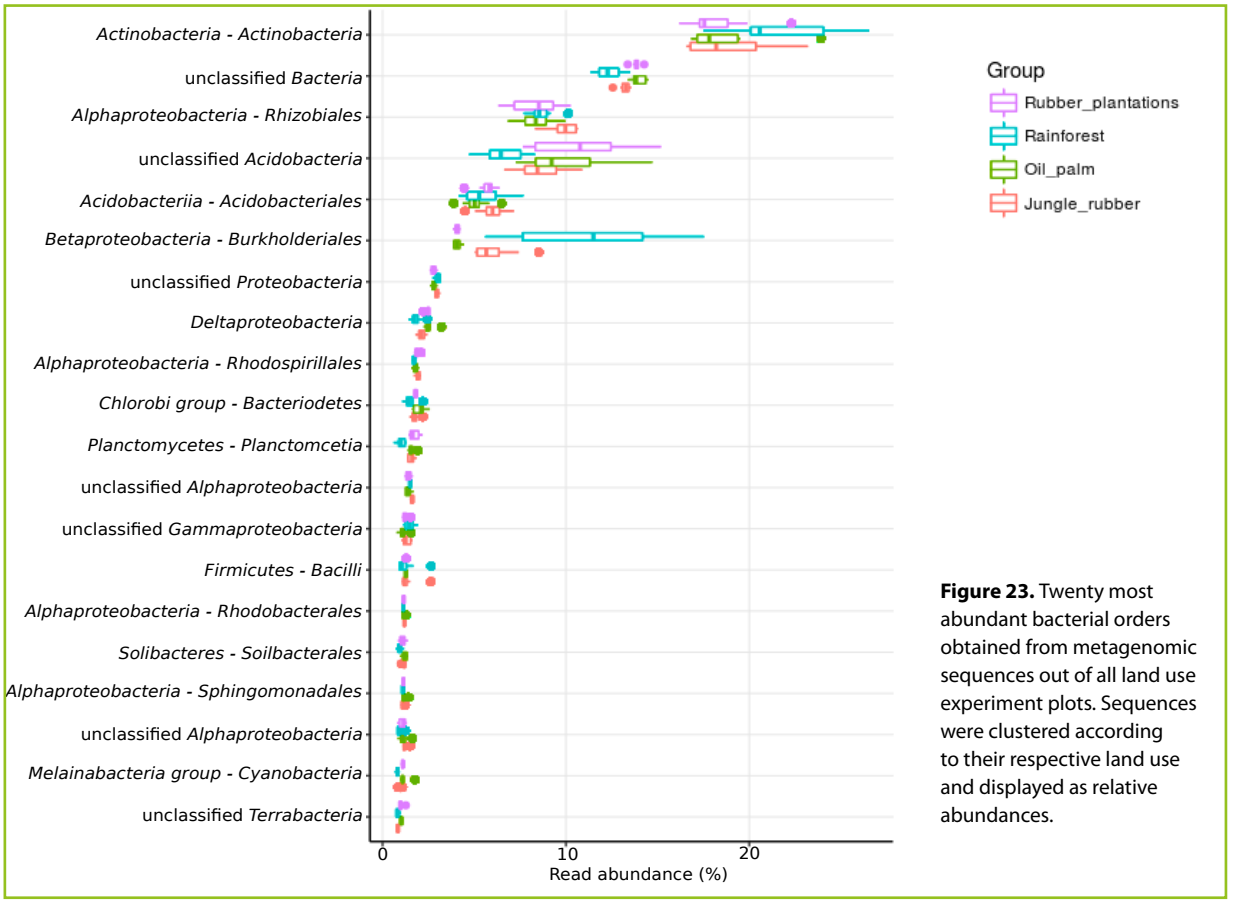

Figure 23. Twenty most abundant bacterial orders obtained from metagenomic sequences out of all land use experiment plots. Sequences were clustered according to their respective land use and displayed as relative abundances.

B04

TITLE: **Diversity of tree hydraulic strategies in intensively used and natural tropical landscapes**

TEAM: Principal Investigators: Christoph Leuschner (UGoe); Triadiati Antono (IPB); Asmadi Saad (UNJA)
Scientific Staff: Pierre-André Waite (Doctoral Researcher)
Associated Scientists: Dietrich Hertel, Bernhard Schuldt.

RESEARCH SUMMARY:
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 lowland 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. In addition, effects of natural landscapes conversion with associated system functions modifications, including hydrological cycle, on systems resistance and resilience to drought periods are poorly understood.

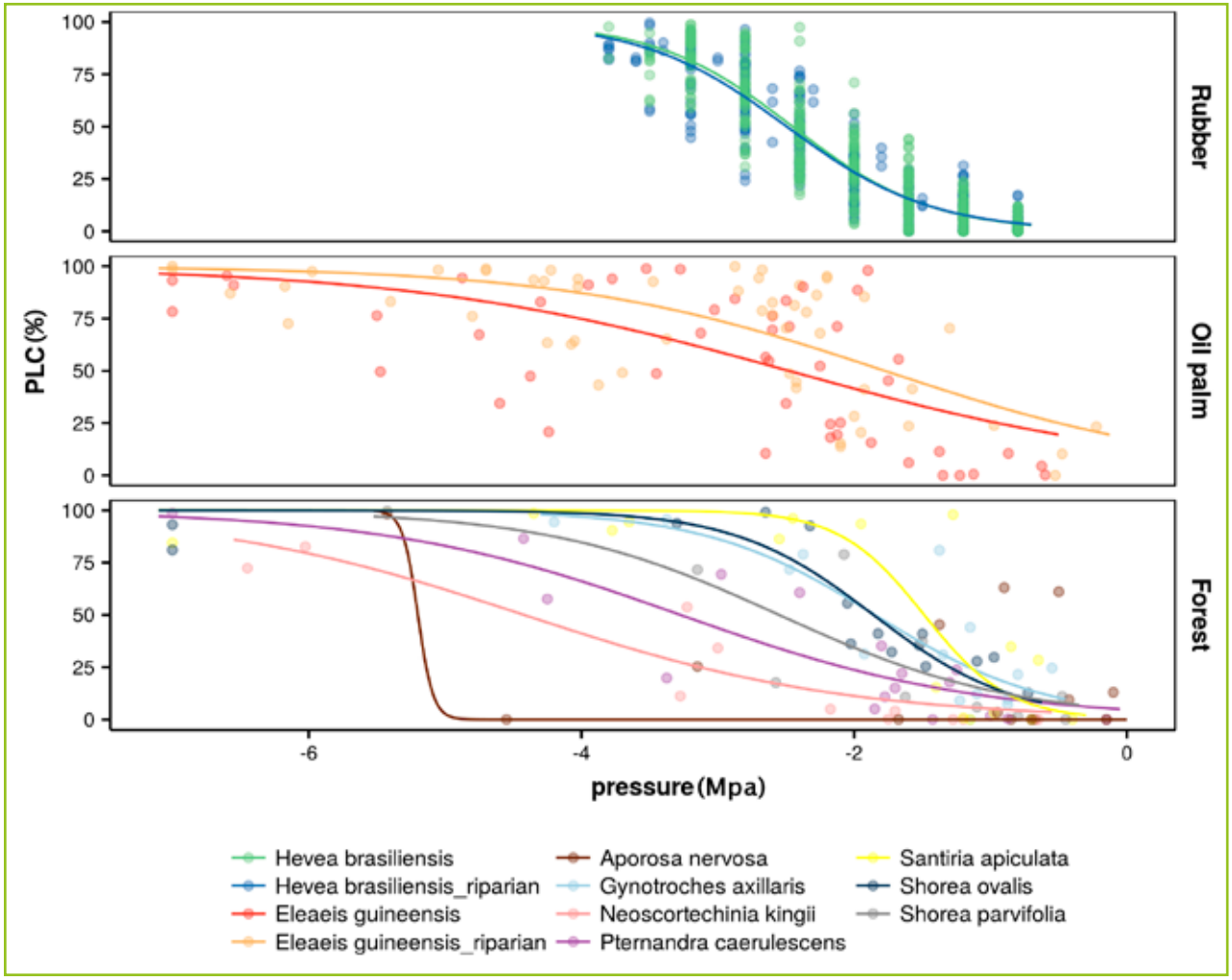

Figure 24. Xylem vulnerability curves of rubber tree, oil palm and 7 forest species.

The aim of the scientific project B04 is to investigate plant sensitivity to drought by studying functional traits related to water transport in different systems in Jambi province: Monocultures of oil palm (*Elaeis guineensis*) and rubber tree (*Hevea brasiliensis*) as well as natural lowland rainforest with an emphasis on the differences

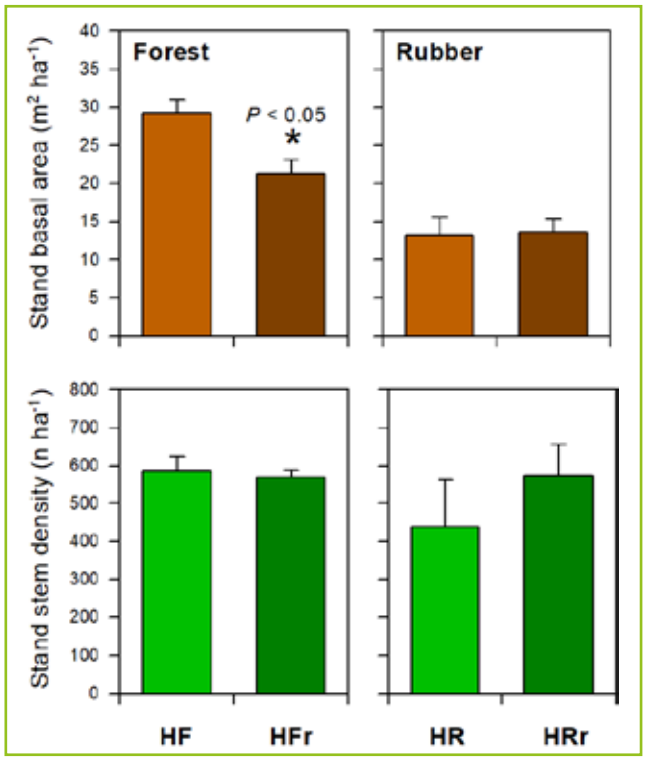

Figure 25. Stand basal area and stem density in Harapan forest and rubber plantation; Differences between well-drained and riparian plots.

Figure 26. Sampling of oil palm fronds in June 2017. From left to right: Rollin (local assistant), Pierre- André Waite (doctoral researcher), Mathilde Millan (master student), Khairul Anwar (local assistant), Syahbarudin (local assistant), Nobon (driver).

between riparian and well-drained plots. During the first two years of the project we measured and calculated multiple traits in all core plots such as tree wood density, stem and branch anatomy- related traits (vessel density per xylem area, theoretical hydraulic conductivity, etc.), leaf- related traits (specific leaf area, turgor loss point, etc.). We also studied the xylem safety against drought-induced hydraulic failure and especially its water potential at 50% loss of conductivity (P_{50}), which is extracted from xylem vulnerability to cavitation curves (figure 24). Those curves and the associated parameters are good indicators of species ability to stand drought events. In addition, to assess hydraulic resistance of the different systems, we aimed to put in relation those traits with annual stem growth increment. Therefore, we measured the Diameter at Breast Height (DBH) of all trees above 10cm stem diameter in CRC plots (forest, jungle rubber & rubber plantations plots of Bukit duabelas and Harapan landscapes) and we are currently measuring 40 trees' DBH per plots every 2-4 months with pre-installed increment tapes (figure 25).
The X-axis represents the percent loss of hydraulic conductance, or water transport capacity, with a maximum of 100% loss (complete hydraulic failure). The y-axis represents leaf negative pressure: The more negative, the more resistant the xylem to cavitation.

B05

TITLE: **Land use patterns in Jambi - quantification of structure, heterogeneity and changes of vegetation and land use as a basis for the explanation of ecological and socioeconomic functions**

TEAM: Principal Investigators: Christoph Kleinn (UGoe); I Nengah Surati Jaya, Tatang Tiryana (IPB); Mohammad Zuhdi, Eva Achmed (UNJA).
Scientific Staff: Lutz Fehrmann (Researcher); Kira Urban (Doctoral Researcher).
Associated Scientist: Edwine Setia Purnama (Doctoral Researcher).

RESEARCH SUMMARY:

The existing official data on land cover and land use change (LULC) from 1990, 2000 and 2013 were produced by visual classification of medium resolution optical satellite imagery (Landsat) which is highly limited by constant cloud cover and issued in suitably distinguishing different transformation systems. However, if analyzed in a spatio-temporal model, these official maps provide indications on the complex land use dynamics in Jambi province over a period of 30 years (figure 27).

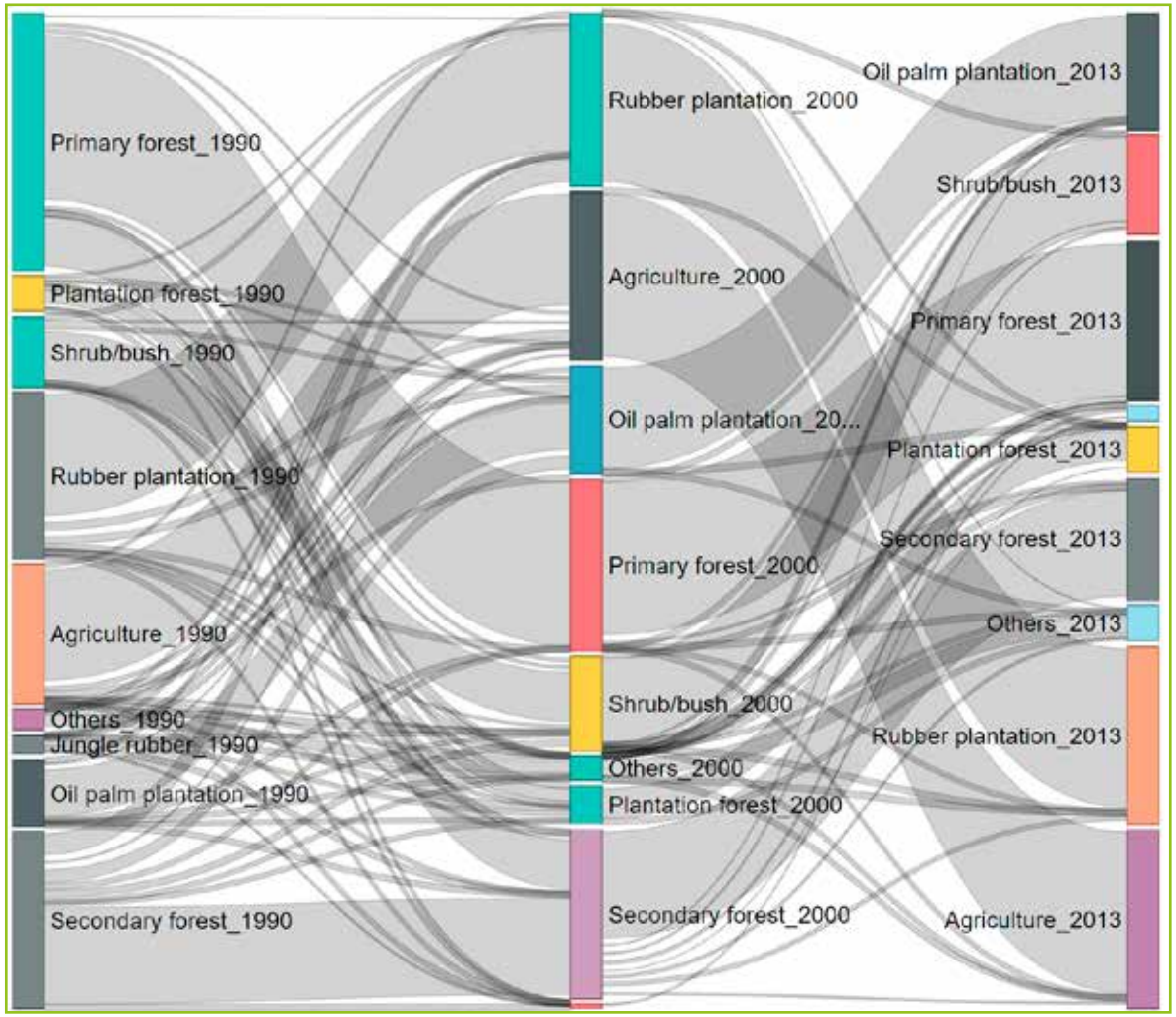

Figure 27. Land use change dynamics from 1990, 2000 to 2013 based on official land use maps.

In order to overcome the problem of unknown quality of the official maps, we implemented a sampling study in high resolution imagery provided by virtual globes (Google Earth, Bing). Land cover and land use was classified for 1009 points over Jambi Province on a systematic grid (7x7 km) using a hierarchical classification key. We complemented the observations by a vector of

terrain and climate data to get insights into drivers and limitations of land use change.

Another ongoing research activity is the analysis of structural complexity of forests. The aim is to distinguish different forest- and/or degradation types based on a combination of remote sensing products. In 2017 a UAV campaign was carried out in Harapan, under which we installed 70 forest inventory plots along 3 gradients of forest structural complexity (figure 28).

From the UAV imagery, we obtained photogram-metric 3D point clouds (figure 29) for which we compute different indices that may then be correlated both to ground-observed complexity and to C-SAR backscatter from Sentinel-1.

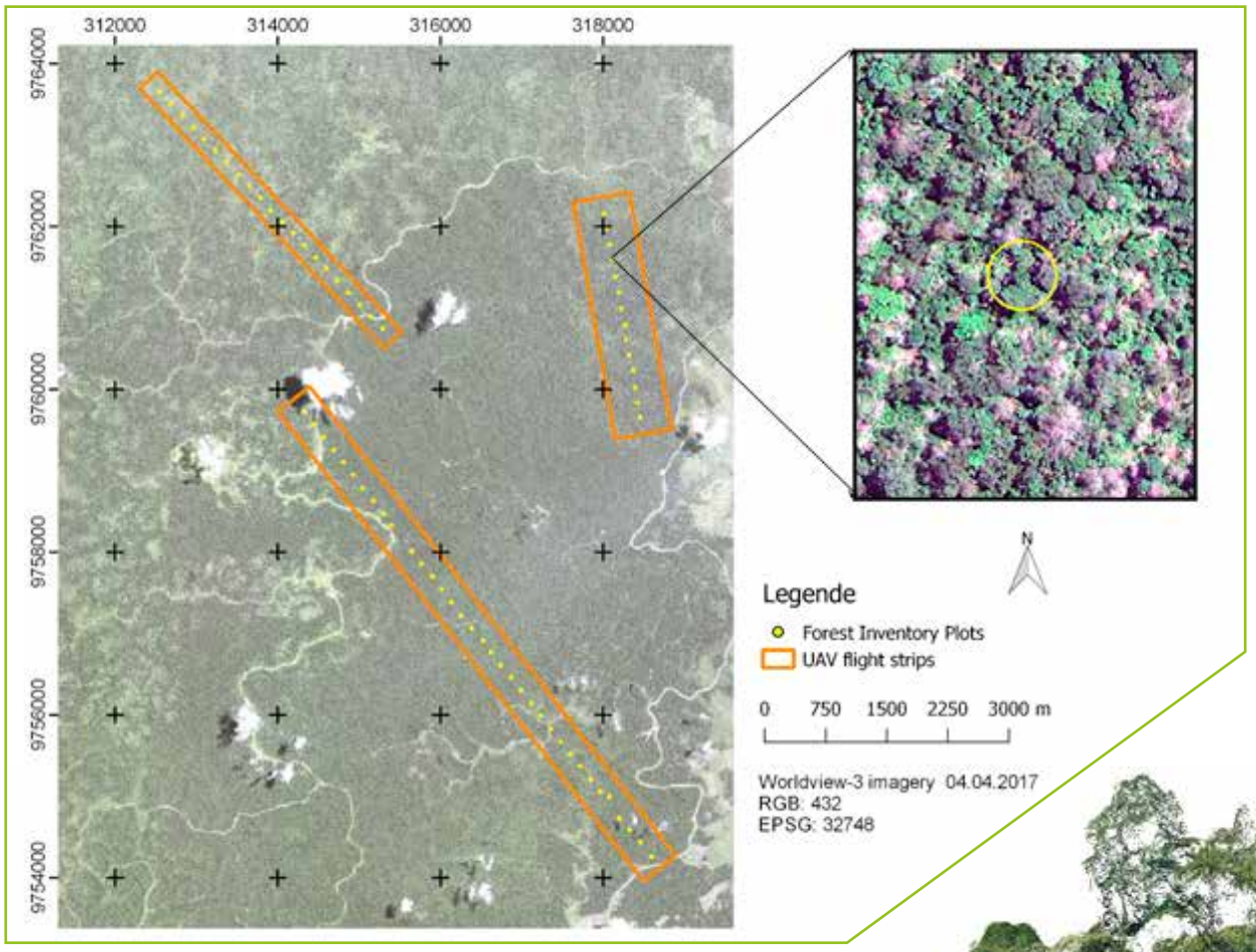

Figure 28. UAV flight strips (red polygons) and filed plots (yellow) along gradients of forest structural complexity.

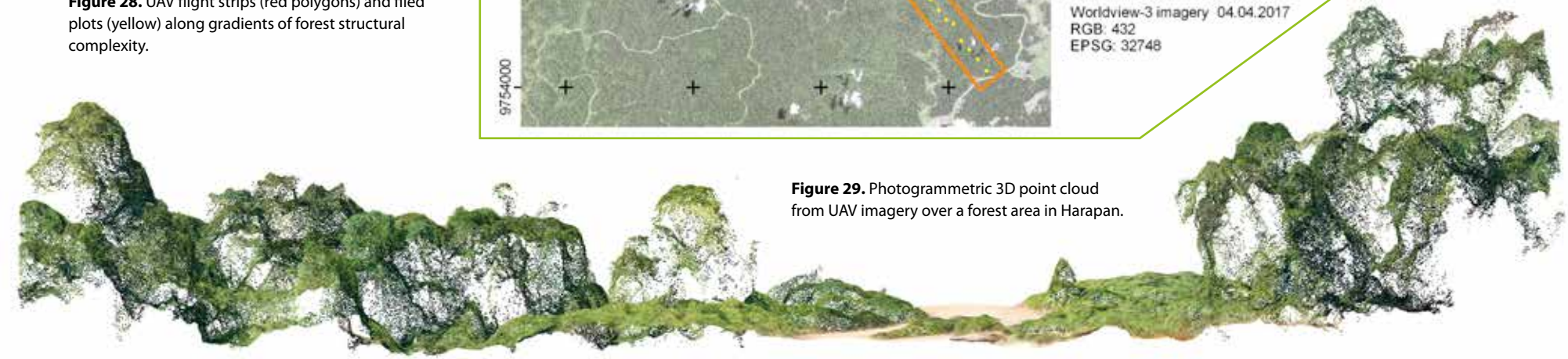

Figure 29. Photogrammetric 3D point cloud from UAV imagery over a forest area in Harapan.

B06

TITLE: **Taxonomic, phylogenetic, functional, and biogeographical diversity of vascular plants in rainforest transformation systems on Sumatra (Indonesia)**

TEAM: Principal Investigators: Holger Kreft (UGoe); Sri Sudarmiyati Tjitrosoedirdjo (IPB); Bambang Hariyadi (UNJA).
Scientific Staff: Fabian Brambach (Postdoctoral Researcher).
Associated Scientist: Katja Rembold.

Figure 30. The B06 team in February 2018 at SEAMEO BIOTROP in Bogor. From left to right: Dirga Shabri Pradana, Fabian Brambach, Dima Meiyandi, Setiabudi, Holger Kreft, Sri Sudarmiyati Tjitrosoedirdjo, Katja Rembold, Nana, Indah Wahyuni, Mei Linda Mardalena. One important change in B06 was that Dr. Katja Rembold (fourth from right) left the project to accept a scientist position at the University and Botanical Garden in Bern (Switzerland). We say goodbye to Katja and thanks her for her valuable work in the past six years. As her successor, we welcome Fabian Brambach (second from left).

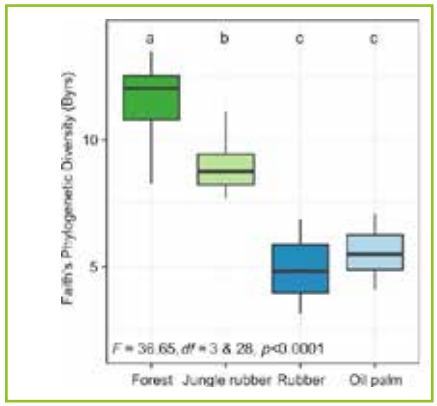

Figure 31. Faith's phylogenetic diversity (measured in Byrs – billions of years) across the four land use systems and a land-use intensity gradient from forest, over jungle rubber to the monocultural plantations of rubber and oil palm. Faith's phylogenetic diversity measures the unique evolutionary history in a given community.

RESEARCH SUMMARY:

The scientific project B06 assesses the effects of land-use changes on different dimensions of plant diversity and vegetation structure. In the second phase, the research focus lies on phylogenetic and functional diversity, and we thereby go beyond comparisons of species diversity and taxonomic composition which were the focus of the first phase (summarized in Rembold et al. 2017, Biological Conservation). To this end, we measured a set of fundamental functional traits (e.g. specific leaf area, wood density, chlorophyll concentration, leaf stoichiometry) in the field and mobilized information about categorical traits like growth form, pollination syndrome or dispersal type from the literature. The aim of this is to investigate how functional diversity and composition changes along the EFForTS land-use gradient. Currently, our two master students Biplabi Bhattarai and Thakur Prasad Magrati are analyzing the trait data for their thesis. Phylogenetic diversity and community structure was analyzed in a recent paper led by our Indonesian Master students Yayan Kusuma (Kusuma et al. 2008, Journal of Applied Ecology). In this study, we analyzed 1,197 species of vascular plants, and 146,599 plant individuals occurring with the 32 EFForTS upland plots. All species were placed in a megaphylogeny of vascular plants. The results showed that forest conversion into agricultural systems led to a pronounced loss of phylogenetic diversity and evolutionary history (figure 31). Compared to forest, phylogenetic diversity was reduced by almost 50% in the monocultural oil palm and rubber plantations, while high levels of diversity were maintained in jungle rubber agroforests. We also detected shifts in phylogenetic community structure from clustered (i.e. species are more closely related than by chance) in forest to overdispersed (less closely related than expected) phylogenetic community structure in the plantations. These trends were partly explained by non-native plant species, which are particularly abundant in oil palm plantations.

Recent and ongoing field work focuses on completing the remaining riparian forest plots, a resampling of all trees, leaf area index and canopy openness.

B07

TITLE: **Impact of tropical land transformation on root and soil associated fungal communities**

TEAM: Principal Investigators: Andrea Polle (UGoe); Sri Wilarso Budi (IPB); Bambang Irawan, Upik Yelanti (UNJA); Henry Barus (UNTAD).
Scientific Staff: Johannes Ballauff (Doctoral Researcher).
Associated Scientists: Rodica Pena (Scientist, UGoe), Nur Edy (Postdoctoral Researcher), Rachmawaty Aisjah Ryadin (Doctoral Researcher).

RESEARCH SUMMARY:

The interaction of plants and soil fungi at the level of fine root rhizosphere provides a key link between above and belowground ecosystem. Saprotrophic decomposition of plant material as well as numerous biotrophic interactions facilitate carbon and nitrogen turnover. For example the Glomeromycota form arbuscular mycorrhiza (AM) in a majority of land plants. This mutualistic interaction provides the host plant with soil nutrients like nitrogen and phosphate while the fungus acquires carbon from the plant. We are investigating the effects of land-use systems and altered plantation management on the soil fungal community as well as the communities in direct contact with plant roots. Results from phase one indicate that conversion of lowland rainforest to monoculture plantations typically results in loss of associated taxa and changes in fungal community structures. We hypothesize that these shifts are linked to reduced fine root and soil carbon content in plantation as the consequence of land transformation. Further, we test whether interaction type and quantity of AM colonization is linked to land-use type and management of oil palm plantations. Root and soil samples were taken in all core- and riparian plots as well as in the enrichment and management experiments. We analyze the fungal communities in all compartments, using next generation sequencing. Further, the vitality, chemical composition and AM colonization rates of fine roots are being investigated (figure 32). In line with our results from the previous phase we observed strong compositional changes of fungal communities due to land-use changes which caused a decline in the abundance of symbiotrophic fungi and increased abundance of saprotrophic and pathogenic fungi in plantation sites. These changes were correlated with altered fine root chemical traits, decline in root tip vitality and shifts in mycorrhizal interaction types. 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.

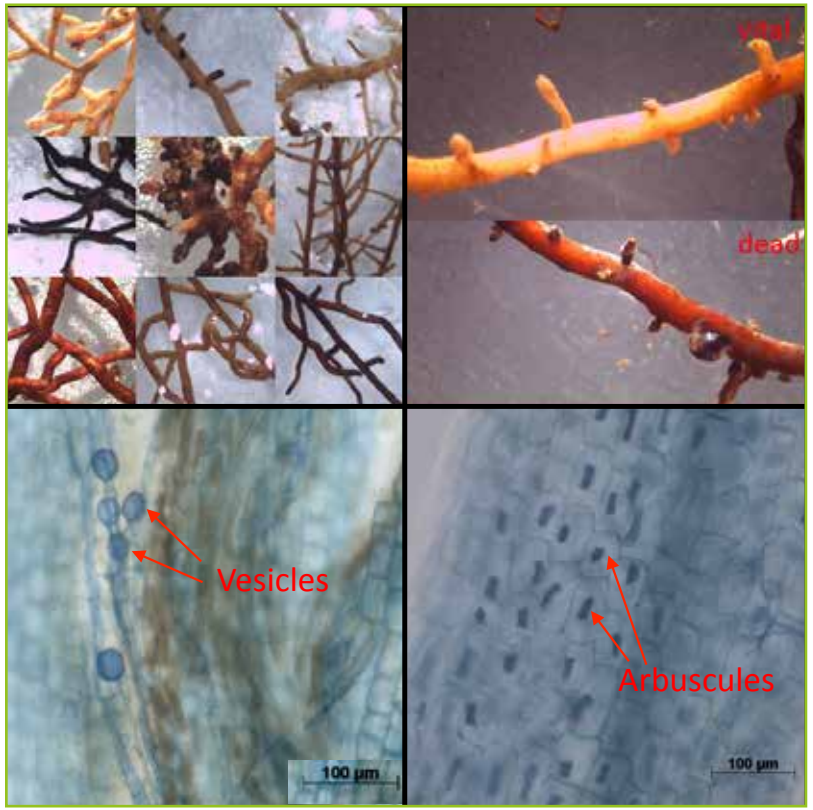

Figure 32. Fine roots of the forest community (top left) and oil palm (top right). Bottom: Two microscopic images of fine roots colonized by arbuscular mycorrhizal fungi. Fungal tissue was stained blue using an acidified ink solution.

B08

TITLE: **Structure and functioning of the decomposer system in tropical lowland rainforest transformation systems**

TEAM: Principal Investigators: Stefan Scheu (UGoe); Rahayu Widyastuti (IPB).
Scientific Staff: Anton Potapov, Valentyna Krashevska (Postdoctoral Researchers).
Associated Scientists: Danilo Harms, Bernhard Hausdorf, Martin Husemann, Matthias Waltert (Scientists), Dorothee Sandmann, Garvin Schulz, Winda Ika Susanti (Doctoral Researchers).

RESEARCH SUMMARY:

Subproject B08 focuses on belowground animal diversity and interactions in soil food webs. Further, ecosystem functions associated with the belowground system are investigated, such as litter decomposition. In 2017 and 2018 the project team continued with the analysis of soil animal species using morphological and genetic approaches. The data on species traits and pictures currently is being integrated into 'Ecotaxonomy database', providing identification keys for species and (undescribed) morphospecies. Collaboration with Hamburg Museum and specialists around the world resulted in published or submitted manuscripts describing new species of spiders, centipedes as well as gamasid and oribatid mites. The research team is working on an array of taxonomic groups focusing on Oribatida, Mesostigmata, Collembola, Pseudoscorpiones and Araneida.

Figure 33. B08 research team and collaborators at the CRC 990 / EFForTS meeting in Hann. Münden (November 2017). Front (left to right): Valentyna Krashevska, Winda Ika Susanti, Rahayu Widyastuti, Damayanti Buchori; back (left to right): Purnama Hidayat, Danilo Harms, Di Ajeng Prameswari, Anton Potapov, Dorothee Sandmann, Jochen Drescher, Stefan Scheu.

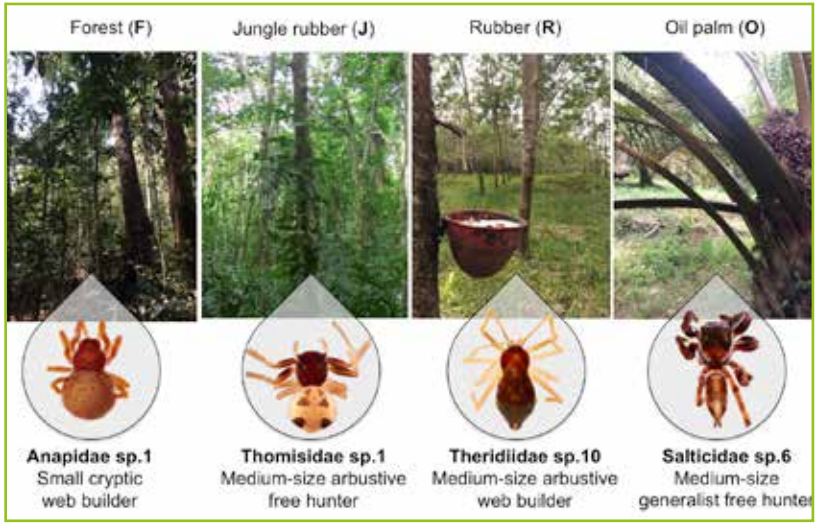

Figure 34. Examples of spider morphospecies found in different land-use systems.

The large data set from the 2013 sampling was compiled and analyzed, and the first synthesis study on biomass and size spectra of soil meso- and macrofauna in tropical ecosystems has been submitted for publication. Further, a manuscript on the response of spiders to rainforest conversion has been submitted for publication exploring the turnover of species and functional traits in soil- and litter-associated spider communities (figure 34). Shift of food resources with conversion of rainforest into plantation systems was studied with fatty acid analysis and now is being prepared for publication. The below- and aboveground micro- and mesofauna of oil palm plantations was investigated using samples of suspended soil from oil palm stems. Among collaboration activities, the decomposition of litter and abundance of functional groups of soil meso- and macrofauna were studied in the framework of the Enrichment Experiment (B11). The community composition of protists and nematodes in core plots vs. riparian sites is investigated using Next Generation Sequencing in collaboration with B02 and B07.

B09

TITLE: **Aboveground patterns of biodiversity and associated ecosystem functions across tropical rainforest transformations systems**

TEAM: Principal Investigators: Teja Tscharntke, Ingo Grass (UGoe); Damayanti Buchori, Yeni Mulyani, Rika Raffiudin (IPB); Fuad Nurdiansyah (UNJA); Dewi Malia Prawirdilaga (LIPI).
Scientific Staff: Kevin Darras (Postdoctoral Researcher), Kevin Li (Doctoral Researcher).

RESEARCH SUMMARY:

Kevin Li completed data collection for a series of projects set in the B11 enrichment plots that focused on the effects of enrichment on pollinator insects. We sampled insect diversity and abundance within the plots and outside and collected pollen off of a subset of insect samples to build pollination networks. We also looked at pollination ecosystem service using phytometer chili pepper plants placed throughout the plots, and for some plots, placed 15 m outside to look at spillover effects. We have also started two projects with Master's students Sonja Schroeck and Jonathan Fung, who will be working on Kevin Li's projects. Sonja will be monitoring colonies of the stingless bee *Tetragonula laeviceps*, placed in a subset of the bird survey landscape sites in forest, shrub, rubber, and oil palm plantations that have a gradient of increasing forest/shrub area in their surroundings. Colonies were installed in July and will be monitored until February 2019. Sonja will monitor bee activity and nest growth, as well as sample insect pollinator diversity at each site.

Jonathan will conduct exclusion experiments on a smallholder oil palm plot to investigate the contributions of different-sized insects to yield. Oil palm is pollinated by a small introduced African weevil, *Elaeidobius kamerunicus*. By excluding larger pollinators, we hope to quantify the role these other pollinators play, through measuring the yield shortfall. Jonathan will also sample oil palm female inflorescence visitors using camera traps and sticky traps.

In 2017, Kevin Darras conducted a large bird and bat mist netting survey, sampling all upland and riparian plots of the Harapan landscape with a team of up to 12 ornithologists, chiropterologists, and field assistants. We collected their feces to identify arthropods, seeds and pollen within, and to construct consumer-resource networks (figure 36).

A methodological bat point count study is ongoing where we use thermal and night vision alongside ultrasound sound recording to detect and identify bats in forest and oil palm sites. An additional taxonomical study, led by MSc Ellena Yusti, focuses on the capture, identification and description of *Hypsugo macrotis*.

Our full-spectrum recordings are ongoing in all core and jungle rubber plots of both landscapes to sample birds and bats. We have also chosen 20 candidate plot pairs in oil palm and forest to survey aquatic arthropods in the Bukit 12 landscape. Crustaceans will be covered by our partner MSc Tia Wulandari (UNJA).

Figure 35. Team of Kevin Li, from left to right: Rosmalia Mareta, Juwita Sri Maranatha, Nurman Marbun, Davig Warisman, Avis Mellivera, Ade Maissy Riany, Fahrurrozi and Kevin Li.

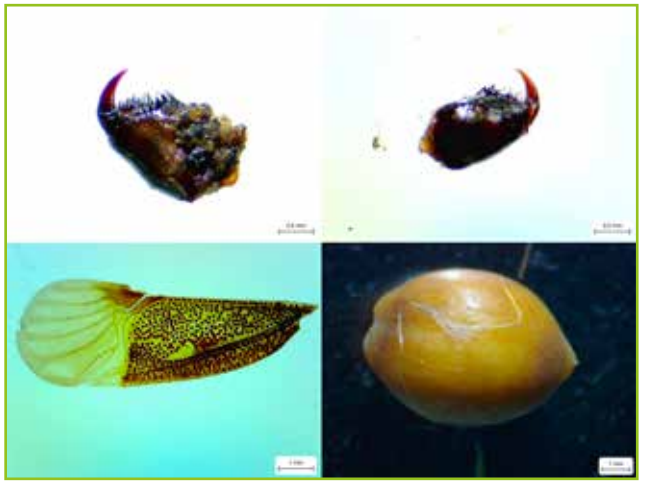

Figure 36. Insect parts and plant seeds contained within fecal samples from birds.

B10

TITLE: **Landscape-level assessment of ecological and socio-economic functions of rainforest transformation systems**

TEAM: Principal Investigators: Kerstin Wiegand (UGoe); Jann Lay (GIGA Hamburg); Surya Tarigan (IPB); Fuad Nurdiansyah, Sunarti, Maria Ulfa (UNJA).
Scientific Staff: Sebastian Renner (Postdoctoral Researchers, GIGA); Jan Salecker (Doctoral Researcher.
Associated Scientists: Craig Simpkins (Postdoctoral Researcher).

RESEARCH SUMMARY:
The main task of the B10 subproject is the development and analysis of EFForTS-ABM, an agent-based ecological-economic land-use change model with focus on smallholder oil palm and rubber farming. The economic submodel simulates smallholder land-use management decisions based on a profit maximization approach. Each household determines factor inputs for all household fields and decides about land-use change based on available wealth. The current model version incorporates heterogeneous farming inefficiencies and learning via social networks. The ecological submodel accounts for carbon sequestration in above-and below-ground vegetation.

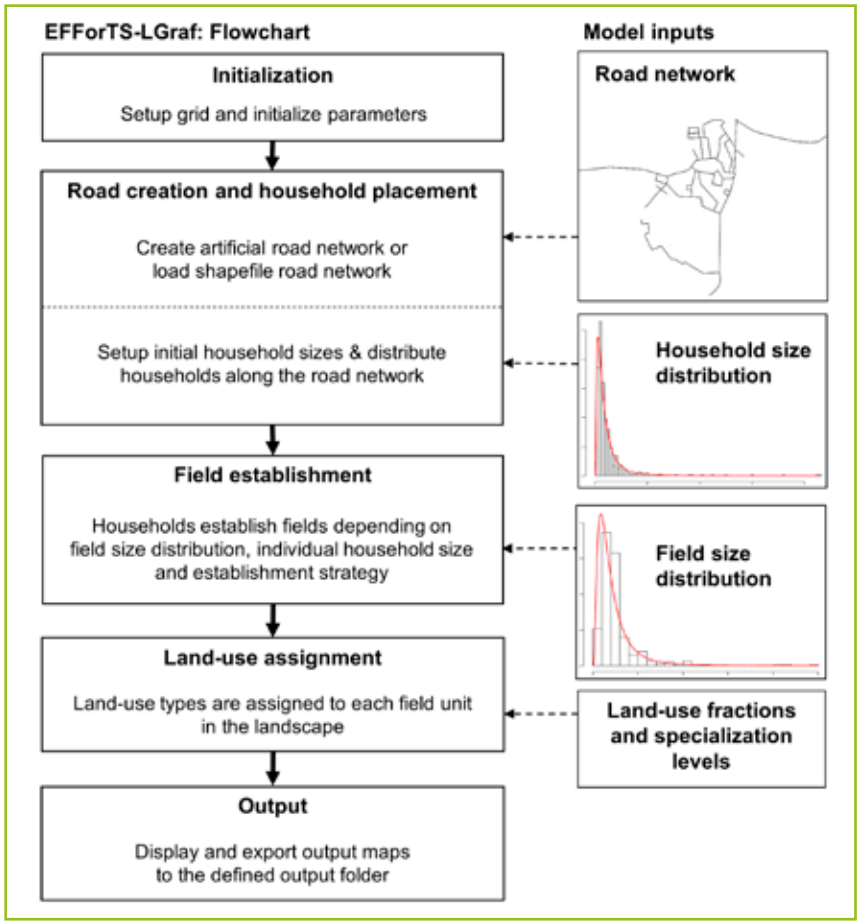

Figure 37. Model flowchart of the landscape generator EFForTS-LGraf. By coupling spatial road patterns and empirical household data, the model generates artificial land-use maps featuring pre-defined landscape characteristics. The resulting maps allow assignment of household individuals to agricultural fields, an information which cannot be obtained from remote-sensing land-use classifications.

Currently we work on model extensions on both submodels to answer more specific questions on trade-offs and synergies in economic benefit and landscape biodiversity.
We are working on a simple land market module, that accounts for consolidation and migration dynamics. We will also implement fallows as an additional land-use option for farmers that are not able to gain profit by harvesting their fields (due to output prices or inefficiencies). Furthermore, we focus on integrating biodiversity measures into EFForTS-ABM. Currently, we develop statistical models for alpha- and beta-biodiversity within Focus 2 and Focus 3 project groups. These models are driven by environmental conditions and will be used to extrapolate species richness from single cells to the whole model landscape via optimization algorithms.
Moreover, we are working on refinement and publication of our individual-based landscape generator EFForTS-LGraf (see fig-

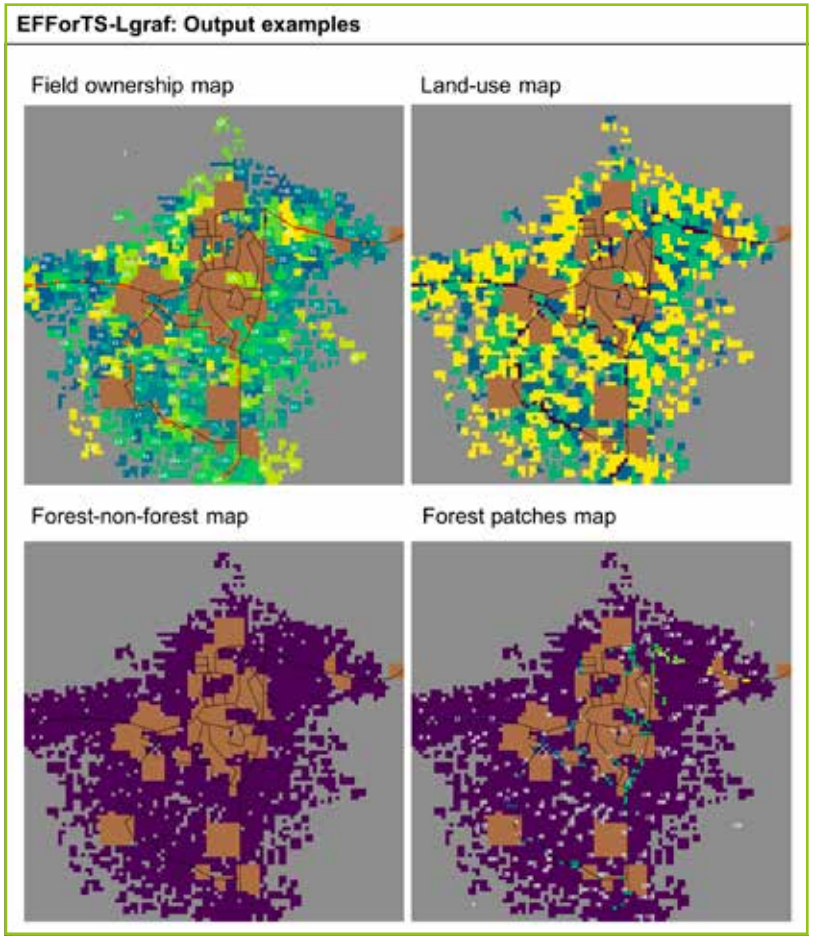

Figure 38. Map output examples produced by the landscape generator EFForTS-LGraf. The individual-based approach enables output with information on household level, such as field ownership and land-use maps. EFForTS-LGraf can also generate maps with information on habitat distribution or habitat fragmentation. Grey cells represent forest matrix, brown cells indicate inaccessible areas such as large plantations and black lines indicate roads (all maps). On the field ownership map clusters of cells with equal shade represent fields that belong to one household (upper left). On the land-use map colors represent three different land uses (upper right). On the forest patches map forest clusters are indicated by a color gradient (lower right).

ures 37, 38). Currently, we implement village structures featuring empirical-based distributions of transmigrant and local smallholder farmer fractions. Within EFForTS-ABM this additional information helps us to refine inefficiency and learning dynamics. Once published, EFForTS-LGraf may also be useful for other groups that are interested in dynamic creation of artificial landscapes with specific characteristics in a spatially-explicit environment.

B13

TITLE: **Impact of management intensity and tree enrichment of oil palm plantations on below- and aboveground invertebrates in Sumatra (Indonesia)**

TEAM: Principal Investigators: Mark Maraun (UGoe); Noor Farikhah Haneda (IPB); Marsetyo (UNTAD).
Scientific Staff: Alena Krause (Doctoral Researcher).

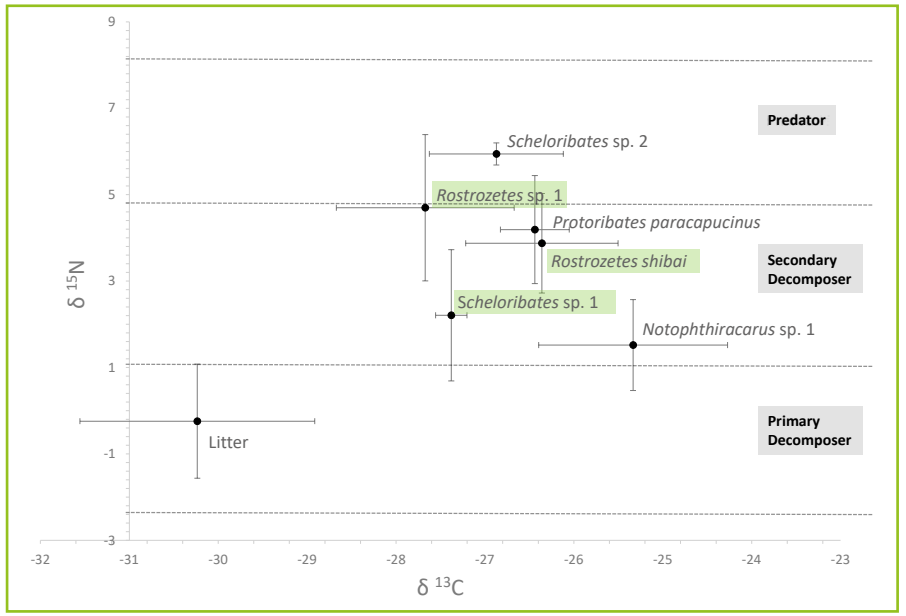

Figure 39. 1 Stable isotope (^{15}N; ^{13}C) data of investigated oribatid mite species (*Notophthiracarus* sp., *Protoribates paracapucinus*, *Scheloribates* sp. 1, *Scheloribates* sp. 2, *Rostrozetes shibai* and *Rostrozetes* sp. 1) from the four land use types and the two landscapes Bukit Duabelas and Harapan. Species highlighted in green are thropically plastic.

RESEARCH SUMMARY:

We investigated the effect of low and high fertilizer treatments, and also of low and high pesticide treatments in oil palm plantation on belowground invertebrate animal communities and their trophic ecology. We hypothesized that the different aboveground treatments will not infect density, diversity and complexity of belowground invertebrate communities.

Stable isotopes (^{15}N; ^{13}C) of oribatid mites were measured. Samples were been taken in October and November 2013 from two study regions, i.e. Bukit Duabelas and Harapan landscape. Within these study regions four systems were investigated (rainforest, jungle rubber, rubber and oil palm). We choose six oribatid mite species (*Notophthiracarus* sp., *Protoribates paracapucinus*, *Scheloribates* sp. 1, *Scheloribates* sp. 2, *Rostrozetes shibai* and *Rostrozetes* sp. 1) which occurred in all landscapes and booth regions as well as 80% of all occurring species in the different 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 (figure 39).

B14

TITLE: **The use of barcoding sequences for the construction of community phylogenies to estimate phylogenetic and functional diversity and their linkages (– Start 1 June 2018)**

TEAM: Principal Investigators: Oliver Gailing (UGoe); Iskandar Z. Siregar (IPB); Bambang Irawan (UNJA).

Scientific Staff: Carina Carneiro de Melo Moura (Postdoctoral Researcher).

PROJECT SUMMARY:

Transformation of forests into intensively managed systems results in a significant loss of biodiversity (Bohnert et al., 2016, Drescher et al., 2016, Rembold et al., 2017), which is associated with ecosystem function (biodiversity-ecosystem function, BEF) (Midgley 2012). However, this association is only partly understood from a small number of ecosystems studied. Loss in biodiversity is expected to have the strongest effect on ecosystem function, if it affects species that have different functional traits important for ecosystem function, and if these traits are strongly phylogenetically conserved. Under these premises, data on phylogenetic and taxonomic biodiversity can provide important additional information to estimate functional diversity and assess the effects of species loss and turnover on ecosystem function. As part of the Central Scientific Service Project Z02, a large number of barcoding sequences are being generated for plant, animal and fungal species. The availability of these sequence data provides the unique opportunity to construct community phylogenies to derive accurate estimates of phylogenetic diversity and its association with functional diversity. This kind of detailed DNA barcoding information with a wide coverage across taxonomic groups and land-use systems is probably unprecedented for the tropics. Additionally, we will test for signatures of coevolution between plants and associated mycorrhizal fungi. We expect that these signatures are most pronounced in undisturbed forest systems. The knowledge on co-evolutionary relationships will help to predict the effects of land transformation on biodiversity and ecosystem function.

Specifically, we propose to (1) analyze the relationship between functional and phylogenetic diversity to test whether basic ecosystem functions can be retained under low diversity across land-use systems (cooperation with Kreft, B06), (2) the effect of alien species on phylogenetic, taxonomic and functional diversity, and (3) the relationship between plant biodiversity and diversity of associated organisms (mycorrhizal fungi, microbes, soil animals) in different land-use systems (in cooperation with SPs Polle (B07), Daniel (B02), and Scheu (B08)).

Group C

FIELDS OF RESEARCH
- Human dimensions

GROUP COORDINATORS
- Meike Wollni, Heiko Faust (UGoe);
- Nunung Nuryartono (IPB);
- Rosyani (UNJA)

REPRESENTATIVES OF DOCTORAL/ POSTDOCTORAL RESEARCHERS
- Fenna Otten (C02)
- Nadjia Mehraban (C07)

C01

TITLE: **Smallholder efficiency**

TEAM: Principal Investigators: Bernhard Brümmer (UGoe); Rina Oktaviani (*R.I.P.), Dedi Budiman Hakim (IPB); Zulkifli Alamsyah, Mira Herlambang (UNJA).
Scientific Staff: Rakhma Sujarwo (Ella), Bernhard Dalheimer (Doctoral Researcher).
Associated Scientists: Thomas Kopp (Postdoctoral Researcher).

*All C01 members deeply mourn the loss of Rina Oktaviani, who passed away unexpectedly in 2018. Thanks for the wonderful collaboration, Rina, we will always keep you and your contributions to our team in good memories.

RESEARCH SUMMARY:

The analysis of environmental efficiency of smallholder rubber producers has been extended from a cross sectional analysis to a first panel based on two survey waves, which allows for first insights into the dynamics of rubber production and the associated environmental effects for 2012 and 2015. Results point towards a contraction of rubber production, which has been induced by a dramatic drop of rubber prices by more than 50% over this period (figure 43). Farmers have reduced input intensity, most notably agrochemicals and labor. While doing so, the trade-off relation between rubber output and loss of biodiversity has become less costly. That is, rubber production, while lower than in the past, has been observed to exert less pressure on biodiversity than in the past on a per unit basis (figure 42). This underlines the role that international prices play not only for farmers' marketed output but also for the environmental effects of production activities.
A third round of data will be collected in 2018 and subsequently included in both technical as well as environmental efficiency analysis. The main objectives are to further determine the dynamics of farm performance and the interplay of that with international price developments, as well as pinning down the exact drivers on the farm input side, which eventually are triggering changes in efficiency over time in practical terms. In particular, hints towards overuse of fertilizer, as found in the first batch of data, shall be subject to a dynamic analysis.
The environmental efficiency analysis has been extended from the examination of biodiversity indicators to the assessment of soil quality parameters. It has been found that degradation induced by land-use change has affected production. Firstly, farmers adjust fertilizer use in accordance with soil carbon (C) content and secondly, production on peat soil and degraded land exhibit substantially lower technical efficiency. Inefficiency effects in smallholder rubber production are marginally decreasing with the level of C-content up to a certain threshold, whereas technical efficiency

in palm oil suffers linearly from C content in soils.

Both biodiversity indicators as well as soil quality parameters from the second round of data collection are now being compiled in order to assess the dynamics of environmental efficiency. Particular attention is paid to the determinants of efficiency changes over time. Furthermore, technical efficiency scores over time are estimated and their performance is evaluated. In both research focuses, the substantial differences in productivity and efficiency between transmigrant and autochthon farmers as well as their development over time are also of particular interest.

Market malfunctioning and efficiency

Concerning the analysis of rubber markets, it has been found that efforts of the International Tripartite Rubber Council (ITRC) have been largely ineffective in steering both international as well as local rubber prices. Policy interventions, which include plantation area regulation, trade restrictions as well as monitoring activities, have been poorly implement as well as experienced insufficient compliance by the member countries Indonesia, Malaysia and Thailand (figure 41). A multivariate time series analysis, in which both long and short-term policy impacts have been assessed, revealed no significant policy shocks to the relevant price data series.

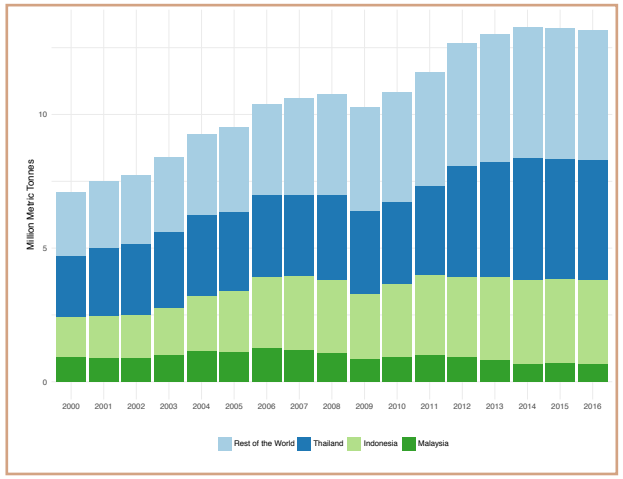

Figure 40. Global and TRC natural rubber production by year (Source: FAO, 2017)

A further aspect with great relevance for rubber price determination in Jambi is the structure of the international rubber market. The exact mechanisms which drives natural rubber prices, in particular the interlinkages with synthetic rubber and crude oil prices, is not well known in the existing literature. In a multivariate price transmission analysis, we will identify the core price linkages, with a special view towards the policy interventions of the Tripartite Rubber Council (ITRC), which is composed of Indonesia, Malaysia and Thailand (figure 40). We analyze these interventions in terms of their effectiveness to influence prices along the supply chain – from the forests to the tires. We find that the TRC has been only semi successful in influencing the international price. Possible causes include non-compliance of the member countries.

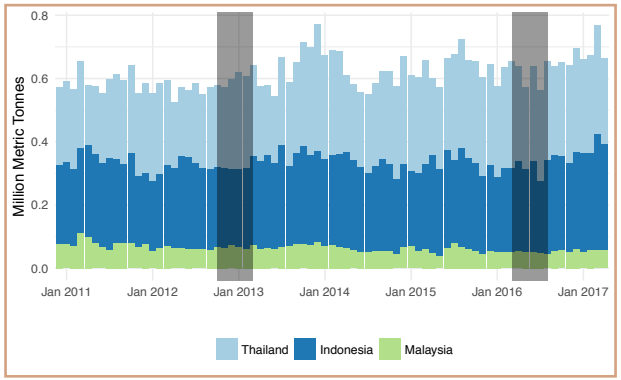

Figure 41. TRC monthly exports of natural rubber from 2011 to 2017 and active export restricted periods (Source: ITC, 2017)

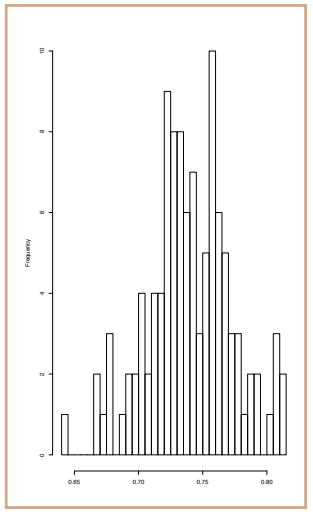

Figure 42. Environmental Efficiency scores of rubber farmers in 2012 (left) and 2015 (right).

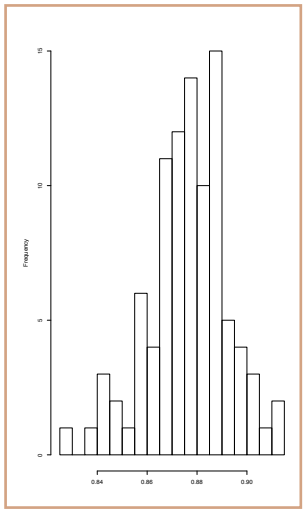

Figure 43. International daily natural rubber price (Kuala Lumpur Exchange), 2012-2017 (Source: Datastream)

With regards to the palm oil market and similar to the rubber case, international price transmission is examined where crude oil

prices are assumed to be in sync with palm oil prices. Yet, the major exporting countries, among those Indonesia, have come out with various attempts to control palm oil prices, which are subject to analysis.

C01 also contributes to the Focus 4 activities with six sub project members being involved in the draft of an overview of all policies that are relevant in rubber production and marketing. A basis has been set by a master student's seminar paper completed in 2018.

C02

TITLE: **Socio-cultural and institutional transformation processes in rural Jambi**

TEAM: Principal Investigators: Heiko Faust (UGoe); Endriatmo Soetarto, Soeryo Adiwibowo (IPB); Rosyani (UNJA).
Scientific Staff: Jennifer Merten, Fenna Otten (Doctoral Researchers).
Associated Scientists: Jonas Hein, Yvonne Kunz (Postdoctoral Researchers).

RESEARCH SUMMARY:

Since October 2017 (publishing of EFForTS Newsletter no. 5), the German-Indonesian research team of CO2 concentrated on three topics for publications: 1. The Indonesian fire crises 2015, 2. The transnationalisation of competing state projects, and 3. Smallholders' sustainability perceptions vs performance in the context of Indonesian palm oil.

The first research reveals that wildfires in tropical rainforests and especially peat fires have abundant and wide-ranging negative effects on the economy, ecology and human health (figure 44). Indonesia has large areas of peat swamp forests that recurrently burn (figure 44). As a reaction to the devastating fire events of 2015, the provincial government of Jambi reimposed a more stringent version of the prohibition of burning land, delegalizing this land clearing method. From a local perspective through qualitative research at the village level it becomes clear that this regulation is maladaptive as the underlying causes making land prone to fires, the sinking ground water table, remains unchanged by the ban. Further, the impacts of the new regulation vary for different groups of the local population, with severe land management restrictions for food crop farmers. The application of a framework on the political and material dimension of vulnerability reveals that the national policy unintentionally causes economic hardship and landscape changes at the local level (Hartmann et al. 2018).

The second investigation deals with Indonesia's peatlands as conflict arenas where different state projects and actors compete. The case presented here stands for a new conservation controversy. The Berbak Carbon Initiatives overlap with a settlement project, inducing struggles among different state apparatuses,

Figure 44. Hazue during the dry season in Seponjen, Jambi province, September 2015.

Figure 45. Dr. Rosyani and Imke Rödel interviewing village authorities in Gurun Modo, Jambi province. From left to right: student of Ibu Rosyani, Amrina (local assistant), Kades Bapak Tukiran, Bapak Solikin (research team stayed in his house), Ibu Rosyani (counterpart of CO2, UNJA), Imke Rödel (master student CO2), local policeman.

transnational actors, and peasants. Empirically we draw on qualitative research conducted in the province of Jambi, Sumatra. We argue that the territorial conflicts mirror the contradictory interests of different state apparatuses influenced by conservation-oriented and development-oriented actors in society but also by supra-national planning institutions. In our case, the contestation becomes visible through inconsistent notions of development and property. We show how political change challenges the implementation of a forest carbon project, illustrating the high risks of mitigating climate change through offsetting (Hein et al. 2018).

The third study investigates how perceptions of sustainability expressed through certification criteria from the consumer perspective influence local discourses and production processes in Jambi Province. In the framework of a case study approach using a set of qualitative research methods in three research villages, the Sustainability Assessment of Food and Agriculture systems (SAFA) allowed to gather data on sustainability performance (figure 46). The findings identified a gap between the supply and demand side regarding their perceptions of sustainable palm oil. Small-scale producers of oil palm put emphasis on economic viability and prosperity. Oil palm expansion was found to affect community life and values in the research villages. Certification schemes, such as the Roundtable on Sustainable Palm Oil (RSPO) have raised environmental awareness but failed to bring perceptions from both sides to a common level. Mediation between stakeholders of palm oil production, harmonization of sustainability criteria and smallholder inclusiveness are of high concern when aiming for sustainable development (Master Thesis by Imke Rödel).

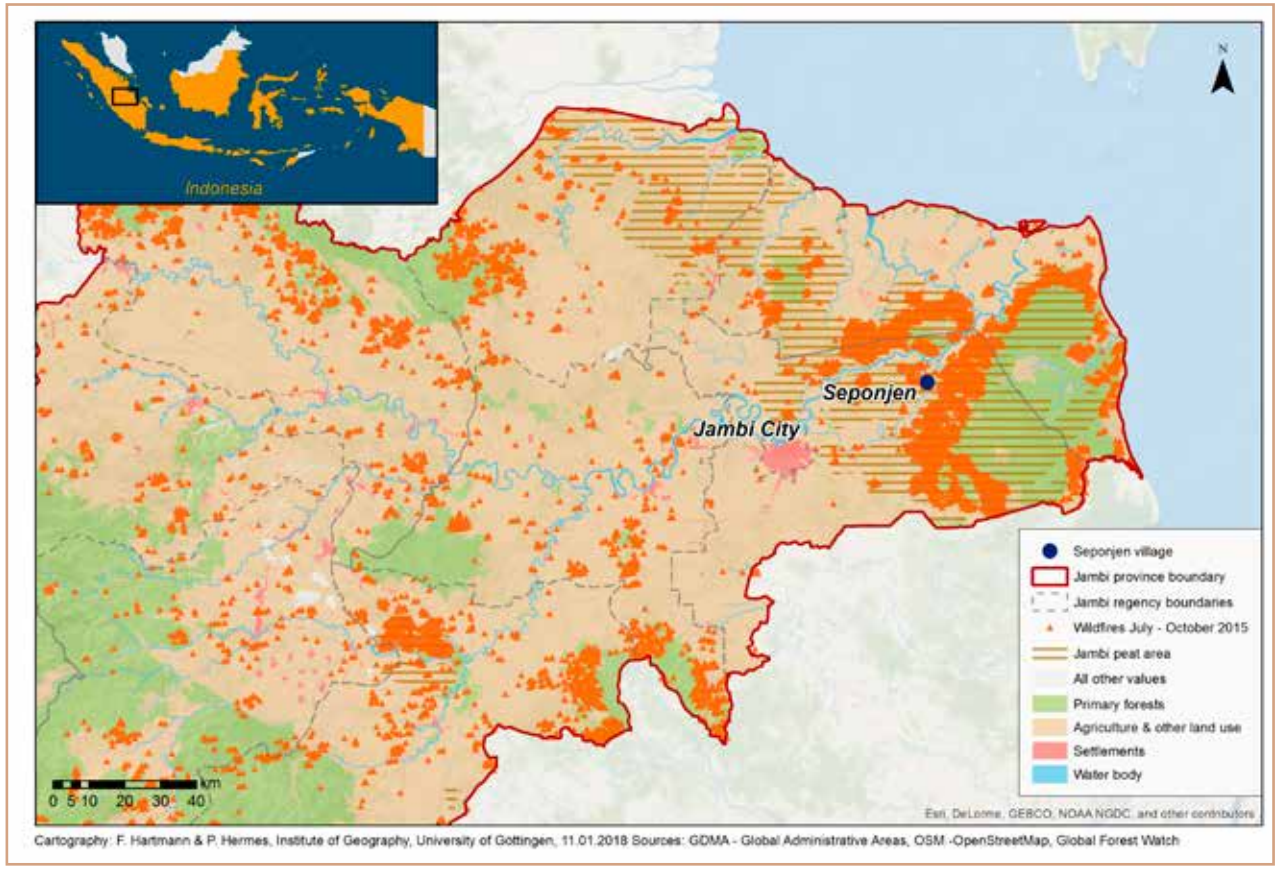

Figure 46. Localisation of the research village (Seponjen) and forest firest in 2015 in Jambi province.

C06

TITLE: **Encouraging the acceptance of RSPO and ISPO certification in Indonesia – a policy analysis**

TEAM: Principal Investigators: Oliver Mußhoff (UGoe); Dompak Napitupulu (UNJA).
Scientific Staff: Arieska Wening Sarwosri (Doctoral Researcher).

RESEARCH SUMMARY:

Risk attitude and time preference: crucial factors for planting oil palm by smallholders? - Arieska Wening Sarwosri, Daniel Hermann, Oliver Musshoff

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 (figure 47). 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.

Figure 47. Holt and Laury task.

Figure 48. The team of C06 in Tebing Tinggi village, Jambi province. From left to right: Dani, Dian, Arieska, Fahan.

C07

TITLE: **Determinants of land-use change and welfare impacts among rural farm and non-farm households**

TEAM: Principal Investigators: Matin Qaim (UGoe); Hermanto Siregar (IPB); Zulkifli Alamsyah Ummi Kalsum (UNJA).
Scientific Staff: Kibrom T. Sibhatu (Postdoctoral Researcher), Nadjia Mehraban (Doctoral Researcher).
Associated Scientists: Christoph Kubitza, Vijesh Krishna (Postdoctoral Researcher), Daniel N. Chrisendo (Doctoral Researcher).

RESEARCH SUMMARY:

Two of the C07 team members, Jonida Bou Dib and Christoph Kubitza, recently completed their PhD program at the University of Göttingen. Christoph was successful in securing funding for a one-year postdoc period from the University, allowing him to continue his research in C07. As a new team member, we welcome Ms. Nadjia Mehraban, who started her work as a doctoral researcher in April 2018.

Between August and November 2018, the C07 team will be busy with implementing the third round of the farm household survey in Jambi (n=700). In parallel, we also carry out a second round of the non-farm household survey (n=400). A brief summary of recently completed research with the first round of the non-farm household data is provided in the following.

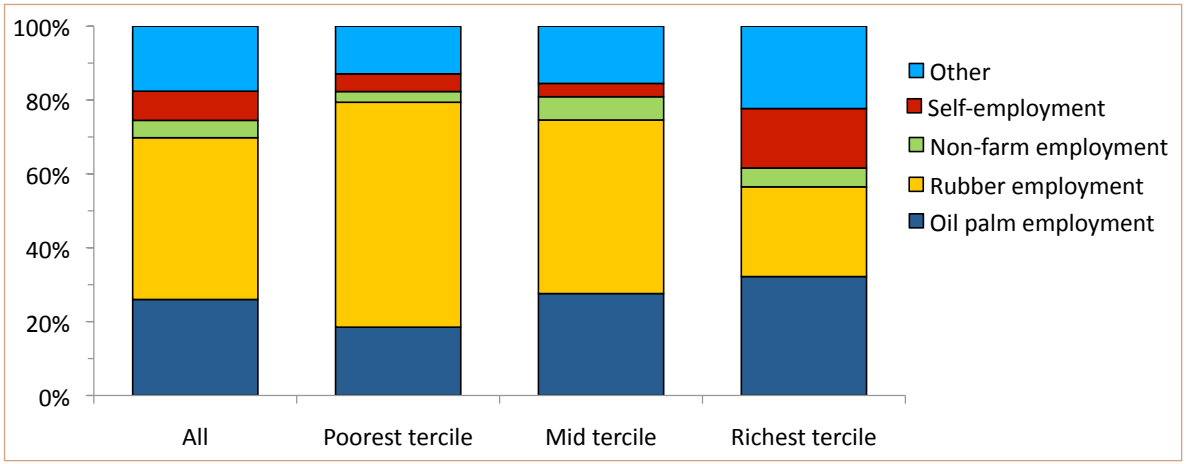

Figure 49. Relative importance of different income sources for non-farm households in rural Jambi (for all non-farm households and by income tercile).

In a first paper, we analyzed the role of different types of agricultural and non-agricultural employment income for non-farm households. Employment in rubber and oil palm are important livelihood components for these households (figure 49). Employment in oil palm is more lucrative than employment in rubber, so involvement in the oil palm sector as a laborer is positively associated with total household income. Regression models show that whether or not a household works in oil palm is largely determined by factors related to migration background, ethnicity, and the size of the village area grown with this crop. These results suggest that further expansion of the oil palm area will likely benefit non-farm households through gains in employment income.

In a second paper, we pooled the data from farm and non-farm households to analyze associations between land use, poverty, and income inequality. On average, farm households have significantly higher incomes and are less likely to be poor than non-farm households in the same villages. Both types of households are better off in villages with a large share of the land under oil palm than in villages where relatively more rubber and other crops are grown. Oil palm does not seem to have significant effects on overall inequality. While oil palm cultivation contributes to increasing inequality among farmers, it tends to decrease income inequality among non-farm households through labor-market and employment effects.

C08

TITLE: **Designing effective policy instruments to induce sustainable land use**

TEAM: Principal Investigators: Meike Wollni (UGoe); Bambang Juanda (IPB); Edison (UNJA).
Scientific Staff: Miriam Romero, Karina Brenneis (Doctoral Researcher).
Associated Scientist: Katrin Rudolf (Doctoral Researcher).

RESEARCH SUMMARY:

The effect of input and information provision for smallholders' tree planting behavior (Katrin Rudolf, Miriam Romero, Meike Wollni)

We implemented an randomized controlled trial (RCT) in order to analyze the effectiveness of input and information provision on smallholders' tree planting activities. To this end, two interventions were designed: the first provided information about tree planting in oil palm, while the second combined information and sapling delivery. 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 adopt but they plant more trees per hectare than farmers who received saplings.

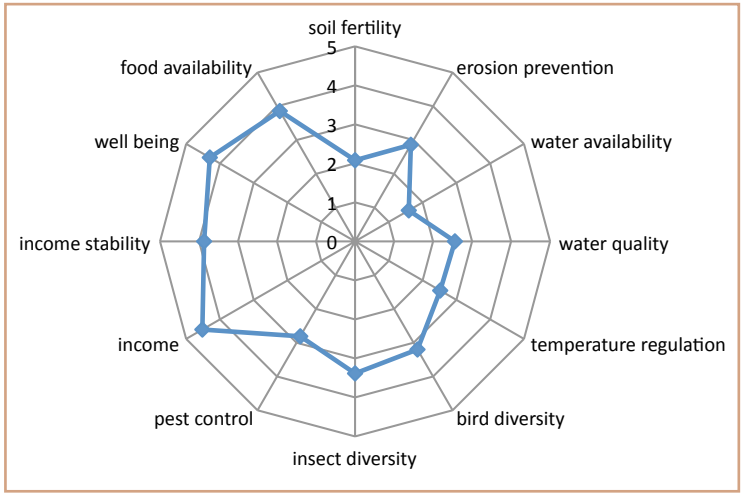

Figure 50. What are farmers' perceived ecosystem functions of oil palm? Note: Measures on 5-point Likert scale, where 1 = decreases very much and 5= increases very much.

Figure 51. Distribution of tree saplings by C08 to farmers in the field.

SELECTED RESULTS:

Understanding oil palm farmers' concern for the environment (Miriam Romero, Meike Wollni)

We investigate smallholders' perceptions of ecosystem functions provided by oil palm and how these perceptions relate to their concern for the environment. Perceptions are measured on a 5-point Likert scale (figure 50). Farmers were asked about different ecosystem functions e.g. soil fertility, water availability, and whether they perceive an increase, decrease or no change in oil palm plantations. We find that farmers' perceptions are consistent with other studies showing that regulating functions are lower in oil palm, while provisioning functions are higher (e.g. income). However, we find that farmers perceive no change in bird and insect diversity, which differs from other studies revealing a decrease in species richness. Furthermore, we find that farmers' perception of decreasing soil fertility and decreasing water availability are positively and significantly correlated with environmental concern. Environmental concern is significantly higher among farmers living in oil-palm dominated villages and is also positively influenced by wealth at the village level. However, farmers with larger oil palm plantations are less environmentally concerned on the average.

C10

TITLE: **Determinants of regional patterns of deforestation and land use in Indonesia (–Start: 1 January 2018)**

TEAM: Principal Investigators: Krisztina Kis-Katos (UGoe); Nunung Nuryartono (IPB); Dearmi Artis (UNJA).
Scientific Staff: Elias Cisneros (Postdoctoral Researcher).

RESEARCH SUMMARY:

The project aims to study the political-economic determinants of deforestation and land use change in Indonesian regions. The project follows two main goals. Its first goal is to upscale selected findings of the CRC 990 on the economic incentives driving land use change in Jambi province (Sumatra) from a nation-wide perspective. Focusing on the variation of economic incentives at a larger analytical scale allows us to link relative shifts in global market demand for major agricultural commodities (among others, palm oil and rubber) to changes in deforestation pressure, conditional on the regional geo-climatic suitability for producing related crops. Building on these results, the second goal of the project is to investigate how interactions between local economic and political incentives shape deforestation in Indonesian regions. The fiscal, administrative and political decentralization process, which started in 1999, devolved substantial decision making powers to the Indonesian regions. Among others, these reforms increased the importance of the local electoral cycle in shaping not only fiscal but also environmental outcomes as districts started issuing more deforestation permits right before mayoral elections. By focusing on the interactions between changes in commodity demand and political incentives, the project aims to understand how economic and political factors may reinforce each other. Results from these regional level analyses can be used as a basis for future collaborative work within the CRC to collect micro level evidence on the factors that shape the local governance environment for land use change.

The project will assemble a yearly panel dataset on 514 Indonesian districts (kabupaten and kota) for the years 2000-2015 and link variations in changes in land use and deforestation to political and economic factors. The analysis will utilize two sources of identifying variation. First, changes in economic incentives will be measured by interactions between changing world market prices (or total global demand) of major commodities and local geo-climatic suitability indices for the related crops. Second, the analysis will utilize the quasi-experimental variation in Indonesian local elections that followed a quasi-random, idiosyncratically timed pattern over the 2000s in order to link changing incentives within the local political cycle to changes in land use and deforestation. Moreover, we will analyse the interactions between changing world market prices of potentially locally relevant crops and the local political cycle to highlight the role of the political process in transmitting (or mitigating) the effects of global demand shocks.

Scientific projects Z02 and INF

Z02 FIELDS OF RESEARCH

- Monitoring of meteorological variables
- Barcoding the vasuclar plants and their roots of the study sites
- Monitoring of aboveground animal biodiversity
- Function as central unit on the Convention of Biological Diversity (CBD)

INF FIELDS OF RESEARCH AND DATA MANAGEMENT

- Information system (EFForTS-IS)
- Embedded research data management
- Integrative statistical analysis
- Small services and general support
- Data sharing and monitoring
- Training and workshops
- Network and dissemination

Z02 – Central Scientific Service Project

TITLE: **Monitoring meteorological variables (WP1)**

TEAM: Principal Investigators: Alexander Knohl (UGoe); Dodo Gunawan (BMKG).
Scientific Staff: Christian Stiegler, (Postdoctoral Researcher).
Technical Staff: Marek Peksa, Edgar Tunsch (UGoe); Basri Hatake, Bayu Puja Kesuma, Darwis (UNJA).

RESEARCH SUMMARY:

In this study we investigate groundwater table depths at twelve riparian locations in the Harapan region (Jambi province, Sumatra, Indonesia). Average groundwater table was lowest at the oil palm riparian sites (HOr1, HOr2, HOr3, HOr4), with 1.47 ±0.76 m below the surface. At the rubber riparian sites (HRr1, HRr2, HRr3, HRr4) we observe average groundwater table of 1.07 ±0.40 m below the surface. Highest ground water table was observed at the forest riparian sites (HFr1, HFr2, HFr3, HFr4), with 0.56 ±0.27 m below the surface. Maximum fluctuation in groundwater table depths span from 1.99 m at forest riparian and 2.12 m at rubber riparian to 3.23 m at oil palm riparian.

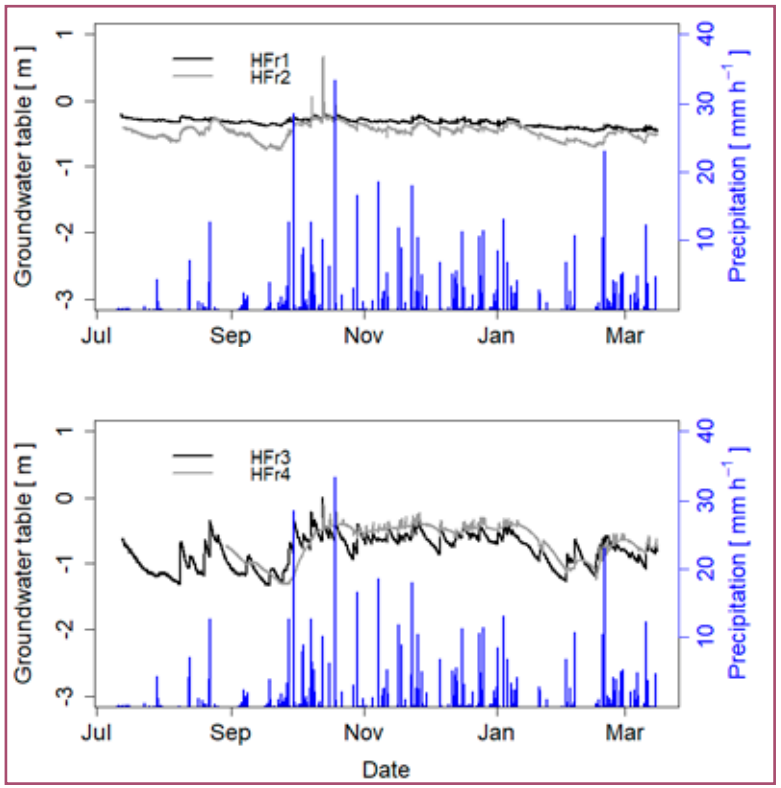

Figure 52. Groundwater table (meter below surface) and hourly accumulated precipitation at the forest riparian plots HFr1 and HFr2 (upper), and HFr3 and HFr4 (lower) during the period 1 July 2017 to 15 March 2018.

Figures 52-54 show the comparison of groundwater table development and accumulated hourly precipitation. Precipitation for the forest riparian locations (HFr1, HFr2, HFr3, HFr4) is measured at our meteorological station near REKI main camp. For rubber (HRr1, HRr2, HRr3, HRr4) and oil palm (HOr1, HOr2, HOr3, HOr4) riparian locations, we use precipitation measurements from our meteorological station

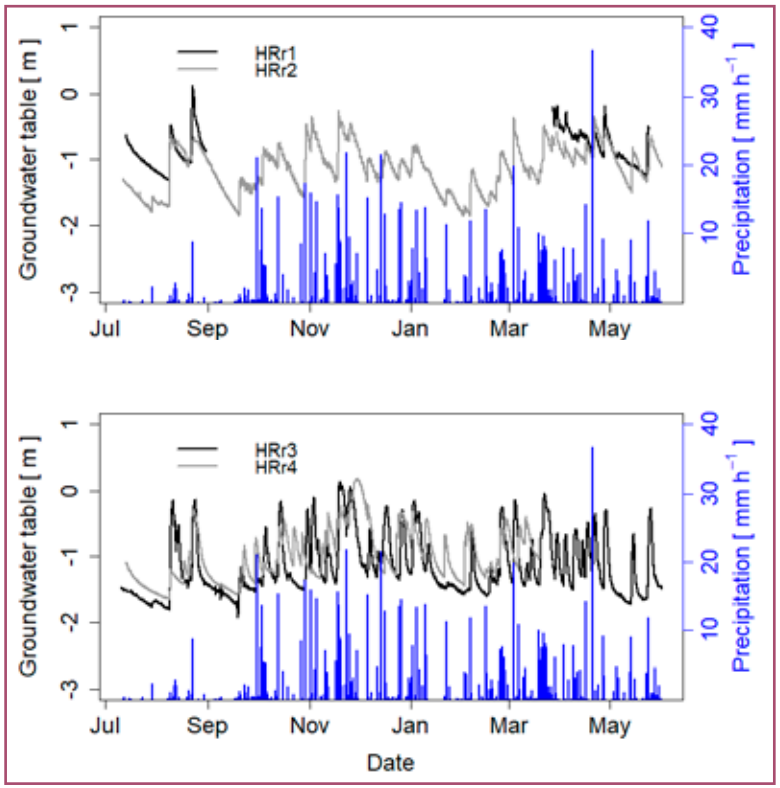

Figure 53. Groundwater table (meter below surface) and hourly accumulated precipitation at the rubber riparian plots HRr1 and HRr2 (upper), and HRr3 and HRr4 (lower) during the period 1 July 2017 to 31 May 2018.

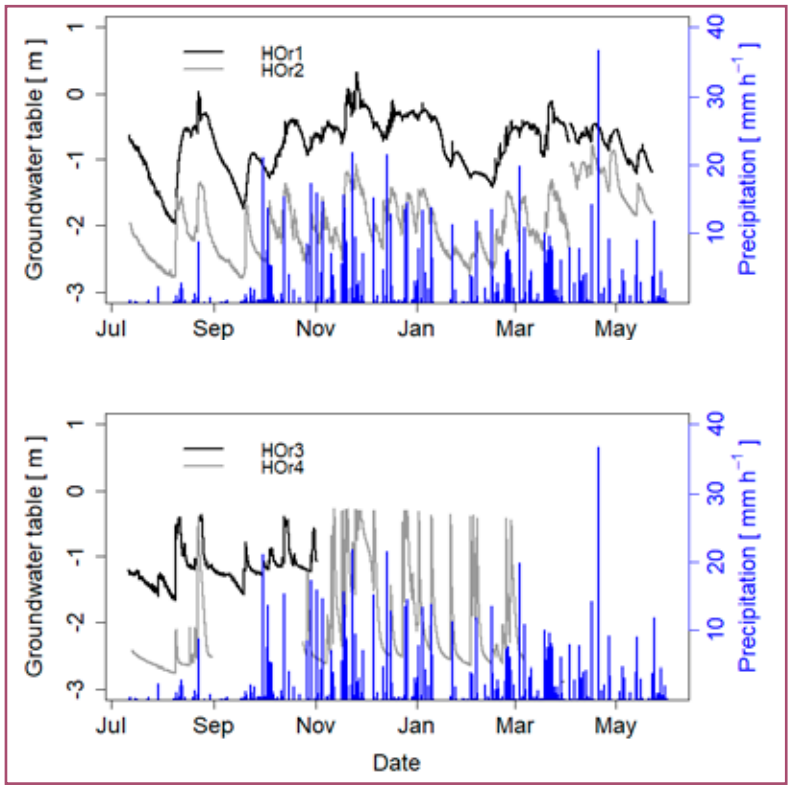

Figure 54. Groundwater table (meter below surface) and hourly accumulated precipitation at the oil palm riparian plots HOr1 and HOr2 (upper), and HOr3 and HOr4 (lower) during the period 1 July 2017 to 31 May 2018.

in Humusindo. In general, all sites show steady increase in groundwater table depth during dry conditions with only little precipitation. Precipitation events lead to an immediate and rapid decrease in groundwater table depths. Due to the very local and small-scale occurrence of some precipitation events and the location of our precipitation measurements in different catchment areas of rivers and creeks compared to the riparian plots, few precipitation events are not reflected in a change of groundwater table depths (and vice versa).

Figure 55. The team of Z02 drilling a groundwater borehole at one of the riparian core plots at Harapan Rainforest (HFr4). From left to right: Sofyan, Basri, Darwis, Bayu, Christian Stiegler.

Figure 56. A groundwater borehole of Z02 at one of the riparian core plots at Harapan Rainforest (HFr1).

Z02 – Central Scientific Service Project

TITLE: **Monitoring aboveground biodiversity: Canopy Arthropods (WP3)**

TEAM: Principle Investigators: Stefan Scheu (UGoe); Damayanti Buchori, Purnama Hidayat (IPB).
Scientific Staff: Jochen Drescher (Postdoctoral Researcher)
Associated Scientists: Amanda Mawan, Daniel Ramos Gutierrez (Doctoral Researchers, UGoe); Rawati Panjaitan (Doctoral Researcher, IPB).

RESEARCH SUMMARY:

We monitor arboreal arthropod communities in the core plots and riparian sites. The overall aim is to reveal the effects of the transformation of rainforest to monoculture plantations on biodiversity, population dynamics, food webs and ecosystem functions. Furthermore, we want to understand how these effects differ between taxa and functional groups and study the effect of time and seasonality on the arthropod species inhabiting the canopies in rainforest and plantations.

So far, we have sampled canopy arthropods in three canopy fogging campaigns: Dry season 2013, rainy season 2013/14, and again in dry season 2017. Collecting from three replicates per plot, we sampled and sorted 726.673 individual arthropod specimen in the two fogging campaigns in 2013/14. Using the same replication design, but with less traps, we sampled a projected 600.000 individuals from all core plots and riparian sites in dry season 2017. We are thus working with a collection of ca. 1.3 million specimens from the canopy fogging. Additionally, we have collected butterflies using sweep netting and banana traps in all core plots and riparian sites, and will collect more from plots in the Biodiversity Enrichment experiment. The team at the Department of Pest and Plant Disease at IPB (figure 57) largely focuses on morphology-based identification of arthropods. The team at the Department of Animal Ecology at UGoe (figure 58) focuses on molecular analyses, stable isotope measurements and photographic documentation of previously identified specimen. We are currently concentrating on four main taxonomic groups, i.e. ants, parasitoid wasps, beetles and spiders. Other taxonomic groups such as butterflies and springtails (Collembola) are being worked on with ABS funding (see chapter III. 3).

Figure 57. The team of Z02 at the Department of Pest and Plant Disease at IPB. From left to right: Muhammad Syaifullah Hiola, Fatimah Siddikah, Kasmiatun, Rizky Nazarreta, Purnama Hidayat, Damayanti Buchori, Mega Mutiari, Nurul Novianti, Rawati Panjaitan, Amanda Mawan, Tika Dwining.

Ants – *Formicidae*:

The taxonomic identification of 130.528 specimens of ants from dry season 2013 and rainy season 2013/14 to 222 (morpho-)species has recently been concluded, and a respective manuscript has been submitted. We demonstrate that forest has the highest species richness (Nsp = 85.6 ± 19.3), followed by jungle rubber (Nsp = 62.8 ± 12.2), rubber (Nsp = 41

Figure 58. The team of Z02 at the Department of Animal Ecology at UGoe. From left to right: Jana Burst, André Junggebauer, Jochen Drescher, Stefan Scheu, Tizian Lang, Jan Kreider, Daniel Ramos Gutierrez.

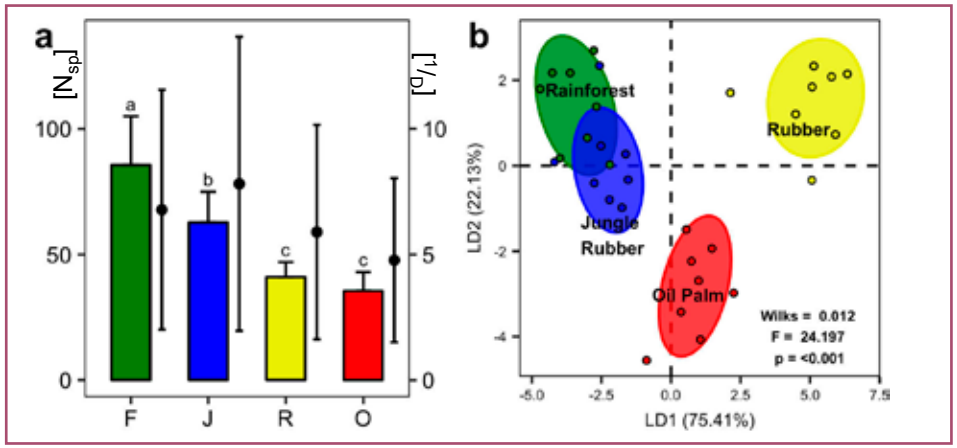

Figure 59. Community measures of arboreal ants in rainforest (F), rungle rubber (J), rubber (R) and oil palm plantations (O) in Jambi Province. We calculated (a) average species richness Nsp and inverse Simpson diversity 1/D and compared averages with ANOVA followed by pairwise t-tests using Holm's correction. Different letters indicate significant differences (all $p<0.0001$). We then used DFA ordination (b) to analyse community composition. P-values below $\alpha=0.05$ indicate a significant discrimination between communities of different land use systems.

± 6) and oilpalm (Nsp = 35.5 ± 7.5), but ant species diversity is not significantly different between the systems (all values are mean ± SD, figure 59a). This pattern is caused by high proportions of rare species in the forest and jungle rubber plots, which leads to a higher species eveness in rubber and oil palm. The ant community composition in forest and jungle rubber are very similar, and significantly different from the community composition in oil palm and rubber (Discriminant Function Analysis, DFA, figure 59b). The reason is that the community inhabiting jungle rubber is sourced from the community inhabiting forest, but that the communities in oil palm and rubber monocultures are dominated by species that are not found in the forest community. This hypothesis is supported by the observation that the monoculture plantations are dominated by tramp ant species such as the yellow crazy ant *Anoplolepis gracilipes*, the black crazy ant *Paratrechina longicornis*, the ghost ant *Tapinoma melanocephala* and the white-footed ant *Technomyrmex albipes*, all of which are considered invasive.

Of the common ant species (those that make up >95% of the entire dataset in abundance, 151 species), we genetically barcoded up to five individuals per morphospecies using a >400bp fragment of COI mitochondrial DNA and an >1000bp fragment of 28S ribosomal DNA, allowing us to check the morphology-based identification to morphospecies in an iterative process. We furthermore used the sequence data to calculate a phylogenetic tree, which we will use to study the effect of habitat selection on the assembly of ant communities in the four land-use systems. We expect to gain insight into the evolutionary direction that the land-

Figure 60. Golden spiny ant *Polyrachis ypsilon*.

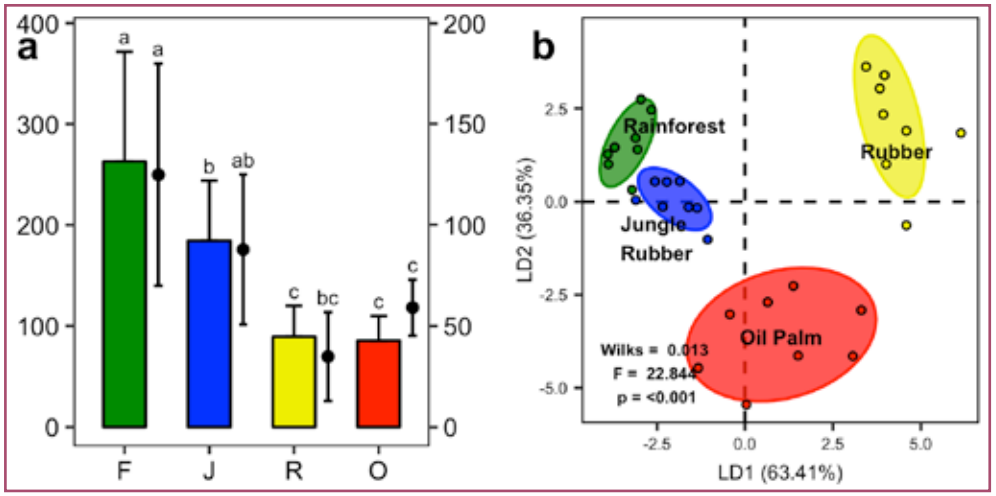

Figure 61. Community measures of parasitoid wasps in rainforest (F), rungle rubber (J), rubber (R) and oil palm plantations (O) in Jambi Province. We calculated (a) average species richness Nsp and inverse Simpson diversity 1/D and compared averages with ANOVA followed by pairwise t-tests using Holm's correction. Different letters indicate significant differences (all $p<0.0001$). We then used DFA ordination (b) to analyse community composition. P-values below $\alpha=0.05$ indicate a significant discrimination between communities of different land use systems.

scape-wide conversion of rainforest to monoculture plantations pushes ant communities in, and what that means for ecosystem functions and services. With the exception of those few morphospecies that are still in revision, all morphospecies confirmed species have been photographed for documentation in the EcoTaxonomy database (see B08). That includes iconic species such as the golden spiny ant Polyrachis ypsilon (figure 60).

Parasitoid wasps – *Braconidae, Ceraphronidae, Encyrtidae, Eulophodae, Platygastridae, Scelionidae*:
We assigned a total of 1.182 morphospecies to 10.070 parasitoid wasps specimens from the dry season 2013 sampling. Members of the Ichneumonidae family have not been sorted, due to the severel taxonomic difficulties of that group. Similar to the patterns in the ants, there is a significantly higher species richness of parasitoid wasps in forest (Nsp = 263 ± 108.9) than in jungle rubber (Nsp = 184.5 ± 59.5), which in turn shows a higher species richness than monocultures of rubber (Nsp = 89.4 ± 30.6) and oil palm (Nsp = 85.6 ± 24.4, all values are mean ± SD, figure 61a). Contrary to the ants, species diversity is significantly higher in forest (1/D = 124.9 ± 55) than in the monocultures (rubber: 1/D = 34.9 ± 22; oil palm: 1/D = 59.2 ± 13.9), with jungle rubber showing intermediary diversity (1/D = 87.9 ±37.1, all values are mean ± SD, figure 61a). Community composition patterns mirror those of the ants, with forest and jungle jubber communities being much more similar to each other than to either of the monoculture communities (figure 61b). In a currently running master thesis, we are testing the usefulness of metabarcoding for biodiversity assessments in taxonomically challenging groups such as the parasitoid wasps. We use a 313bp large fragment of COI to barcode up to 50 randomly chosen individuals from each core plot (total = 987 individuals, abundance in rubber and oil palm is often below 50 individuals in total) on the Illumina sequencing platform. We will then compare relative abundances of molecular operational taxonomic units (MOTU's) with abundances of morphospecies to asses the degree to which these two approaches correlate. We have also taken pictures of 274 type specimens as a first step towards photographic documentation in the EcoTaxonomy database, e.g. wasps of the family Braconidae (figure 62).

Figure 62. Parasitoid wasp of the family Braconidae.

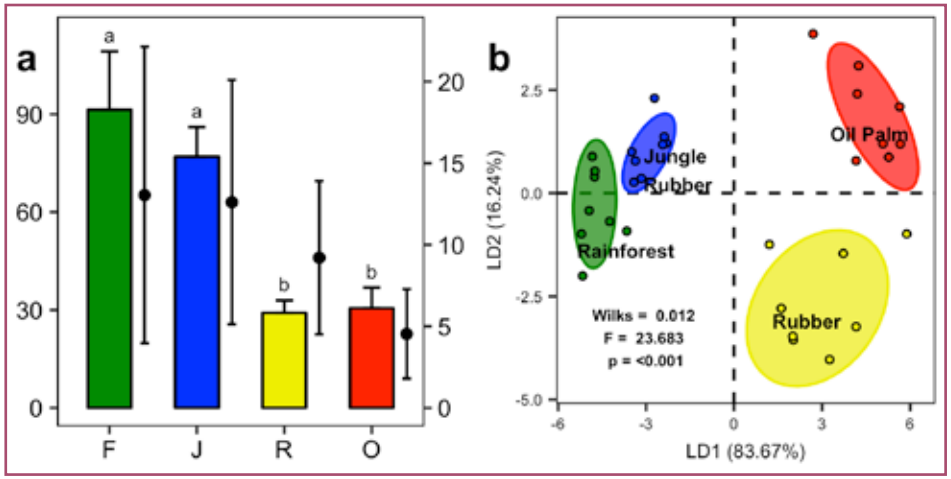

Figure 63. Community measures of canopy beetles in rainforest (F), rungle rubber (J), rubber (R) and oil palm plantations (O) in Jambi Province. We calculated (a) average species richness Nsp and inverse Simpson diversity 1/D and compared averages with ANOVA followed by pairwise t-tests using Holm's correction. Different letters indicate significant differences (all $p<0.0001$). We then used DFA ordination (b) to analyse community composition. P-values below $\alpha=0.05$ indicate a significant discrimination between communities of different land use systems.

Beetles – *Coleoptera:*

Three families of beetles have been selected for morphological identification, i.e. the weevils Curculionidae, the click beetles Elateridae, and the rove beetles Staphylinidae. In total, we have sorted 12.078 specimens of these three beetle families to 325 morphospecies. On average, there are more than three times as many beetle morphospecies in the forest plots (Nsp = 91.4 ± 17.9) than in rubber (Nsp = 30.5 ± 6.4) and oil palm (Nsp = 29.1 ± 3.8), while jungle rubber plots still contain more than twice as many species as the plots in monocultures (Nsp = 77 ± 9.1, all values are mean ± SD, figure 63a). Simpson's diversity is not significantly different among the land use systems. Community composition, however, differs significantly between the land use systems, with forest and jungle rubber again showing the most similar communities, while oil palm and rubber communities are distinct from each other and from forest/jungle rubber (figure 63b). Next planned steps with the beetles are to export a subset to UGOE, from where we will send them to taxonomic experts worldwide for final checking. Stable isotope analyses of certain taxa are also planned, as is the morphospecies identification for other families from that order.

Spiders and others – *Aranea*

Daniel Ramos Gutierrez has joined our team as doctoral student in the beginning of 2018. He focuses on the analysis of ecological patterns in canopy spiders from the core plots. To get started with the identification work, Daniel spent three months at the CeNak (Centrum für Naturkunde) at Hamburg University, to learn about the morphological identification of tropical spiders. Although the dataset is far from complete, trends are starting to emerge: The 13.346 spider individ-

Figure 64. The anterior median eyes of a jumping spider (Salticidae).

Figure 65. The species of the spider genus *Myrmarachne* (Salticidae) mimick ants.

uals that constitute the samples from two subplots of each core plot from the dry season 2013 belong to at least 28 different spider families, and 268 morphospecies have already been established. One of the abundant families are the jumping spiders Salticidae, which are memorable for their enlarged anterior median eye pair (figure 64) and the genus *Myrmarachne*, which contains species that mimick the body shape of ants (figure 65).

INF Research Data Management and Integrative Statistical Analysis

TEAM: Principle Investigators: Wolfram Horstmann, Thomas Kneib, Ramin Yahyapour (UGoe); Suria Darma Tarigan (IPB); Junaidi Sutan (UNTAD).
Scientific Staff: Johannes Biermann (Data management, SUB), Paul Magdon (WebGIS), Peter Pütz (Statistical consultancy), Bernd Schlör (GWDG).
Associated Scientific Staff: Timo Gnadt (Data management, SUB).

RESEARCH SUMMARY:

INF provided consultancy for the statistical analysis of research data and contributed to two EFForTS papers which are planned to be submitted in 2019 at the latest. In October 2017, a well-attended course on applied statistical inference and general issues in quantitative research was taught. The course was recorded and made accessible to all EFForTS members. As a new format for assisting in statistical analysis, INF invented the supervised data consultancy where members of EFForTS could work on their statistical analyses while being assisted by a consultant. Two such meetings were held in April 2018 and further courses are planned with the next one probably taking place at the end of 2018. The exact topic has still to be identified by consultation with the other researchers involved in EFForTS.

Upon request, Paul Magdon (WebGIS) prepared a digital surface model (DSM) for the entire Province of Jambi. The DSM is based on Advanced Land Observing Satellite (ALOS) data and can be downloaded either as raster with a spatial resolution of 30m or as a systematic grid of points with a grid width of 1000m. The data is used for an EFForTS manuscript ID 198. Furthermore, we provided support and access to our remote sensing lab for supporting the biodiversity enrichment project to process with their unmanned aerial vehicle (UAV) images. We did also prepare a map with vegetation indices using RapidEye satellite images from the year 2013 for the B10 protect. We are continuously managing users and data request for spatially and remotely sensed data via the Efforts WebGIS Platform http://efforts-webgis.uni-goettingen.de/
Timo Gnadt has joined the Göttingen eResearch Alliance. His tasks in the support of EFForTS-IS and the entire data management are now taken over by Johannes Biermann (Biermann@sub.uni-goettingen.de, efforts-is@uni-goettingen.de).
The evaluation of the planned upgrade for the EFForTS-IS from BExIS 1 to BExIS ++ is still in progress, as not all functions required by EFForTS are yet available in the new version. We are planning an early beta phase with selected test users, as soon as we are able to upgrade.

II. Integration of Ecological and Socioeconomic Research

Integration / integrative research activities across disciplines is realized through

- the establishment of a joint enrichment planting experiment (B11, EFForTS-BEE)
- oilpalm management experiment
- four thematic foci / overarching joint hypotheses.

1. The enrichment experiment

B11

TITLE: **Biodiversity enrichment in oil palm plantations: plant succession and integration (EFForTS-BEE)**

TEAM: Principal Investigators: Dirk Hölscher, Holger Kreft, Meike Wollni (UGoe); Leti Sundawati, Damayanti Buchori, Yeni Mulyani (IPB); Bambang Irawan, Rince Muryunika (UNJA).
Scientific Staff: Clara Zemp (Postdoctoral Researcher).
Associated Scientist: Watit Khokthong (Doctoral Researcher).

RESEARCH SUMMARY:

EFForTS-BEE is a long-term biodiversity enrichment experiment in a conventional oil palm plantation and was established as part of the B11 project in December 2013. In total 52 tree islands were planted in a monoculture oil palm plantation, with different levels of diversity (0, 1, 2, 3 and 6 species) and island sizes (5 m x 5 m to 40 m x 40 m), in addition to 4 management-as-usual plots. The aim of the experiment is to test if mixed-species tree planting is a suitable strategy to restore ecosystem functioning and increase biodiversity in oil palm plantations, and to analyze the socio-economic and ecological trade-offs.

Increasing stand structural complexity is a key component of ecological restoration. Using a terrestrial laser scanner, we showed that stand structural complexity in the enrichment plots is already significantly higher compared to oil palm monoculture. Furthermore, stand structural complexity

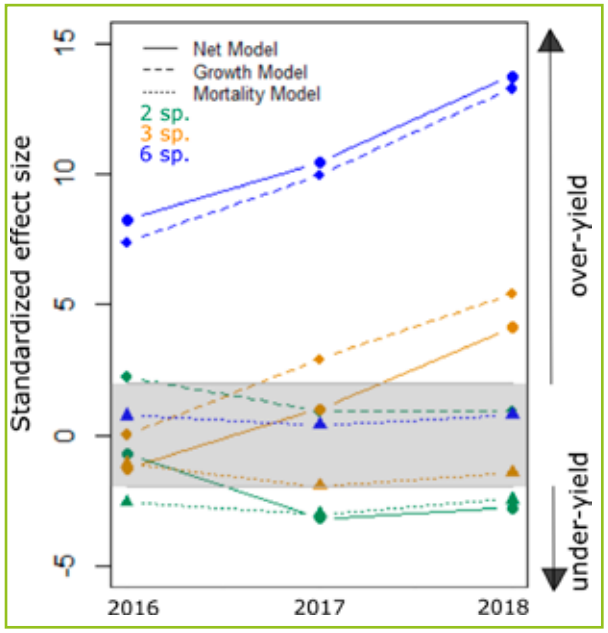

Figure 66. Effect of tree growth and mortality on basal area in mixtures (2, 3 or 6 species-plot) compared to mono-species plots in the EFForTS-BEE experiment. Positive standard effect size (above gray area) means that that observed tree basal area in mixture is significantly exceeding probabilistic estimations based on growth rates (dashed lines), mortality rates (dotted lines), or both growth and mortality rates (solid lines) found in monoculture. Method adapted from Potvin et al. (2008).

Figure 67. EFForTS-BEE team in April 2017, from left to right: Eduard Siahaan (field assistant), Clara Zemp (postdoctoral researcher), Johanna Kückes (master student), Lena Sachsenmaier (master student), Alejandra Valdés (master student), Ozi (field assistant), Ojan (field assistant), Juliandi (field assistant) and his son.

increased with tree 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 (see figure 66). 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.

To evaluate the overall effect of tree planting on biodiversity and ecosystem functions and services, we also integrate and coordinate inter-disciplinary research activities from different sub-projects in EFForTS. During the second phase, 18 researchers or students conducted analyses on (a) the environment (soil, micro-climate, surrounding matrix), (b) plants (tree survival and growth, plant water stress, understory vegetation, seed and pollen rain, tree recruitment, vegetation structural complexity), (c) animals (bird, bat, aboveground and soil invertebrate communities), (d) soil micro-organisms (prokaryotes and fungi) and (d) socio-economics (oil-palm yields, benefits from the planted trees, incentive for enrichment planting). Furthermore, EFForTS-BEE in now member of TreeDivNet, a global platform for ecosystem research in tree diversity experiments.

2. Four thematic foci

Focus 1

TITLE: **Assessment of ecological and socioeconomic functions, synergies and trade-offs across different land-use systems**

REPRESENTATIVES: Ingo Grass, Oliver Mußhoff

RESEARCH SUMMARY:

In the past months, Focus 1 has been intensively working on an interdisciplinary manuscript on socioeconomic-ecological trade-offs of land-use transition. The manuscript brings together research groups from clusters A, B and C. In particular, we investigate how agricultural expansion at the expense of forests and land-use transition of smallholders from jungle rubber to rubber monocultures and oil palm affect biodiversity, ecological functions and profits of farmers. 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 such as carbon storage, nutrient and greenhouse gas fluxes and climatic conditions, profit increases also come at the expense of ecosystem multifunc-

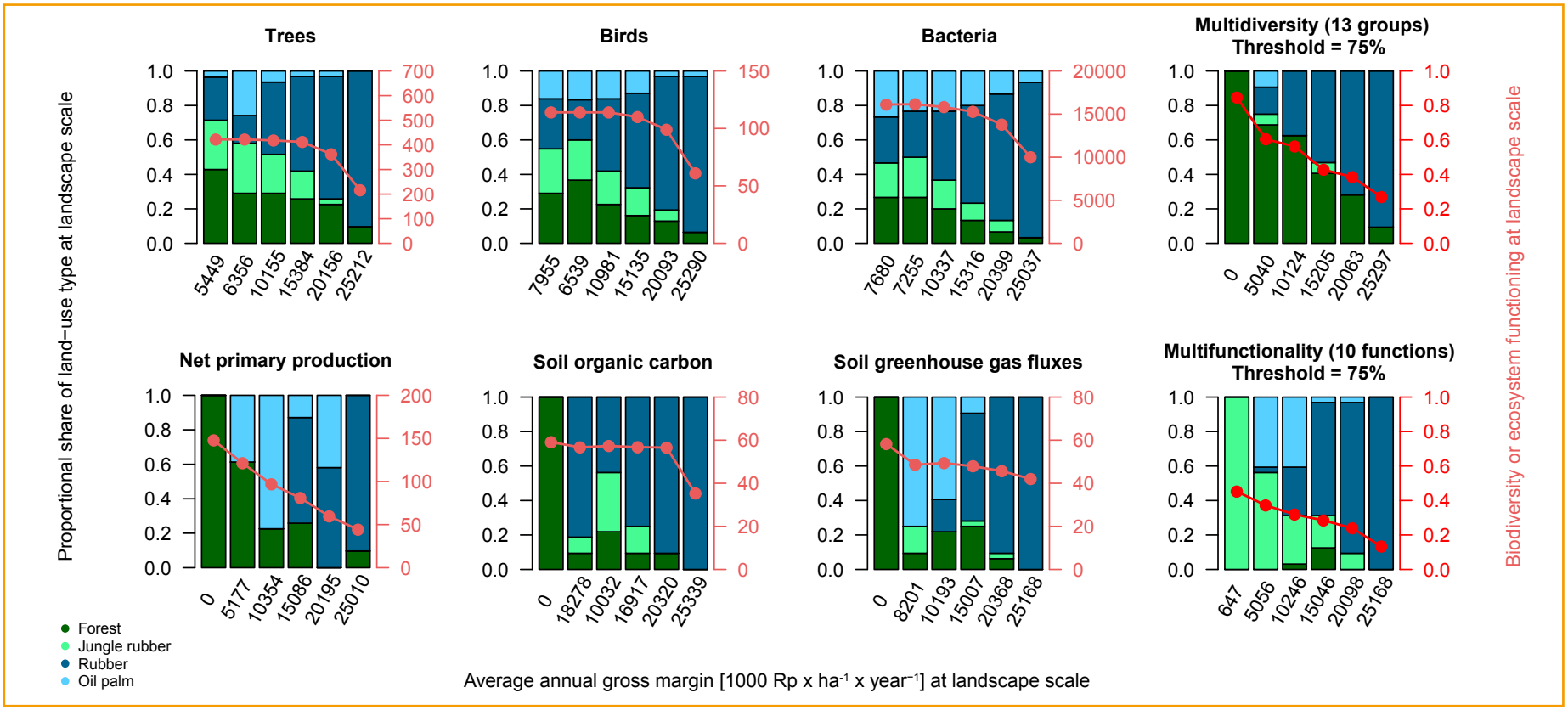

Figure 68. Optimized landscapes for highest possible levels of biodiversity or ecosystem functioning under increasing profit expectations. Shown are landscape solutions for example taxonomic groups and ecosystem functions, as well as solutions for multidiversity and multifunctionality that measure biodiversity and ecosystem functioning of all studied groups and functions, respectively. Each bar represents a landscape solution as identified by a genetic algorithm fed with plot-level information on biodiversity or ecosystem functions and profits of smallholder famers. Colors indicate landscape composition, i. e., the proportional share of the four studied land-use systems (lowland rainforest, jungle rubber, rubber monoculture, oil palm monoculture). The realized biodiversity (species richness) or ecosystem function (standardized function measures) in each landscape are shown as red dots, connected by lines to visualize trends with changes in in landscape compositions under increasing profit expectations. Note that the realized annual gross margin for each landscape solution (values below bars) can exceed the a priori defined minimum profit expectation (from left to right for all groups or functions: 0, 5000, 10000, 15000, 20000, 25000 Rp × ha^{-1} × year^{-1}).

tionality, 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 (figure 68). 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.

Focus 2

TITLE: **Quantifying the effects of spatial, temporal and social heterogeneity on ecological and socioeconomic functions**

REPRESENTATIVES: Holger Kreft, Matin Qaim, Meike Wollni

RESEARCH SUMMARY:

Ongoing research of the CRC demonstrates that land-use systems differ significantly in key ecological and socioeconomic functions. However, there is also a high degree of variability in the functions within each land-use system, suggesting an important role of spatial, temporal and social heterogeneity. For instance, differences in soil quality, plant and tree age, stand structural attributes, spatial configuration and historical land use as well as social factors, local institutions such as land property rights, and access to markets and infrastructure may additionally affect ecological and socioeconomic variables measured for each land-use system. Understanding the role of heterogeneity is key for understanding complex socio-ecological systems as a whole, for identifying win-win solutions of efficient, sustainable land-use management and for balancing human needs and ecosystem functions and services in human-dominated landscapes. Focus 2 contributes in this direction.

Various papers from the different projects have analyzed relationships between land property rights, agricultural input intensity, biodiversity, environmental efficiency, productivity, and farm income in rubber an oil palm. Understanding these relationships helps to explain ecological and socioeconomic heterogeneity. Research combining socioeconomic data with satellite imageries on historical land use showed how important formal land titles are for farmers' decisions to intensify production and increase the yield levels on the area that is already cultivated. Higher yields decrease farmers' incentives to encroach additional forest land, which underlines the important relationships between land property rights, deforestation, and related land-use changes (Kubitza et al. 2018a). Other research showed temporal heterogeneity in the economic effects of land use depending on international price developments, which can entail further land-use change. The low rubber prices in 2015 has increased the relative profitability of oil palm cultivation and has thus provided additional incentives to expand the oil palm area in Jambi (Kubitza et al. 2018b). Heterogeneity in the social effects of land-use change was also analyzed for different types of households, including farm and non-farm households. While the expansion of the oil palm area increases income inequality among farming households, it tends to decrease inequality among non-farm households due to labor market effects (Bou Dib et al. 2018a, 2018b).

Two multidisciplinary paper initiatives integrate a wealth of information related to Environmental processes and biodiversity of different taxonomic groups. In one study, the focus is on the question how stand structural components affect the species richness of different groups of organisms (Rembold et al. in prep.). Overall, there is a strong loss in structural complexity from forest to more uniform plantations and this is generally strongly linked to species loss. However, the response of individual groups was highly variable. Highly variable response of biodiversity was also documented in another ongoing focus paper on species turnover (Kreft et al., in prep.)

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[3] Kubitza, C., V. V. Krishna, K. Urban, Z. Alamsyah, M. Qaim (2018a). Land Property Rights, Agricultural Intensification, and Deforestation in Indonesia. *Ecological Economics* 147, 312-321.

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Focus 3

TITLE: **Quantifying the effects of spatial, temporal and social heterogeneity on ecological and socioeconomic functions**

REPRESENTATIVES: Stephan Klasen, Thomas Kneib

CONTRIBUTING AUTHORS: Jan Salecker & Craig Simpkins (B10)

RESEARCH SUMMARY:

Jan Salecker is heading the study to explore species distributions at different spatial scales, in pursuance of hypothesis 3. The goal of the study is to extrapolate the community composition from the 32 core plots to the entirety of the EFForTS study area. To achieve this goal, the group has decided to utilize the Dynamic Framework for Occurrence Allocation in Metacommunities (DynamicFOAM) algorithm [1]. DynamicFOAM is an optimization algorithm, which builds species lists for each community in a region with the constraints on estimates of the number of species present (α-diversity), the pair-wise dissimilarity in species composition (β-diversity) and environmental data linked to the occurrence of species at each site. It is clear from this description that this algorithm requires models of both α- and β-diversity, along with an estimated regional surface of the driving environmental variables. At this stage in the study the group has developed a generalized linear model for α-diversity, currently tested on the available bird's species data (figure 69), with plans to extend this model to other taxa. This model was developed by Mats Mahnken as part of his masters' thesis. The group has also developed a model of β-diversity for a large sample of the studied taxa. This model was developed using generalized dissimilarity modelling and has been developed in conjunction with the focus 2 project lead by Holger Kreft. Due to the development of these models we have completed two out of the three major steps to implementing the DynamicFOAM algorithm, the final step left to be completed is to estimate the driving environmental variables, identified by the α- and β-models, over the entire EFForTS study area. We are currently looking at methods which may be used to produce these estimates. Beyond this we need to implement the algorithm using the available field data and use these results to get a measure of the community composition over space. The results from this analysis will also be used to inform the agent-based model EFForTS-ABM being developed by the B10 group.

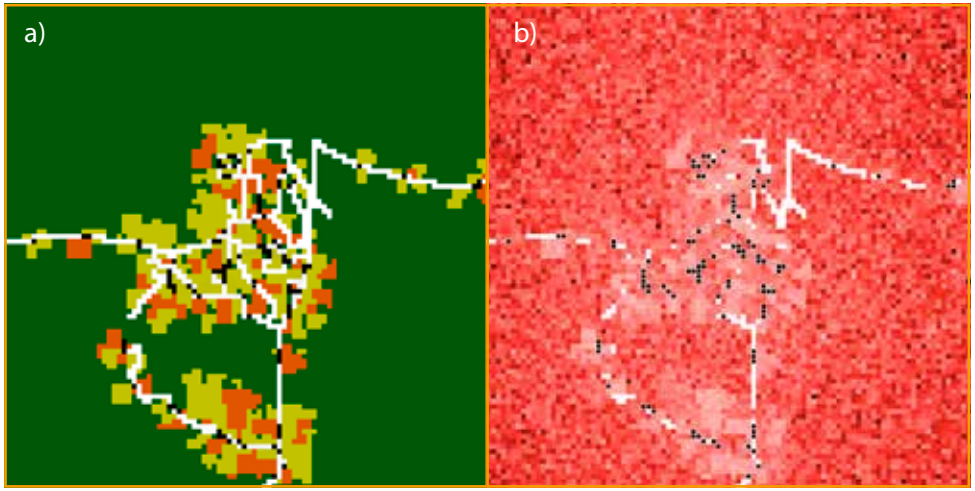


Figure 69. Predicted birds a-diversity, as estimated by our current generalized linear model, integrated into the B10 agent-based model EFForTS-ABM. figure (a) represents the land-uses as represented in EFFoRTS-ABM for an example landscape where green=forest; yellow=oil palm; red=rubber; black=houses; white=roads. Figure(b)represents the predicted a-diversity for this example landscape with darker colors representing higher biodiversity.

References

[1] K. Mokany, T. D. Harwood, J. M. Overton, G. M. Barker, and S. Ferrier. Combing α- and β-diversity models to fill gaps in our knowledge of biodiversity, Ecology Letters, vol. 14, no. 10, pp. 1043-1051, 2011.

Focus 4

TITLE: **Quantifying the effects of spatial, temporal and social heterogeneity on ecological and socioeconomic functions**

REPRESENTATIVES:

Bernhard Brümmer, Thomas Kopp, Teja Tscharntke

RESEARCH SUMMARY:

In the second phase of EFForTS, Focus 4 addresses the heterogeneous nature of the relationships between the dimensions of sustainability in order to identify policy responses for re-balancing of ecological and socio-economic functions in Jambi. Fischer et al (2018) provide a selective overview of possible combinations along two dimensions, food security and biodiversity, as displayed in figure 70. The ongoing work in Focus 4 aims to expand such a perspective by a) including more dimensions of ecosystem services in the context of Jambi (e.g., cultural heritage and aesthetic values associated with specific land use, raw material provision and the associated income generation, or water regulation services); and b) disentangling the effects of within and between landscape heterogeneity on the resulting trade-offs. Simple win-win settings as expected by Fischer et al. at the landscape scale though agro ecological landscapes are unlikely to emerge as effective targets at the policy-relevant scales. Reconciling socio-economic and ecological services seems to require an adequate mix of improved management, sustainable intensification, and less intensive land use in certain areas.

Policy measures with relevance for land use in Jambi have been devised at various levels, after discourses in very heterogeneous policy arenas, from the local and provincial level up to the international level. We currently work on the development of policy scenarios as a tool for coping with the complex interactions between policy measures, governance, and power at various levels. Such scenarios, which consist of a clearly defined set of policy interventions and assumptions on the remaining relevant conditions in the system, will provide a common way of integrating policy in various SPs (e. g., B10 Wiegand/Lay, C09 Klasen et al.) and in our focus 4.

Developing policy scenarios for such ends entails a number of steps. We are currently in the process of the first step: in light of our previous and ongoing research activities, the focus consortium identifies the core policy dimensions which have shaped land use in Jambi over the past decades, e.g., transmigration programmes, land rights policies, or environmental regulations. Angga Eko Emzar, a master student in C01, has written a seminar paper entitled "Indonesian Rubber Policy Overview: International and Domestic Applied Rubber Policy Measures and Its Impacts on Rubber Trade During 38 Years". This paper has been presented at a seminar, attended by CRC researchers.

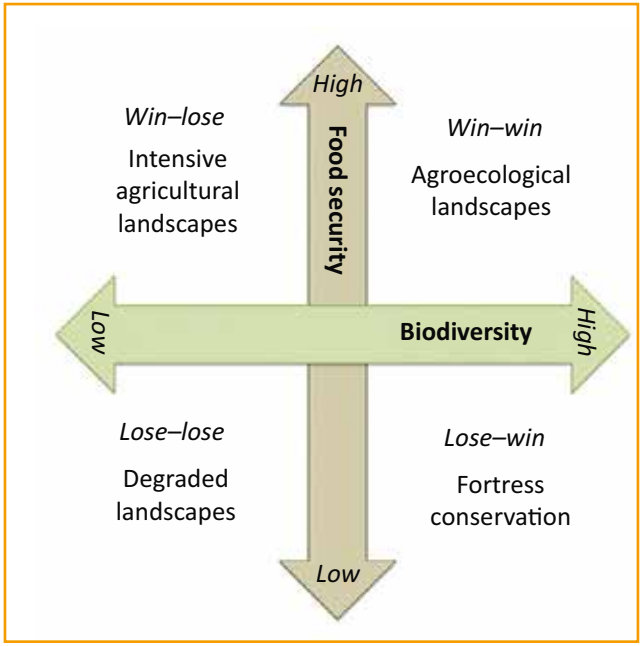


Figure 70. Selective overview of possible combinations along two dimesnions, food security and biodiversiy; Fischer et al., 2018).

Once the manuscript with the policy inventory is ready, a simplified foresight process will be done for those policy dimensions – what are the major drivers of change in the mid-term and long-term, and which plausible policy measure in the aforemen¬tioned dimensions would be suitable to address these changes? Finally, these policy measures will be combined into a set of scenarios, which can be thought of typical bundles of specific policy options. In interaction with individual SPs, these scenarios will be further refined according to the modelling needs in the specific SPs.

Such a coordinated approach across the policy relevant SPs will facilitate a comparative assess¬ment at a later stage. In addition, the combina¬tion of individual measures into scenarios will allow to go beyond the unidimensional analysis of individual policy measures. In order to devel¬op such policy scenarios, an initial meeting will be scheduled towards the end of this year, where input from the all CRC members will be collect¬ed. From this first collection of ideas, a set of sce¬narios will be distilled and distributed to all CRC members for comments and additions. Close collaboration with the projects that implement policy analysis and modelling will ensure that the final scenarios can be broadly used across different SPs.

References

[1] Joern Fischer, David J. Abson, Arvid Bergsten, Neil French Collier, Ine Dorresteijn, Jan Hanspach, Kristoffer Hylander, Jannik Schultner, and Feyera Senbeta (2018): Reframing the Food–Biodiversity Challenge. In: Trends in Ecology and Evolution (forthcoming).

III. ABS – Biodiversity Research, Access to Genetic Resources and Benefit Sharing

1. **Complementary research projects of counterparts and stakeholders in 2017 and 2018**
2. **Capacity building workshops (2018)**
3. **CRC-ABS scholarships**
4. **Supplementary measures**

The approval of the *Convention on Biological Diversity* (CBD) in 1992 was the first step of a new approach to the biodiversity resources and their use, which includes the national sovereignty principle, mutually agreed term and sharing benefits of the use of biodiversity. The Nagoya Protocol on *Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization* to the Convention on Biological Diversity (ABS) is the legally binding mechanism to implement access and benefit sharing. Both Germany and the EU signed it on 23 June 2011 and the Republic of Indonesia on May 11, 2011. The DFG is one of the few funding agencies around the world that has implemented (since 2002) its own guidelines to promote the application of the principles and procedures of ABS among its applicants. It actively takes part in international discussions on ABS, particularly advocating for the requirements of basic (non-commercial) biodiversity research and for facilitating access according to article 8a[1] of the Nagoya Protocol (https://www.cbd.int/abs/text/).
In 2013, DFG approved funding of ABS measures with central research funds of the CRC 990, and since November 2013, EFForTS supports the project partners in Indonesia.

In Phase 1 (2012–2015), EFForTS awarded 33 short-term research grants to counterparts and stakeholders (LIPI, PTPN VI, PT Humusindo, BKSDA, PT REKI, Ministry of Forestry) to strengthen the research cooperation and to complement existing research activities addressing new scientific questions. Besides, EFForTS set up a research station at PT. Humusindo and a field laboratory at the National Park Bukit Duabelas, and provided compensation payments for farmers (plot owners).

In Phase 2 (2016 to 2019), the ABS funding scheme has been extended. In addition to the promotion of complementary research projects of counterparts and stakeholders, EFForTS supports capacity building workshops and awards scholarships for junior researchers at the partner universities in Indonesia. The CRC-ABS scholarships conform to the DAAD (German Academic Exchange Service) guidelines.

1 Nagoya Protocol, article 8a. Special considerations: Create conditions to promote and encourage research, which contributes to the conservation and sustainable use of biological diversity, particularly in developing countries, including through simplified measures on access for non-commercial research purposes, taking into account the need to address a change of intent for such research.

1A. ABS – RESEARCH PROJECTS OF COUNTERPARTS AND STAKEHOLDERS IN 2017

In 2017, the Joint Management Board in Indonesia approved 30 research grants in the amount of Rp 1.390.945.500 (ca. 80.000 EUR) from counterparts and stakeholders. ABS-project deliverables conform to the new funding scheme regulations by DIKTIRISTEK in Indonesia.

SUMMARY REPORTS OF FUNDED ABS PROJECTS IN 2017

Research projects of counterparts funded at IPB

Name	Counterpart	Title
Rika Raffiudin	A01	The Effect of land-use change on the foraging behavior and pollen diversity in honey of the Giant Bee *Apis dorsata* in Sumatra, Indonesia

Background

The giant honey bee *Apis dorsata* is the most efficient and common pollinator in Indonesian natural and agroforestry ecosystems. It is also important for honey production. The bees migrate annually, flying to the regions where plants are in bloom and nesting in certain trees, commonly Gluta renghas. However, much of the natural forests in Sumatra have been logged on a large scale and since then converted to monoculture plantations of acacia (*Acacia* sp.), oil palm (*Elaeis guineensis*), or *Eucalyptus*. It is unknown how *A. dorsata* is responding to these changes and it needs scientific investigation. We thus investigated: (1) the foraging behavior of *Apis dorsata* and, (2) the pollen content of the honey harvested from *A. dorsata* in landscapes dominated by plantations (Kampar, Riau) and forest (Kerinci, Jambi) in Sumatra.

Method

Two colonies of *A. dorsata* each in Kampar and Kerinci were observed at their nesting tree from a tree-house hide 20-30m above the ground. We measured the numbers of bees flying out of the nest, flying into the nest with and without pollen and the flight directions. Honey was harvested from all the colonies. The pollen in the *A. dorsata* honey was analyzed using a combination of acetolysis preparation and fuchsine stain (to account for pollen with delicate features). A total of 1200 pollen grains were counted and identified in each honey sample.

Results

The foraging activities of *A. dorsata* showed similar patterns in the different regions of Kampar and Kerinci. However, there were many fewer foraging bees at noon in Kampar than in Kerinci. Of the three directions of flight in Kampar, the southwest direction was the dominant one taken by the bees. The nesting tree of *A. dorsata* in Kampar was in remnant forest surrounded by an area of eucalyptus and oil palm plantations. Based on our observation, the southwest foraging direction taken by the bees was to the oil palm plantation. Analysis of

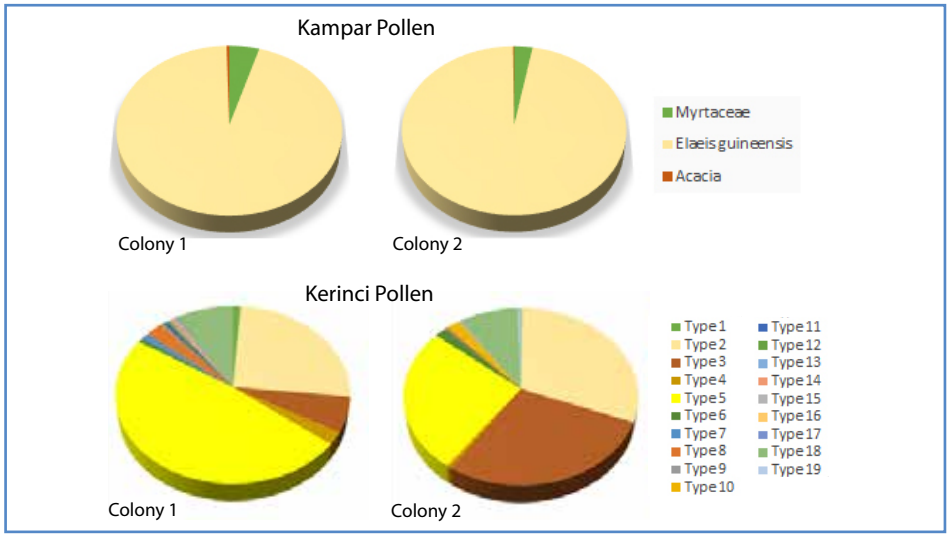


Figure 71. Bee pollen from honey in colony 1 & 2 in Kampar and Kerinci (Kerinci pollen identification still ongoing).

the pollen content of the honey harvested from Kampar revealed that oil palm (*Elaeis guineensis*) pollen dominated (figure 71). This was in agreement with bee flight direction. Our study is the first description of way in which land use affects the ability of the giant honey bee to forage adaptively for pollen from the monoculture plantations surrounding their nest. In contrast, however, in Kerinci, there was no dominant pollen taxon. Those most abundant were from *Ilex* and the Asteraceae family. Pollen concentration and pollen diversity are much higher in Kerinci compared to Kampar (figure 71). The more diversified foraging behavior of *A. dorsata* in a more diverse heterogeneous landscape of forest and agriculture Kerinci (Jambi) landscape suggests adaptive behavior of this important pollinator bee.

Tania June, Yudha Kristanto	A03	Turbulence characteristics of the oil palm canopy and their influence on sensible and latent heat fluxes

Objectives

To analyse the turbulence characteristics of the oil palm boundary layer surface and determine their implications for energy and water vapour fluxes.

Methods

Micrometeorological profile data (solar radiation, air temperature, wind speed and direction, humidity, soil temperature, and air pressure) were collected from the micrometeorological tower station in PTPN VI Jambi for the period 2014–2017. The turbulence characteristics were analysed using the profiles and gradients of the atmospheric characteristics (solar radiation, wind speed, temperature and water vapour) to produce surface roughness (roughness length, zo and zero plane displacement, d), turbulence transfer coefficient Km, and friction velocity u*, shearing stress τ and TKE (turbulence kinetic energy). Fluxes of energy, momentum and water vapour were calculated using the aerodynamic method. Influences of the atmospheric stability (neutral, unstable and inversion/stable) were taken into consideration using the Richardson Number Ri and the generalized stability factor ζ. The effect of turbulence on momentum and heat fluxes were determined and correlated with the eddy correlation measurement.

Research Summary

Turbulent motion in the air is generated by two main factors, i.e. buoyancy production and friction between moving air and rough surfaces (figure 72). Turbulence reached maximum when surface heating was greatest under unstable conditions during the day time over rough canopy surfaces and dissipated at

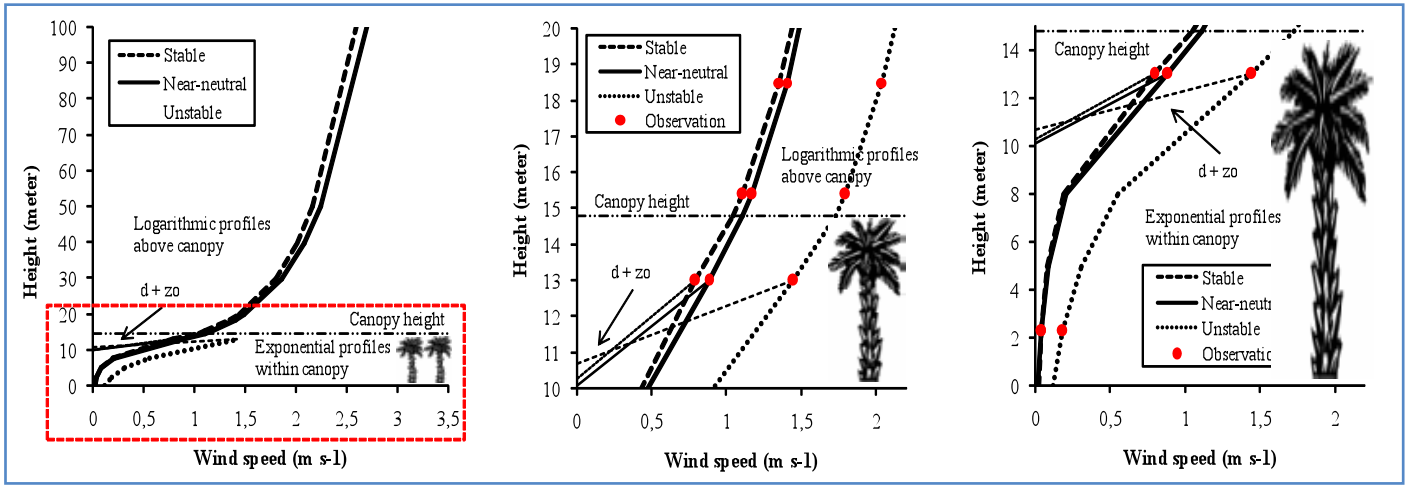
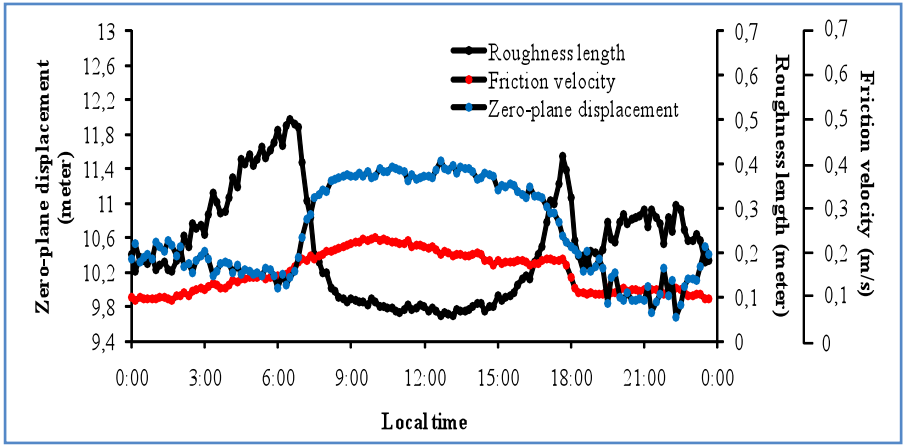


Figure 72. Wind profile characteristics above and below oil palm canopies under stable, neutral and unstable atmospheric stabilities (data analysed from 2015). The surface roughness was obtained through aerodynamic wind profiles and corrected using Monin-Obukhov's similarity theory. Above the canopy, wind profile follows the logarithmic pattern with equation: $u(z) = \frac{u_*}{k} * \{\ln(\frac{z-d}{zo}) - \Psi m(\zeta)\}$. Under the canopy the wind profile follows an exponential pattern with equation: $\bar{u}z = uh * e^{\alpha(\frac{z}{h}-1)}$. Ψm (ζ) is the correction factor for atmospheric stability and is correlated with Richardson number Ri and α is the attenuation coefficient for wind in oil palm canopy calculated as 2.7 (function of LAI and wind profile). The zero-plane displacement (d) value of oil palm is 10.31 11.14m (≈ 0.7-0.75 canopy height, hc), roughness length (zo) 0.18-0.49 (≈ 0.01-0.02 canopy height, hc), and friction velocity (u*) 0.13-0.20ms^{-1}.

night time. The turbulence characteristics (roughness length z_o, zero plane displacement *d*, friction velocity u*, and turbulence kinetic energy TKE) of oil palm were studied for the period 2014-2017. The data were collected from the site at PT Perkebunan Nusantara VI Batanghari, Jambi. The palms were 14.8 meters tall with LAI 2.05, and the canopy coverage was 78.6%. The structure of the oil palm canopy relates to its surface roughness and influences meteorological profiles and turbulence. Increased wind speed increased friction velocity, roughness length + zero-plane displacement, and increased turbulence (figure 73). Turbulence kinetic energy is strongly influenced by the magnitude of friction velocity. It is generated by wind shear and buoyancy, transported by pressure fluctuations and divergences, and dissipated into thermal energy (figure 74). All these components relate significantly to the amount of heat flux (both latent and sensible) with R^2 more than 0.75. Most of the energy available in the oil palm was used for evapotranspiration (latent heat fluxes), rather than sensible heat fluxes indicating that the palms had no lack of water during the period of measurements.



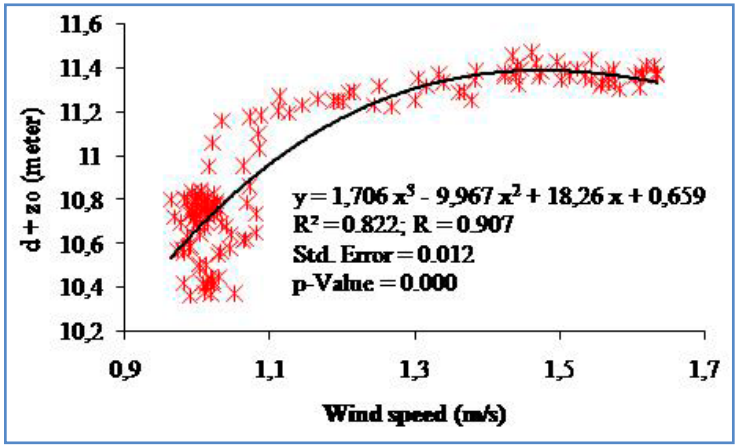
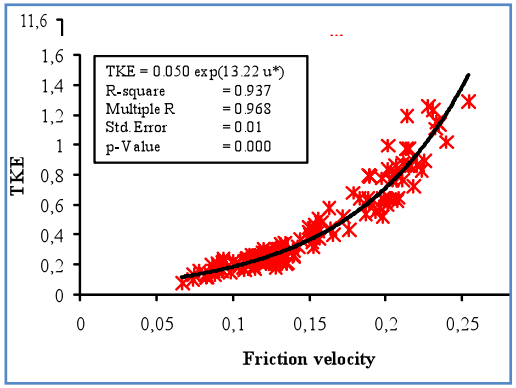
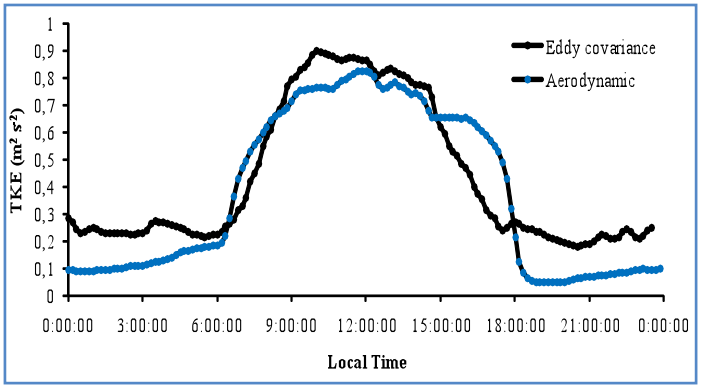


Figure 73: Diurnal pattern of turbulence characteristic parameters of oil palm (above). Data from 2014-2017 were averaged at intervals of 10-minutes. The average diurnal value of d = 10.71m, zo=0.26m and u* = 0.16ms^{-1}. The surface roughness parameter d+zo is significantly influenced by wind speed (below).





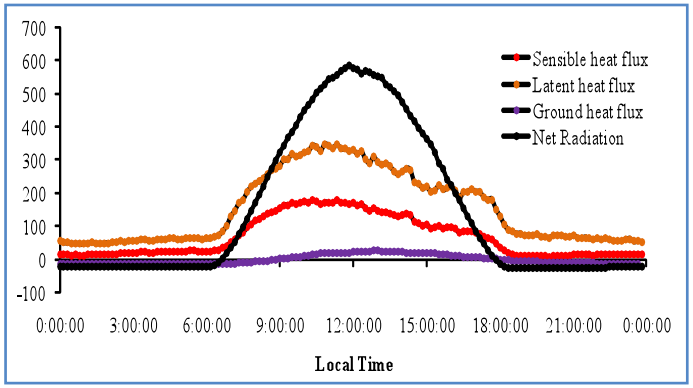


Figure 74: Diurnal pattern of Turbulence Kinetic Energy (TKE) (above) control the pattern of latent and sensible heat fluxes (below). The existence of turbulence significantly enhances the flux transfer process (with $R^2 > 0.75$).

Kukuh Murtilaksono	A04	Dissolved organic carbon under oil palm plantation in the small catchment of PT Perkebunan Nusantara VI, Jambi

Introduction

Research on dissolved organic carbon (DOC) carried by surface water and stream water is still very rare, particularly in Indonesia. The carbon content of the soil can be successfully used to predict the mean concentration in stream water in a catchment (Aitkenhead et al. 1999). The OBJECTIVES of this study were to characterize the DOC of stream water under oil palm plantation in a small catchment (Bajubang) in PT Perkebunan VI, Jambi province.

Methodology

The research was carried out from June to December 2017 in the Bajubang catchment of 168 hectares under oil palm plantation. Water was sampled 27 times during five months at five sites along the course of the stream in the upper, middle, and lower regions of the catchment. The water samples were analysed for the concentration of Na by emission, PO4 using blue molibdate, and for Fe, Al, and Mn using atomic absorbtion spectrophometer. DOC was measured by spectrophotometer at an absorbance of 254nm. Data on daily precipitation was taken from a nearby weather station run by another research team. Correlation analysis was applied to DOC and other parameters to determine the hydrological characteristic of the catchment. The concentration of DOC at the outlet of the catchment was determined using stream discharge data.

Result and Discussion

DOC is highly and positively correlated with the concentrations of Al (r=0.88) and Fe (r=0.94), with PO4 (r=0.73) and, although slightly lower, with Mn (r=0.62). There was no or only low correlation between DOC and Na cation concentration (r=0.35). In the soil profile at Bukit Duabelas National Park, Jambi DOC was more highly correlated with Fe and PO4 than Na (Murtilaksono et al. 2016; Anwar et al. 2016).
DOC concentration is significantly and highly correlated with the discharge of the stream (r=0.94) (figure 75).

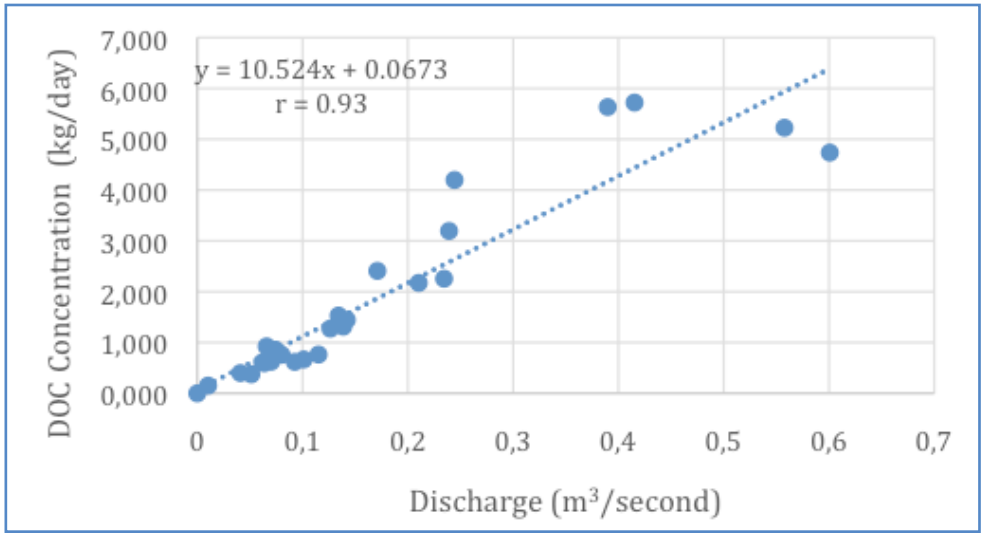


Figure 75. Correlation of dissolved organic carbon (DOC) concentration and stream discharge of the catchment Bajubang in PT Perkebunan VI, Jambi province.

The average DOC transported along the stream was 10.76 kg per day or 290.65 kg during the whole 27 days of sampling. Thus there is a large amount organic carbon that is dissolved in the water and washed out of the catchment.

References

[1] Anwar S, Murtilaksono K, Hartono A, Putra GS. 2016. Fluxes of dissolved organic carbon and nutrient leaching in a toposequent of Bukit Dua Belas National Park, Indonesia. International Journal of Advances in Science, Engineering and Technology(IJASEAT) Vol-4,Iss-4 (Spcl Iss- 2)
[2] Murtilaksono K, Anwar S, Hartono A, Sunarti, Kuzyakov Y. 2016. Dissolved organic carbon flux on a toposequent in Bukit Dua Belas National Park, Indonesia. International Journal of Advances in Science, Engineering and Technology (IJASEAT) Vol 4, Iss-4 : 45-47.

Anja Meryandini, Mazidah Noer Inayah	**B02**	Isolation and selection of *Actinomycetes* with xylanase and cellulase activity

Background

Soil is a habitat dominated by microorganisms such as bacteria, fungi, algae, and protozoa. The quality and quantity of these microorganisms affect soil fertility because the microorganisms act as microbial decomposers (Rao 1995). The diversity of microorganisms is determined by the availability of food for microorganisms. Lignocellulosic litter is composed of cellulose, hemicellulose and lignin. Culture methods were used to isolate xylanolytic and cellulolytic actinomycetes. The main objectives of this study were to isolate xylanolytic and cellulolytic actinomycetes so that they could be used in further research such as using the isolates as to produce fertilizers or to produce prebiotics.

Approach

Soil samples were collected from jungle rubber plots, rubber plantations and from oil palm plantations. The actinomycetes were isolated using HV Agar ISP4 Media. Xylanolytic actinomycetes were selected using xylan media and cellulolytic actinomycetes using CMC media. The quality of the enzymes was calculated using hydrolytic index.

Results

From the eleven samples we isolated 99 Actinomycetes. Of these 84 had xylanolytic or cellulolytic activity. The actinomycetes were grouped by colour: white, grey, dark brown, brown, black, yellow, red (figure 76).

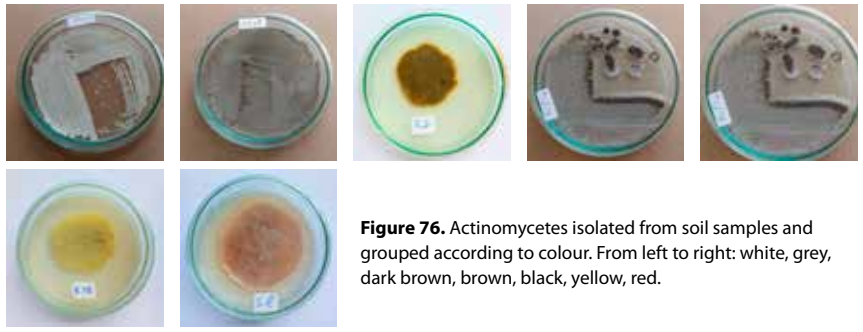


Figure 76. Actinomycetes isolated from soil samples and grouped according to colour. From left to right: white, grey, dark brown, brown, black, yellow, red.

Triadiati Antono	**B04**	Root hydraulic conductivity of rubber and oil palm in riparian and non-riparian sites in Jambi Province

Background and methods:

Water movement from the soil to the atmosphere is controlled by the conductance of the components of the hydraulic pathway. Accordingly, roots have an important role in water uptake and transport through the xylem to the shoot. The water transport rate through the xylem is determined by the hydraulic efficiency of the conductive cells. Therefore, xylem hydraulic properties play an essential role in supporting growth and photosynthesis and influence sensitivity of plants 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 as yet very limited, especially in tropical agroforestry systems that differ seasonally in water availability.

The scientific project B04 focuses on the diversity of tree hydraulic strategies in both intensively used and natural tropical landscapes in Jambi, Sumatra. Due to the complexity of this topic, researchers from Germany will focus on the aboveground component (stem hydraulic properties) and researchers from Indonesia will focus on the belowground component (root hydraulic properties). We will jointly analyse the dataset and correlate root and stem hydraulic conductance to each other and to total aboveground growth performance.

The OBJECTIVE of the study is to analyse the variability in xylem anatomy and the derived hydraulic traits of small- and medium-sized roots (1 10mm in diameter) up to a soil depth of 0.5m in each of four riparian and non-riparian rubber and oil palm sites. We predicted that (i) vessel diameter and hydraulic conductivity is a function of root diameter and that (ii) vessel diameter and hydraulic conductivity differ between riparian and non-riparian sites in equally-sized roots.

The study site was located in Jambi, in rubber and oil palm plantations in both riparian and non-riparian sites. In order to analyse the root diameter and the root anatomy and to derive the hydraulic properties of the roots, root segments were assessed across a 0.5m deep soil profile.

For the complete xylem cross-sectional area without bark, we determined the total hydraulic conductance, calculated from single vessel diameters. The potential hydraulic conductivity was calculated according to the Hagen Poiseuille equation.

Sri Wilarso Budi	**B07**	Abundance and diversity of arbuscular mycorrhizal fungi from different ecosystems in Jambi, Sumatra

Background and Methods

Mycorrhizal fungi play important roles in a sustainable soil-plant system. These fungi provide numerous benefits to their host including better phosphorous (P) nutrition, increased absorption of nitrogen, production of plant growth hormones, defence of the roots against soil borne diseases, and increased plant growth and productivity. Arbuscular mycorrhizal fungi (AMF) are a type of mycorrhizae that are very widespread in natural ecosystems. The OBJECTIVES of this research were to determine the abundance and diversity of AMF under different land use types in the lowland rain forest zone located in Bukit Duabelas National Park and Harapan Forest Jambi Province compared to riparian areas in the same region.

Results

The number of AMF spores in oil palm plantations was higher than in all other ecosystem types whether in Bukit Duabelas, Harapan Rain Forest or in the riparian ecosystem (figure 77). This finding is of interest because it confirms results in non riparian transformed ecosystems. This research also demonstrates that in transformed riparian ecosystem the number of AMF spores was higher in oil palm plantations than in either natural forest or in rubber plantations. AMF have a seasonal pattern of spore production that is closely related to plant phenology. Ecosystem disturbance may also influence the abundance and distribution of AMF spores. Rubber plantations and oil palm plantation are disturbed ecosystems and have higher spore numbers than undisturbed jungle rubber ecosystems. The number of AMF spores in an ecosystem is correlated with P availability in the soil. The greater the availability of P in the soil the lower the number of AMF spores is likely to be. High P availability indicates a fertile soil but low P availability indicates the contrary, an infertile soil. The diversity of AMF spores was low in disturbed ecosystem (figure 78). This low diversity of AMF species in oil palm plantations might be due to (i) loss of host plants and (ii) unfavourable edaphic conditions for regeneration of AMF in the transformed land. The amount of organic matter in the soil also plays an important role in AMF sporulation. Further research is needed to determine whether the transformation of forests to rubber plantation or oil palm plantation reduces soil fertility.

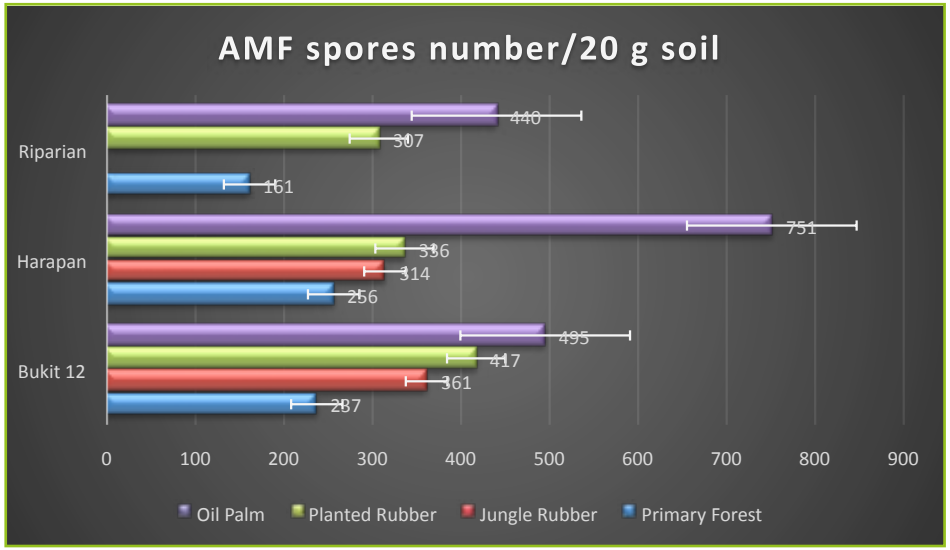


Figure 77. Number of AMF spores in different ecosystem types. Jambi Province.

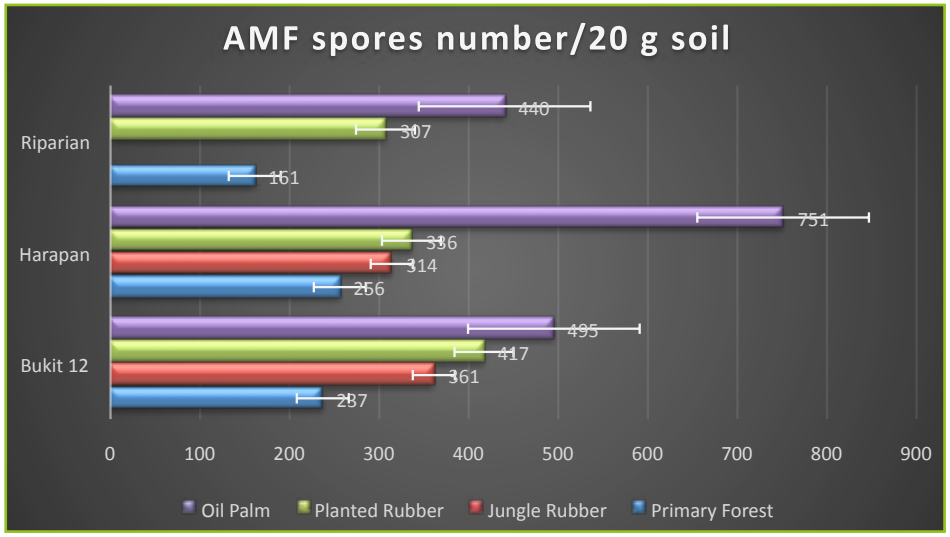


Figure 78. Number of AMF genera in the different ecosystem types, Jambi Province.

Yeni Aryati Mulyani	B09	Assessment of understory bird community using mist nets and capacity building by training novice bird banders

Background and Objectives

Until this study, there was only a little information on understory birds in urban forest parks in Jambi City. Furthermore, there is still little study of bird communities using mist nets in Indonesia because local researchers do not have the necessary skills. Therefore, the objectives of this project were to investigate the understory bird community in urban forest parks and, at the same time, improve the skills of local young researchers in Jambi in using mist nets in studying bird communities.

Methods

The activities consisted of a workshop, field practice, and data collection in Muhammad Sabki Urban Forest Park, Jambi City. The training workshop included topics such as bird banding ethics, the authorization of bird banding authority and the necessary permits, and simple methods of surveying birds. The field practice lasted for a total of five days. It included learning techniques of surveying birds, setting up mist nets (figure 79), bird identification, handling birds whilst taking morphometric measurements, and identifying molt status and brood patch presence. Bird surveys were also conducted between bird banding activities. Participants were required to make a short presentation at the end of activities in October 2017.

Figure 79. Training participants practicing setting up mist nets

Figure 80. The two protected species that were captured and banded during the project: Collared Kingfisher (a), and Blue-eared Kingfisher (b)

Figure 81. Training workshop participants at Muhammad Sabki Urban Forest Park, Jambi

Results

A total of 23 bird species were recorded during the activities, although only 8 species from 10 individuals were captured and banded. Three of the species recorded are protected by Indonesian law, two of them were captured and banded (Collared Kingfisher and Blue-eared Kingfisher, figure 80). There were fourteen participants in total. They consisted of UNJA students and B09 assistants plus an observer from Kerinci Bird Club (figure 81). The UNJA students had no

previous experience with mist netting and only limited knowledge of birds. But all were able to set up mist nets after the training in October. At the end of the training period, the participants established a bird study group that is still currently active. This project showed that the isolated urban park forest still holds a diverse bird community, which includes protected species, but only few species used understory vegetation. The activities improved the knowledge and awareness that the participants have about bird research methods and motivated them to be involved further in bird research.

Damayanti Buchori, Akhmad Rizali	**B09**	Effect of land-use types on species diversity and composition of insect pollinators in Jambi

Background and Objectives

Insect pollinators are a group that plays an important ecosystem role. However, their presence can be affected by land use changes as is the case for ants (Rubiana *et al*., 2015). The objectives of this research are therefore to investigate the effect of land-use types, both in wet and dry sites, on the species richness and the composition of insect pollinators in Jambi.

Methods

The ecological research was conducted from August to October 2017 in the Harapan landscape in wet and dry sites. Each site contained different land-use types i.e. secondary forest, oil palm plantations, and rubber plantations. Insect pollinators were collected by direct sampling (insect net) and traps (malaise, yellow pan and yellow sticky traps). Direct sampling was conducted on flowering plants and all traps were placed around flowering plants inside 50x50m plots.

Results

In total, we found 442 individuals belonging to 3 insect orders (Hymenoptera, Lepidoptera, and Diptera). These 442 fell into 47 pollinator morphospecies. Analysis of variance showed that species richness differed significantly between land-use types ($F_{2,20}$=7.052 P=0.004) but not between different sites (i.e. wet vs dry) ($F_{1,20}$=0.191 P=0.666). The abundance of insect pollinators was also significantly different between land-use types (F2,20=5.242 P=0.014), but not between sites ($F_{1,20}$= 0.087 P=0.7706). The abundance of insect pollinators was higher in oil palm and rubber plantations than in secondary forest. This indicates that insect pollinators prefer an open canopy (oil palm and rubber plantations) than a dense canopy (secondary forest).
The species composition of insect pollinators differed significantly between land-use types in the dry site (R=0.760, P= 0.002) but not in the wet site (R=0.218, P= 0.073). Some species seem to be more different between land use types than others. For example, the genus *Tetragonula* (Hymenoptera: Apidae) were more highly abundant in secondary forest than in oil palm and rubber plantations, whereas *Ceratina* spp. (Hymenoptera: Apidae) and *Ypthima* spp. (Lepidoptera: Nymphalidae) were more highly abundant in rubber and oil palm plantations (figure 82).
In conclusion, land-use types have an impact on the presence of insect pollinators both in richness and abundance.

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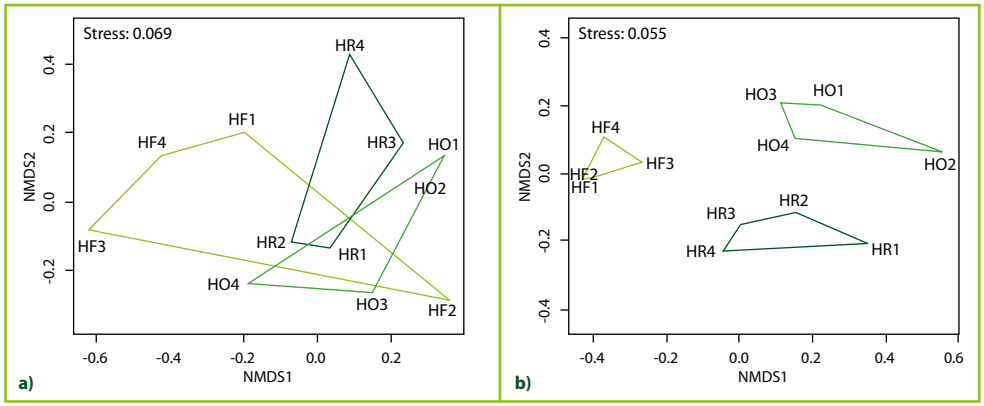

Figure 82. NMDS ordination of species composition of insect pollinators between land-use types in (a) the wet site and (b) the dry site based on Bray-Curtis dissimilarity index (HF = Secondary Forest; HR = Rubber Plantation; HO = Oil Palm Plantation).

Suria Darma Tarigan	**B10**	Assessing the relative impact of changes in soil infiltration and plant evapotranspiration on catchment water yield in the Tropical Lowland Rainforest Transformation Systems (Sumatra, Indonesia)

Background and Objectives

Infiltration and evapotranspiration have a dominant role in water flow regulation. Water flow regulation, in turn, affects water yield and so determines whether there is water scarcity (drought) or excess (flooding) in an area. The evapotranspiration rate is determined mostly by land use or vegetation type but the infiltration rate depend on soil management practices. The infiltration rates in the rainforest transformation system falls into two categories. There are high infiltration rates (>30 cm h^{-1}) under forest but low infiltration rates (<10 cm h^{-1}) under agricultural plantations (oil palm and rubber) (Tarigan et al. 2016).

The OBJECTIVES of the research were: a) to measure infiltration rate in oil palm plantations under different management practices and, b) to assess the relative impact of changes in soil infiltration and plant evapotranspiration on the catchment water yield.

Methods

Data was collected in the PTPN VI and Harapan landscape in Jambi Province. The data collected was: a) soil infiltration rate under different land uses and plantation management practices (including mechanical and manual weeding), b) continuous river discharge for the calibration of a watershed hydrological transport simulation model, c) changes in evapotranspiration assessed from data in the literature. Infiltration was measured using a double ring infiltrometer. Continuous river discharge was measured using a HOBO data logger. The Soil & Water Assessment Tool (SWAT) hydrological transport simulation model was then used to assess the relative impact of change in soil infiltration and plant evapotranspiration on the catchment water yield. The research question was whether reduced infiltration or increased transpiration had caused significant impact on the catchment water yield. To answer this question, we calibrated and validated the SWAT model and assessed the relative impact of changes in plant transpiration and soil infiltration on the catchment water yield component.

Results and Conclusion

We found that soil infiltration rates under oil palm are very low (0.1 2.3 cm $hour^{-1}$, figure 83). Soil degradation and compaction are probably the reasons for these very low infiltration rates.

The infiltration rates in oil palm plantations are very low due to soil degradation and compaction and minimal management. Changes in the soil infiltration rate have a greater effect on fluctuations in catchment water yield than do changes in evapotranspiration. The fluctuations in catchment water yield because of the changes in the soil infiltration rate have the potential to lead to water scarcity during the dry season and flooding during the wet season.

Based on the SWAT simulation model, changes in the soil infiltration rate affected the catchment water yield more than changes in evapotranspiration (figure 84).

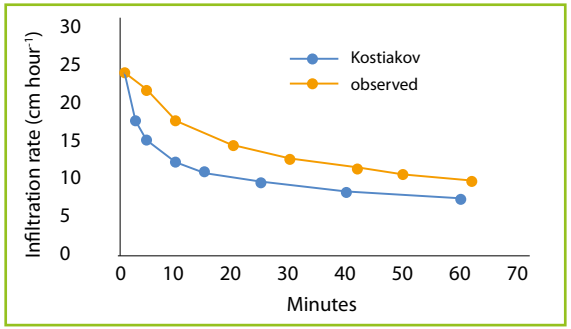

Figure 83.
The very low infiltration rates under oil palm (in cm $hour^{-1}$). Comparison of the Kostiakov model predictions (blue) and the observed rates (orange).

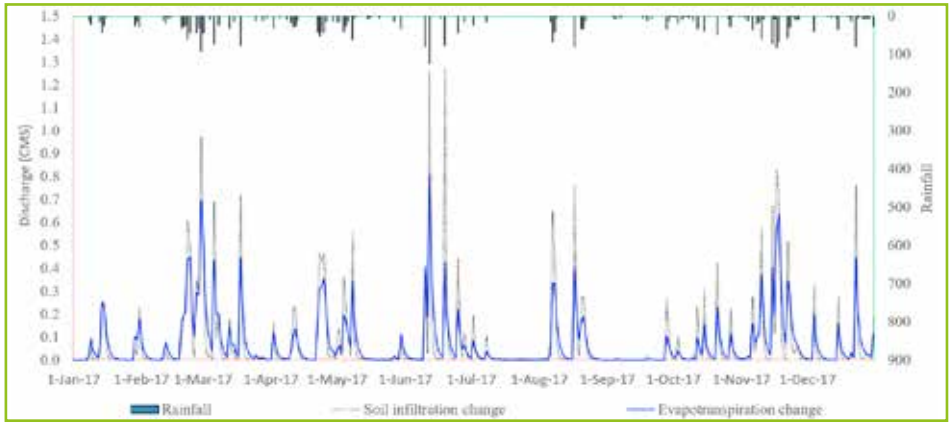

Figure 84. Relative impact of change in infiltration and evapotranspiration on the catchment discharge.

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Leti Sundawati, Budi Kuncahyo	**B11**	Oil palm agroforestry yield and financial estimation modeling

Background and Methods

The study was conducted at the B11 – Biodiversity enrichment experiment in oil palm plantations (EFForTS-BEE) of PT Humusindo, Jambi Province. To provide an illustration of the expected future yield and financial benefit of the biodiversity enrichment experiment, we applied system modeling, a method for estimating the future condition and situation based on the previous and current situation.

Results

There were 6354 trees of 6 species planted in the 48 plots of the experiment. About 3 years after planting (last measurement on September 2017), not all tree species were growing well. Only sungkai, petai and jengkol showed very good growth performance (survival rate, diameter and height). Their average diameter, height and production (timber volume or fruit production) were then estimated using the volume estimation formula: $V=1/4*\pi* D^2 *T*f$ where f=0.7. The yield of sungkai, jengko and petai were simulated for 25 years (sungkai) and for 30 years (jengkol and petai) using the software program STELLA (figure 85).

Sungkai wood is categorized as fancy wood, because it has an attractive grain pattern. This wood is therefore usually used for furniture and interior design. Sungkai is usually harvested at 20-25 years old. Petai start bearing fruit at 5 7 years old and continue until they are 23-28 years old. When young they produce about 200-300 fruits but the number increases to 1000 1100 at 15 years old. The jengkol, petai and sungkai trees planted in the experimental plots are still young (about 3 years old). Nevertheless, some of the jengkol trees have already started fruiting. Jengkol starts to produce fruit at 4 5 years old and is able to continue producing until 25-30 years old. Mature jengkol trees are able to produce about 15-20 kg jengkol beans.

The size of tree islands or plots size or plot size affects the ecological and economic benefits of biodiversity enrichment plantings (Teuscher et al. 2016; Gerard et al. 2017). The bigger the tree island the higher the ecological and economic (in regard to oil palm yield) benefits. Based on these results, the model used in our research assumed an island size of 40x4m (1600m^2), biodiversity levels of 1, 2, and 3 species, and planting distance 5x5m. It also assumed a smallholder oil palm plantation of about 3ha as the management unit. The biodiversity enrichment plot was simulated as being in the middle of the 3ha oil palm plantation. The financial benefit estimation was therefore based on 2.7ha oil palm and a 0.16ha tree island. At PT Humusindo the oil palms are planted in a 9x9m triangular grid, resulting in ~143 oil palms per hectare. The fresh fruit bunch (FFB) price received by farmers during the research period was IDR 1500/kg, the market price of jengkol and petai was IDR 5000/kg, and sungkai IDR 2,000,000/m^3.

Monoculture oil palm and oil palm agroforestry with different biodiversity enrichment levels was financially analyzed using feasibility criteria of Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Rate of Return (IRR). At an interest rate

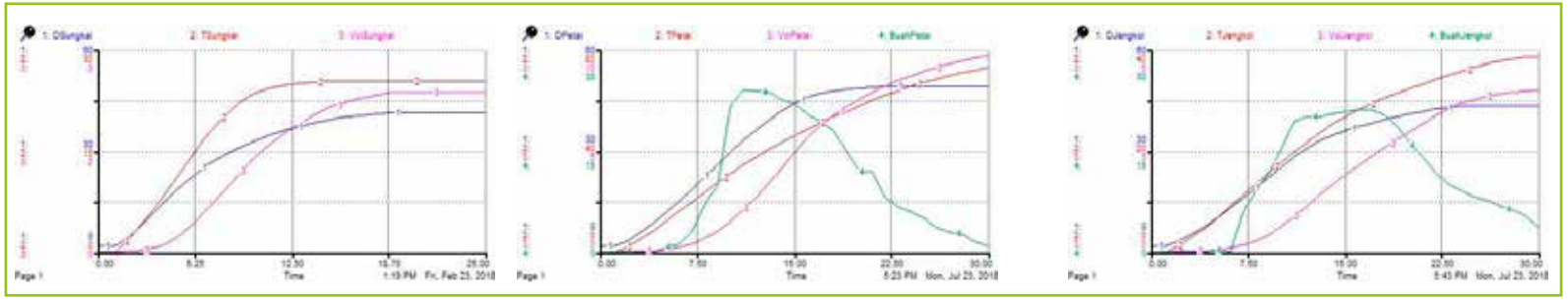

Figure 85. Estimation of the average diameter (cm), height (m) of sungkai (left), petai (middle) and jengkol (right) and volume (m^3) of sungkai, fruit production (kg) of petai and jengkol planted in B11 plots. Blue line (-1-) is tree diameter, red line (-2-) is tree height, purple line (-3) is tree volume and the green line (-4-) is fruit yield.

of 8%, time of 25 years and management unit of 3ha, monoculture oil palm is a very feasible investment with high NPV (IDR 162,685,167). But enrichment oil palm plantation with sungkai, jengkol and petai, not only with one species but also with 2 or 3 species (sungkai, jengkol, petai) give higher NPV, BCR, and IRR. Therefore, biodiversity enrichment of oil palm plantations using high economic value tree species in island plots of 1600m^2 at every 3ha oil palm plantation gives higher returns than monoculture oil palm. Enrichment thus provides economic as well as ecological benefits.

Iskandar Z Siregar	**Z02**	Developing DNA barcoding markers for *Shorea* species

Background

Shorea spp are ecologically and commercially important tropical forest dipterocarp tree species in Indonesia. However, it is still a challenge to correctly identify species in the field because the species are morphologically similar at the seedling stage. I therefore carried out two main activities. One was identifying endangered Dipterocarps in Harapan Rainforest, Jambi using DNA Barcoding ITS2 (Chen et al. 2010). The other was identifying three of the main *Shorea* species in Harapan Rainforest, Jambi using ITS1 and ITS2 (Essene 2014). This study was also part of the *Shorea* project.

The OBJECTIVE of this research was to develop DNA barcoding markers able to reliably discriminate between Shorea species in Harapan Rainforest, Jambi, Sumatra, Indonesia using Internal Transcribed Spacers (ITS).

Approach

DNA samples were taken from the leaves of five endangered dipterocarps *(Shorea accuminata, S. guiso, S. leprosula, Hopea mangarawan, and H. sangal)* in Harapan Rainforest, Jambi Province, Indonesia. ILTS2 was then amplified from the DNA (Chen et al. 2010). The DNA sequences were then used to construct phylogenetic trees using Neighbour Joining (NJ) clustering.

Further, DNA sample were collected from three *Shorea* species i.e *S. ovalis, S. leprosula*, and *S. guiso*, from Harapan Rainforest, Jambi Province, Indonesia. The

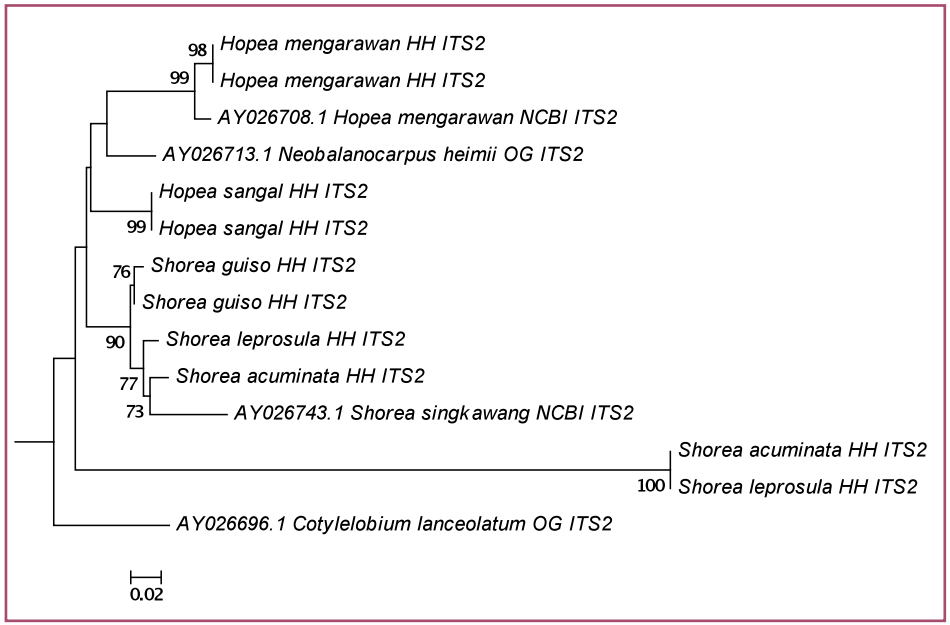

Figure 86. Phylogenetic tree based on ITS2. HH: Hutan Harapan/Harapan Rainforest, OG: out group, cf.: confirmation.

ILTS1 and ILTS2 were then amplified from the DNA samples. The edited sequences were assigned as barcodes to a particular taxon by comparing them with the nucleotide sequences in BLAST, NCBI.

Results and Conclusions

The phylogenetic tree constructed using ITS2 showed that ITS2 successfully differentiated *Hopea* species from *Shorea* species (figure 86). This finding indicated that ITS2 loci differentiated between these dipterocarp genera. However, it was not possible to differentiate between the three Shorea species.

ITS1 successfully identified *Shorea ovalis* at the species level, and *Shorea guiso* and *Shorea ovalis* at the genus level. While ITS2 was unable to identify the three *Shorea* species at the species level, it was able to separate the two genera. However, this study is not yet completed yet and more analysis is needed to ensure the accuracy of DNA Barcode ITS1 and ITS2 for identifying *Shorea* species. The

additional analysis should include calculating the barcoding gap and constructing a full phylogenetic tree.

This initial study showed that ITS2 (Chen at al. 2010) successfully separated *Hopea* and *Shorea* species suggesting that ITS2 was able to differentiate dipterocarps at genus level. Likewise, the preliminary study of *Shorea* species using ITS1 (Essene 2014) showed that the loci successfully identified *Shorea ovalis* at the species level and *Shorea guiso* and *Shorea ovalis* at the genus level and that ITS2 (Essene 2014) was unable successfully to identify the three *Shorea* species at the species level but was able successfully to identify them at the genus level.

Purnama Hidayat	**Z02**	Diversity of Butterflies (Lepidoptera) across rainforest transformation systems in Bukit Duabelas and Harapan Forest, Jambi

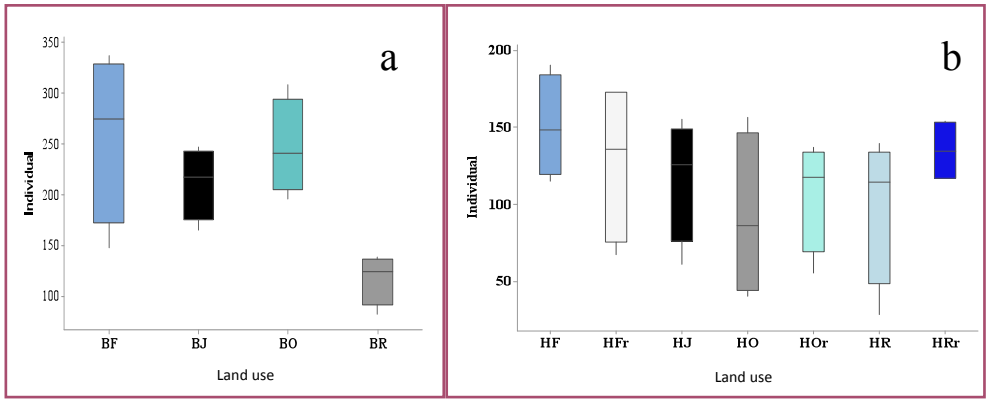

Figure 87. Number of individual butterflies collected in Bukit Duabelas (a): heterogeneous forest (BF), jungle rubber (BJ), oil palm plantation (BO), rubber plantation (BR); and Harapan Forest (b): heterogeneous forest (HF), heterogeneous forest riparian (HFr), jungle rubber (HJ), oil palm plantation (HO), riparian oil palm plantation (HOr), rubber plantation (HR), and riparian rubber plantation (HRr).

Introduction and Methodology

The occurrence of butterflies is strongly correlated with the presence of the species of plants on which the adults lay their eggs. The occurrence of these host plants depends, in turn, on the habitat. Thus, transformation of the habitat will affect the biodiversity of butterflies (Nidup *et al.* 2014). Due to their host-plant specificity and the relative ease with which they can be identified, butterflies make excellent organisms for the rapid assessment of biodiversity in the field and serve as bio-indicators for environmental change. The specific role of butterflies in the old growth secondary forest in Sumatra such as on the edge of Bukit Duabelas National Park or in the restoration forests such as Harapan Rainforest / PT REKI (Origia et al. 2012) remains severely understudied. Furthermore, it is currently unclear to what degree butterflies thrive in cash-crop monocultures such as rubber and oil palm.

The main OBJECTIVE of this research was therefore to determine the species richness of butterfly populations across a rainforest transformation gradient in Jambi Province (EFForTS Core Plots and Riparian Sites).

The sampling of butterflies and rapid biodiversity assessment were conducted in EFForTS 32 core plots and 12 Riparian Sites in Jambi from August to October 2017. Two collection METHODS were used: (1) direct surveys and scan sampling (Martin & Bateson 1993), i.e. immediate recording of butterflies seen in the existing core plots, and (2) using bait traps to attract butterflies. The final identification and preservation of specimen was performed at the Laboratory of Insect Biosystematics, Department of Plant Protection, IPB. The identification was based on the guide books by Parsons (1999) and D'Abrera (1990).

Result and Discussion

A total of 6641 individuals falling into 209 species were collected in Bukit Duabelas and Harapan Forest. There were 3334 individuals in 145 species, collected across 16 observation plots in Bukit Duabelas and 3307 individuals in 179 species collected across 28 observation plots in the Harapan Forest. The Shannon-Wiener diversity (H') was higher in the Harapan Forest (4.15) than in Bukit Duabelas (3.88). Both are over 3.5 and are therefore considered high (Maguran 1988). The number of individual butterflies collected was highest in sites with heterogeneous forest type land use than elsewhere, both in the Harapan Forest and Bukit Duabelas (figure 87). The butterfly diversity (index H') for every type of land use is shown in figure 88. There were two species of IUCN-protected butterflies recorded in Bukit Duabelas. These were *Trogonoptera brookiana* Wallace and *Troides amphrysus* Crammer (figure 89a and 89b).

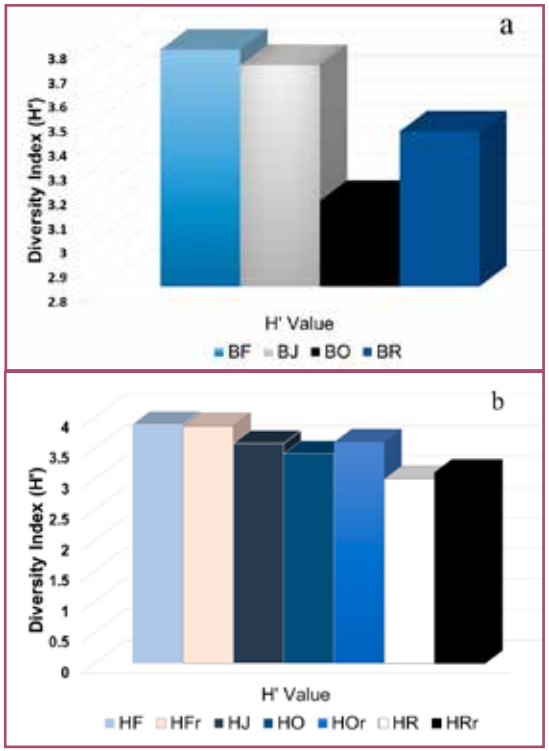

Figure 88. The Shannon-Wiener Diversity Index (H') of butterflies in Bukit Duabelas (a): heterogeneous forest (BF), jungle rubber (BJ), oil palm plantation (BO), rubber plantation (BR); and Harapan Forest (b): heterogeneous forest (HF), heterogeneous forest riparian (HFr), jungle rubber (HJ), oil palm plantation (HO), riparian oil palm plantation (HOr), rubber plantation (HR), and riparian rubber plantation (HRr).

The diversity of butterflies in the rainforest transformation systems in Bukit Duabelas and and Harapan Forest was relatively high and varied. Continuous conservation effort is needed to preserve the butterflies in these areas.

Figure 89. The IUCN-protected species of butterflies found in Bukit Duabelas Forest: *T. brookiana* (a) and *T. amphrysus* (http://insecta.pro/gallery/41401) (b).

Research projects of counterparts funded at UNJA

Name	Counterpart	Title
Damris Muhammad, Linda Handayani, Samsidar	**A05**	Impact of land transformation and the factors that regulate nitrogen fluxes in the soils of the Rainforest Transformation System as a function of soil depths

Background

Transformation of tropical lowland forest affects soil nitrogen (N) fluxes to the atmosphere. The soils of palm oil plantation are the most affected. However, application of fertilizer for long period of time in the palm oil plantation may contribute to the availability and cycling of N in the soils. The majority of studies measured soil N emission at the soil surface. However, there is limited information on N emission at different soil depths. The OBJECTIVE of this study is to measure and quantify soil N emission to the atmosphere in oil palm plantations compared to that of secondary forest in Jambi region as a function of soil depth.

Methods

Static PVC chambers covered by a rubber septum were installed at random in palm oil plantation and in secondary forest at depths of 0, 5 and 10 cm below soil surface. Gas was collected from inside the chamber by inserting a syringe needle through the chamber septum at 0, 2, 4, 6 and 8 weeks after installation.

Results

The highest N emissions were found at the soil surface. The concentration for secondary forest was 0.218±0.069 mg N m-2 d-1 and that for oil palm plantation 0.225±0.071. The concentrations decrease with soil depth. At the soil surface equivalent N emission was found for both systems. However, in the deep soil layer emission for the oil palm plantation was significantly higher (figure 90). The figure compares the soil N emission values between secondary forest and palm oil plantation at different soil depths. The application of fertilizer in the palm oil plantation seems to influence soil N emission to the atmosphere. Because there

is a greater N emission from the deep soil layer of palm oil plantation, it is possible that the deep soil emission contributes a greater fraction soil N emission at the surface.

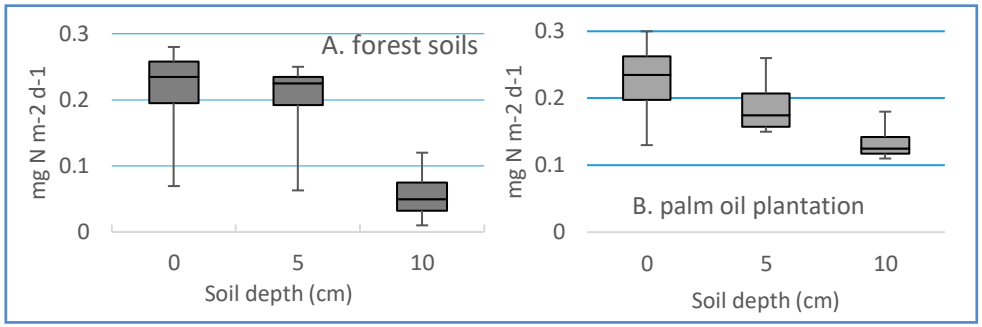

Figure 90. Soil nitrogen emission from forest (left, A) and palm oil plantations (right, B) at various depths.

Hesti Riany, Ummi Mardhiah, Zulkarnain	**B02**	Isolation and amplification of the 16S rRNA gene for metagenomic analysis from the oil palm rhizosphere in different locations (based on soil textures)

Background and Method

Soil microbes, especially bacteria, play key roles in ecosystems and influence a large number of important ecosystem processes, such as nutrient acquisition cycling, plant productivity, soil formation, biocontrol of some diseases, and fertilizer. The rhizosphere (root zone) is an important habitat for bacteria to function as plant growth promoters and protectors of plants from pathogenic infection. The large area of oil palm tree plantations in Jambi Province provide good habitat for soil bacteria. But oil palm tree plantations in Jambi grow on soils of different textures. It is assumed that different soil textures lead to different diversities of soil bacteria in the root zone of the oil palm trees. The OBJECTIVES of this study were to investigate the diversity of soil bacteria in the oil palm rhizosphere from different soil textures. The bacteria in the collected soil samples were identified by conventional methods and by DNA extraction and amplification of the 16S rRNA gene.

Result

Eight soil textures were recognized in this study: sandy loam, sandy clay, loamy sandy, salty clay, salty clay loam, sandy clay loam, sandy and clay. And we found four genera of bacteria: *Streptomyces*, *Micrococcus*, *Bacillus* and *Azotobacter*. In the attempt to use the metagenomics method we obtained DNA of purity 1.2-1.7. Sequences of more than 3000bp were detected by electrophoretic visualization. Unfortunately, however, 16S rRNA genes were not obtained. A more effective optimization procedure is therefore needed before sequencing and metagenomics analysis can be successfully applied.

Mohd. Zuhdi, M. Edi Armanto, Sungkono Hening	**B05**	Exploring peat spatial variability using very low frequency electromagnetic waves

Background and Methods

This research evaluates a new method of mapping and measuring peat spatial variability by means of Very Low Frequency Electromagnetic (VLF-EM) radio waves as an alternative to boreholes (figure 91).

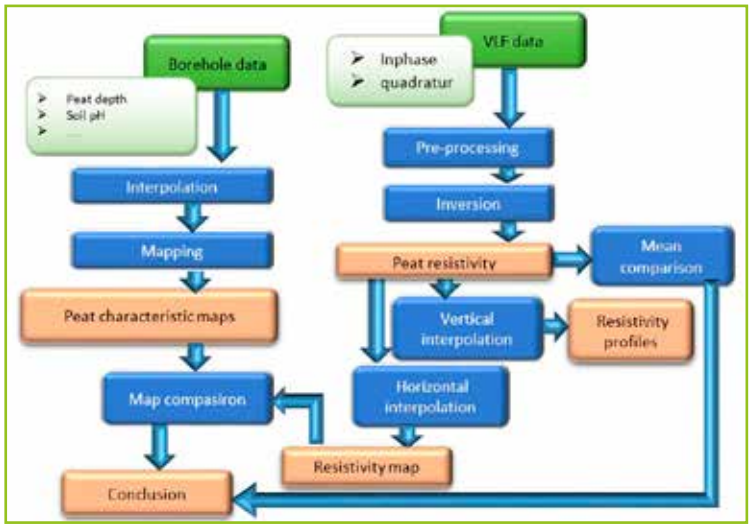

Figure 91. Flow-chart diagram outlining the data analysis of the borehole **ba**sed observation and the VLF-FM method.

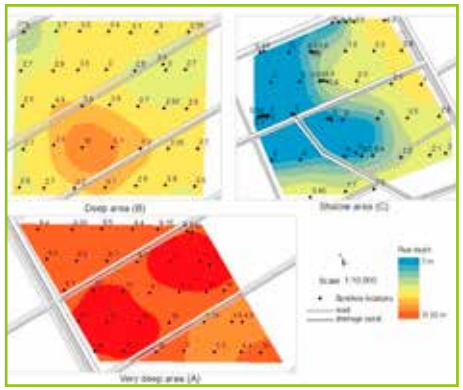

Figure 92. Maps of peat depth interpolated from borehole data in three areas: deepa are (B, top left), shallow area (C, top right), and very deep area (A, bottom).

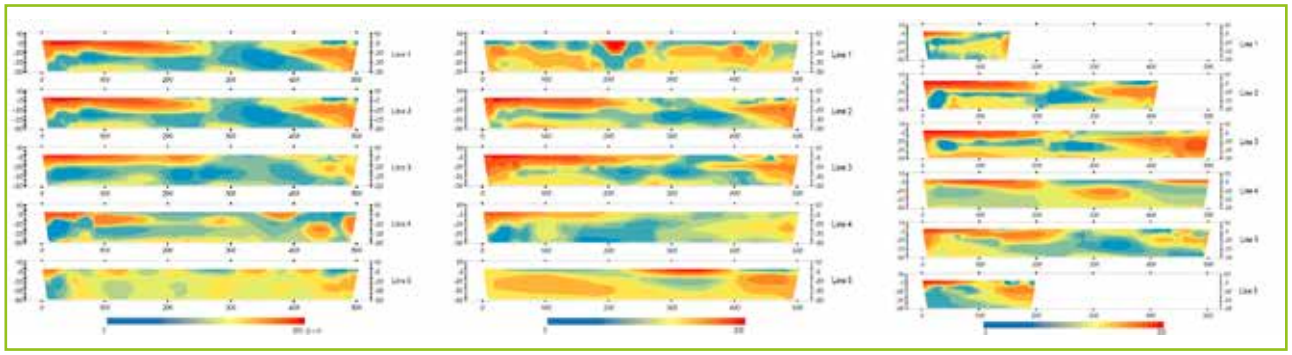

Figure 93. Resistivity profiles in three peat areas; very deep (left), deep (middle) and shallow (right).

The research location was a peatland in Seponjen Village, Sub District of Kumpeh, Muaro Jambi District, Jambi Province of Indonesia. The research areas had different depths of peat; A) very deep peat (8–15m), B) deep peat (3–8m) and C) shallow peat (0–3m).

Result

BOREHOLE

Peat depth tends to increase as the distance from the main river increases. Depth is anisotropic with respect to the river (figure 92).

VLF-EM

The resistivity tends to decrease with depth (data not shown here, see ABS report 2017). The mean comparison shows a statistically significant difference between the area of very deep peat and the area of shallow peat. However, there were no differences between the area of very deep peat and the area of deep peat. The depth in which resistivity start to be different tends to follow the depth of peat. In the area of very deep peat, the resistivity is similar (statistically not different) until a depth of -7.32m. This is equal to the depth of peat in this area. In the deep peat area, however, resistivity is similar until -4.72m. This is also equal to the depth of the peat (figure 93).

Conclusion

VLF method can be apply to distinguish different depth of peat, but cannot be used to map peat depth spatial distribution.

Bambang Irawan Gindo Tampubolon, Hasbi Hasibuan (PT. Humusindo)	B11	Effects of fertilizer regime and time of planting in a Biodiversity Enrichment Experiment

Background

In reference to the B11 Biodiversity Enrichment Experiment of EFForTS we applied a similar scheme at a large-scale oil palm plantation at PT. Mekar Agro Sawit (which belongs to PT. Humusindo Makmur Sejati) located in Aur Gading, Jambi. We specifically wanted to assess the effects of fertilizer and time of planting on the growth and survival rate of the trees and the production of oil palms.

Objectives

The specific objectives were: (1) to study the interaction between the age of the oil palms when the enrichment trees were planted and the fertilizer regime, (2) to study the impact of the age of the oil palms when the enrichment trees were planted on the growth and survival rate of the trees and production of oil palm and, (3) to study the impact of fertilizer on the growth of trees and the production of the oil palms.

Figure 94. a) Bulian (*Eusideroxylon zwageri*) 6 months after planting, **b)** Jengkol (*Archidendron fauciflorum*) 6 months after planting **c)** Petai (*Parkia speciosa*) 6 months after planting **d)** Sungkai (*Peronema Canescens*) 6 months after planting.

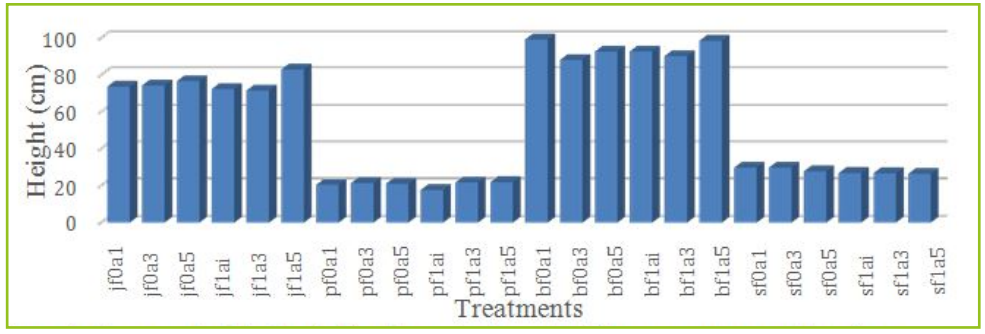

Figure 95. The mean height (cm) of each species in each of the treatment combinations.

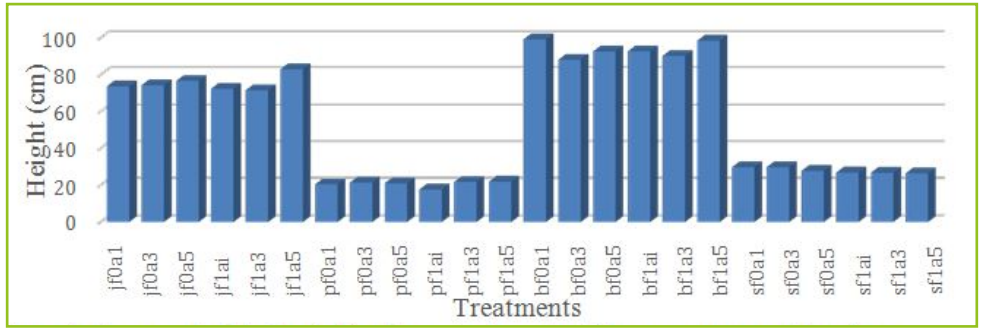

Figure 96. The mean diameter (mm) of each species in each of the treatment combinations.

Method

The experimental applied a split plot randomized design with the age of oil palm as the main plots and fertilizer regime as the sub plots. The first factor consisted of three levels: a1, one year old oil palm; a3, three year old and a5, five year. The second factor consisted of two levels: f0, no additional fertilizer to trees and f1, additional fertilizer calculated based on soil nutrient content. There were thus six treatment combinations each with five replicates. There was therefore a total of 30 plots.
Four different tree species were selected based on economic considerations. These were, in the main, the economic value of their products and their ecological effects. The selection consisted of two fruit tree species petai (Parkia speciosa) and jengkol (Archidendron pauciflorum). And also two wood producing species bulian (Eusideroxlyon zwageri) and sungkai (Peronema canescens). A total of 600 trees were planted, 150 of each species. Each enrichment tree was planted centrally between four oil palm trees.

Results

Preliminary measurements of height and diameter of trees planted in the oil palm landscape are depicted in figure 95 and figure 96, respectively. Jengkol had the highest standard deviation for height and also for diameter. Petai has the lowest standard deviation on both measures. Bulian has the greatest mean height and the biggest seedlings compared to other species and petai the smallest seedlings. Details of height and diameter performance of each species in each of the treatment combinations show the variability between treatments.

Jauhar Khabibi, Noor Farikhah and Mark Maraun	**B13**	Characteristic of wood durability and wood destroyer organism in oil palm plantation, rubber plantation and natural forest in Jambi province

Objectives of the study

The objectives of this study were (1) to analyze the wood characteristics from oil palm agroforestry, rubber agroforestry, and secondary natural forest and, (2) to assess the diversity of termites as wood decaying organisms in these three ecosystem types.

Material and Methods

Fagraea fragrans Roxb. wood was collected in the District of Muaro Jambi, Jambi Province. The solubility of the wood sample was analyzed using four potential solvents: hot water, cold water, ethanol-benzene (1:2), and NaOH 1% (TAPPI T 264 om-88 1988). The proximate analysis included measurements of the moisture content (TAPPI T 264 om-88 1988), volatile matter (ASTM E872-82 1998), ash content (TAPPI T211 om-02 2002), and fixed carbon (Cordero et al. 2001).

Termites were collected from the three ecosystem types using a transect sampling protocol (Jones and Eggleton 2000).

Results and Discussion

Fagraea fragrans wood from the natural forest has higher solubility than wood from the other ecosystem types. The proximate analysis shows that *F. fragrans* wood from the natural forest also has a higher ash content than wood from the other types. Otherwise, there were no significant differences between ecosystem types in the other proximate analysis parameters measured for *F. fragrans* wood (figure 97). The natural forest has more termite diversity than do oil palm plantation and rubber plantation (figure 98).

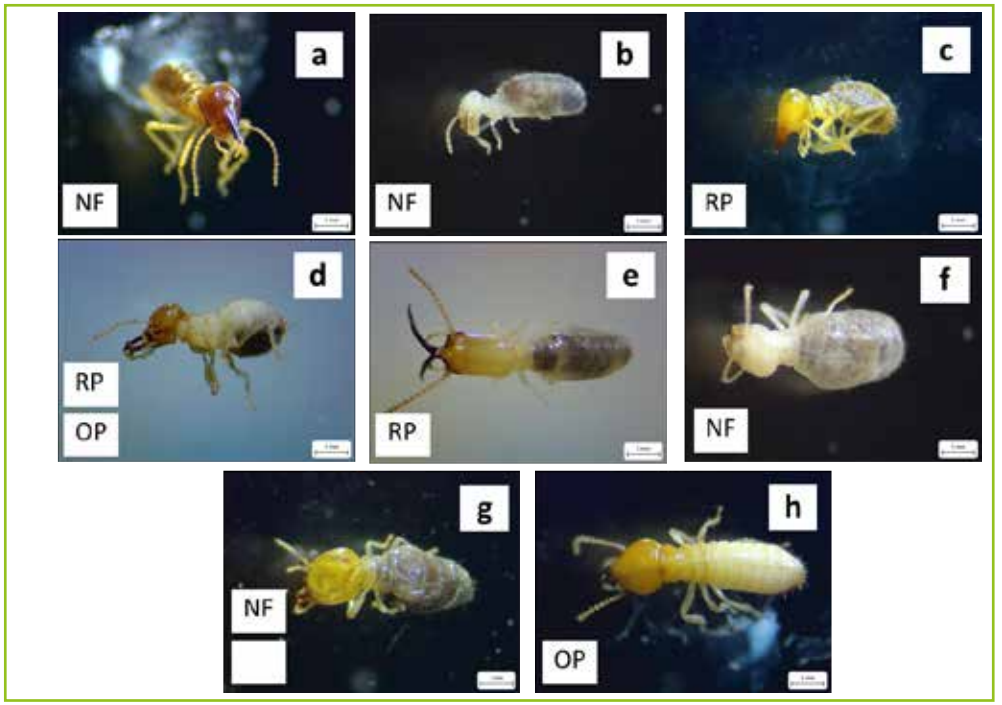

Figure 97. The subfamilies of termites from oil palm plantation (OP), rubber plantation (RP) and natural forest (NF). (1) *Nasutitermitinae*: a. *Bulbitermes*, b. *Hirtitermes* and c. *Nasutitermes*; (2) *Termitinae*: d. *Globitermes* and e. *Termes*; (3) *Macrotermitinae*: f. *Macrotermes* and g. *Microtermes*; (4) *Coptotermitidae*: h. *Coptotermes*.

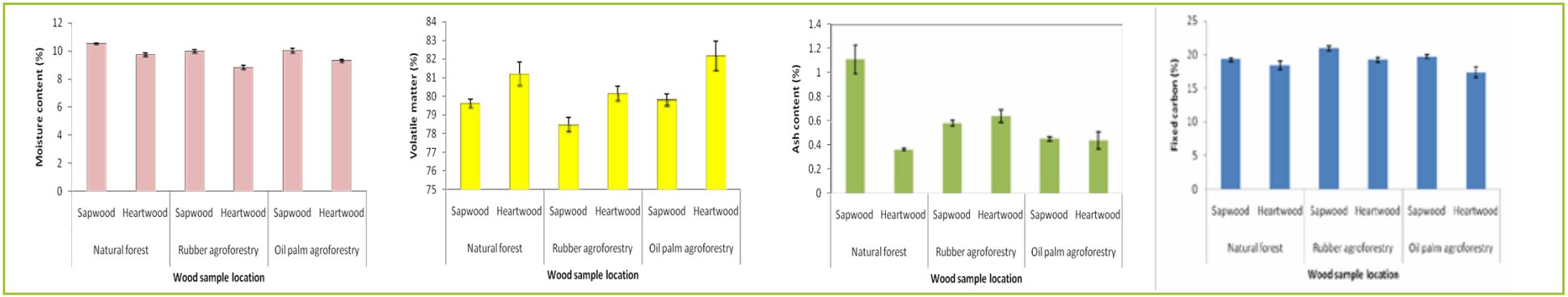

Figure 98. Relationships between wood sample location and the results of the proximate analysis (a) moisture content, (b) volatile matter, (c) ash content, and (d) fixed carbon.

Mirawati Yanita, Zulkifli Alamsyah, Ernawati Hamid	C01	The impact of the rubber auction market on the transmission price for farmers in Jambi Province

Background and Methods

Jambi province depends crucially on its agricultural sector (Kopp, 2014) 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 socio economic 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 analyze 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.

Results

The transmission of agricultural product prices from low-market consumer market is an indicator that reflects the monopsonic or olygopsonic strength of the trader. We found that there were eight PLK in Bungo and six PLK in Tebo. In Bungo 450 farmers joined the PLK with a minimum of 150 farmers. The transaction volume at Bungo was 50 tons at a time. In Tebo 350 farmers joined with a minimum of 170. Here the transaction volume was 40 tons at a time. There was a minimum of three buyers and a maximum of six.

Farmers only got 40-60% of the export price from selling their rubber in the auction market. This condition explains the vulnerability of the farmers' position. One of the reasons is farmers who do not optimally implement their marketing function (figure 99).

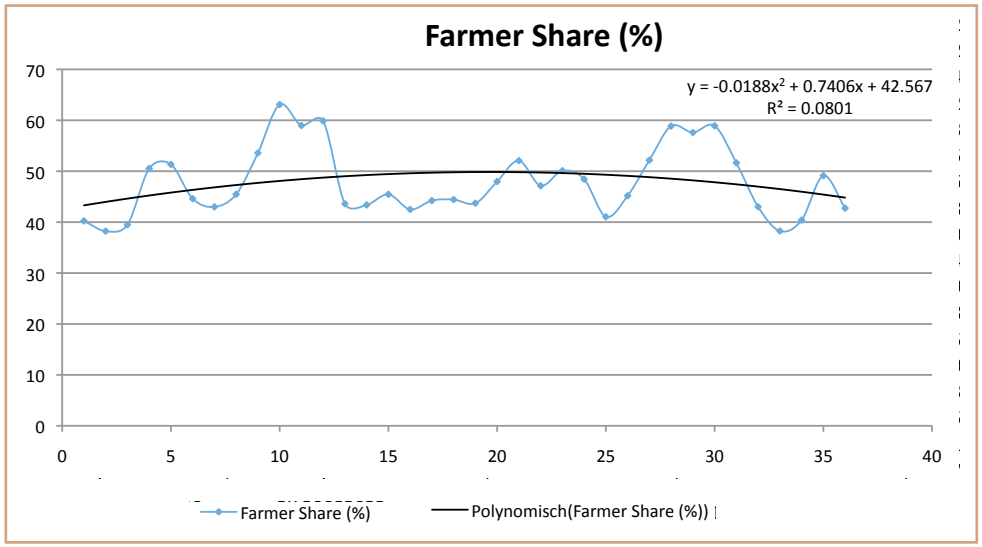

Figure 99. Realized share of the export price obtained by famers selling in the auction market.

Conclusion

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 40 60%. Price changes at the export level are transmitted very little to farmers and their effect on farmers is very low.

Rosyani, Rukayah Rofiq	C02	Independent smallholder strategies to sustain the roundtable on sustainable palm oil (RSPO) certification. Oil palm smallholder group association Tanjung Sehati (Gapoktan), Merangin District, Province of Jambi, Sumatera, Indonesia

Background

The Round Table on Sustainable Palm Oil (RSPO) is a voluntary certification scheme for sustainable palm oil production for both companies and smallholders. In Indonesia, 112 companies have obtained RSPO certification. These include the Asian

Agri group, the Wilmar group and the Sinar Mas group. In contrast, very few smallholders have obtained RSPO certification. This is probably because smallholders, particularly independent smallholders, face several problems. These are associated mainly with limited funds, limited knowledge, unclear title to land, and low availability of seedlings, pesticide, fertilizer, and documentation. 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.

Objectives

Objectives of the study were 1) to understand the motivation of Gapoktan Tanjung Sehati in obtaining RSPO certification, 2) to investigate the internal and external factors necessary for sustaining RSPO certification, 3) to analyze the strategies undertaken by Gapoktan Tanjung Sehati in maintaining RSPO certification for the long term.

Approach

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), 10) 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 an aggressive one.

Edison, Ira Wahyuni	C08	Financial feasibility study of smallholder oil palm in Sungai Bahar sub-district Muaro, Jambi District, Jambi Province

Background

Sungai Bahar sub-district Muaro has the largest area of household oil palm. Nevertheless, both the quality and the quantity produced are still low compared to private and state oil palm. Average household palm oil production is 9.93 tonnes per hectare per year. Thus production is less than a tonne per hectare per month. Almost all household production of fresh fruit bunches yields less than non ¬household forms of palm oil production. This is caused by many factors, from using bad seed to poor maintenance and also a weakness of state management. The problems of low production level, and also other problem such as the inability of household palm oil producers to bargain for a suitably high price. Thus, household oil palm faces many financial problems. The OBJECTIVES of the study were 1) to identify the production costs for farmers of household oil palm, 2) to identify the annual income of farmers and 3) to analyze the financial feasibility of household oil palm in the research area.

Results

Smallholder oil palm plantations in the research area had an average production cost of Rp. 9,961,585 per ha per year. The average income from the oil palm plantation business per ha per year was Rp. 19,118,532 and the average income from the oil palm plantation business per farmer per year (area of 2.5 ha) was Rp. 25,412,602. Based on the value of the above three investment criteria, the net present value (NPV) is positive (NPV>0) with a value of Rp. 30,113,603. This indicates that the oil palm plantation business is a feasible form of cultivation and yields a profit of Rp. 30,113,603. An internal rate of return (IRR) of 24.50% indicates that the business is able to survive an interest rate of up to 24.50%. In other words, this business has a breakeven point at the interest rate of 24.50%. The value of IRR obtained at 24.50%>12.75% (bank interest applicable) means that it is feasible to carry out an oil palm cultivation business.

The cost benefit ratio obtained was 2.934. This means that oil palm cultivation is feasible for smallholders because every Rp. 1.000 of expenditure yields Rp. 2.934. By looking at these three financial analyses it is clear that smallholder oil palm plantation business is feasible in the research area.

Revis Asra, Joko Ridho Witono (LIPI), Elva Gemita (PT REKI)	**Z01**	Conservation of Dragon's Blood Palm (Daemonorops spp.) in Harapan Rainforest, Jambi

Introduction

A non-timber product of Indonesian forests that is very valuable is the red resin obtained from the fruit of Daemonorops spp. This resin is used as a coloring, as an anticoagulant for blood, and also pharmaceutically against various ailments (diarrhea, tumor, and viral and microbial diseases) (Gupta et al., 2007). The distribution of species in the genus Daemonorops is mostly the tropics and subtropics of southeastern Asia. It is rare and, according to the IUCN red list species (2006), included in the list of threatened species. The habitat of Daemonorops spp. is near rivers. The objectives of this study were to (1) establish an inventory of Dragon's blood palm (Daemonorops spp.), to (2) analyze the sex ratio of Daemonorops spp sex ratio, to (3) assess the number of individuals per clump, to (4), analyse the growth rate in each clump, and to (5) create a demonstration plot of Dragon's blood palm near the forest education facility in Harapan Rainforest.

Methodology

This study used survey methods and data collection was carried out by the method of purposive sampling. The identification of the Daemonorops spp. from the Forest Ecosystem Restoration area was conducted in Herbarium Bogoriense.

Result

We located as many as 43 clumps. These consisted of: 17 clumps of *Daemonorops draco*, 17 of *Daemonorops didymophylla* and 9 of *Daemonorops micracantha*. In addition we located a fourth species the scientific name of which is still in doubt. All four species produce red resin.

The sex ratios of the three named species were (male:female) *D. draco* (1:1.8), *D. didymophylla* (1.84:1) and *D. micracantha* (1:2).

The tree species most commonly found in association with Dragon's blood palm were Thottea corymbosa, Psicotria pridifolia, Uvaria sp., Bhesa paniculata, Dacryodes rostrata, Ginothroces axillaris, Nephellium cuspidatum, and Palaquium sumatrana.

Harapan Rainforest Dragon's blood palm was planted in the Forest Education facility of Jambi University. Two species were planted, *D. draco* and *D. didymophylla*. Dragon's Blood Palm is a source of income for Orang Rimba (indigenous people) living in the Harapan rainforest area. It is hoped that these plantings will lead to an increase in the number of Dragon's blood palm in this area and so increase the income of Orang Rimba.

Upik Yelianti (UNJA), Elva Gemita (PT REKI)	Z01	Inventory and conservation of indigenous orchids in the Harapan Rainforest, Jambi province

Background and Objectives

Harapan Rainforest (HRF) covers 98,554 ha of dry lowland forests of which 46,385 ha is located in Jambi Province and 52,170 ha in the province of South Sumatra. The entire site has undergone some degree of logging in the past.

Orchids are one of the indigenous species in HRF that are endangered due to increasing forest exploitation, forest fires, logging, land conversion into palm oil plantations and illegal collection and selling.

The study was conducted to firstly collect and determine the species composition and diversity of indigenous orchids in HRF. Secondly, the collected orchids will be propagated later by tissue culture and replanted in the HRF as conservation measure.

Methodology – collection and inventory

Orchids were collected using the exploration method. Each individual species was documented photographically, sampled and stored in a herbarium for identification using reference books.

Results

Fifteen species have been identified in HRF: Bromheadia *finlaysoniana* (lindl.) Miq., *Bulbophyllum flavesences* (Bl) Lindl., *Bulbophyllum acutum* J.J.Sm., *Bulbophyllum medusae* (Lindl.) Rchb.f), *Bulbophyllum sumatranum, Bulbophyllum* sp1, *Bulbophyllum* sp2, *Coelogyne plantagine* Lindl., *Coelogyne furstemannii* Rchb.f., *Cymbidium bicolor* Lindl., *Cymbidium finlaysianum* Lindl., *Dendrobium leonis* (Lindl.) Rchb.f., *Eria pulchella* Lindl., *Gramatophyllum speciosum* Bl. and *Paphiodilum* sp. The majority lives as epiphytes on marapayang, kemang, bacang, kedondong, and terap. The most commonly found species are from the genus Bulbophyllum (see ABS report 2017).

Figure 100. The indigenous orchid *Bulbophyllum sumatranum* found at Harapan Rainforest, Jambi province.

Figure 101. The indigenous orchid *Coelogyne plantagine* found at Harapan Rainforest, Jambi province.

Figure 102. The indigenous orchid *Dendrobium leonis* (Lindl.) Rchb.f. found at Harapan Rainforest, Jambi province.

Research projects of counterparts funded at UNTAD and Universitas Brawijaya (UB)

Name	Counterpart	Title
Syahrul Kurniawan	**A05**	Nutrient release from decomposition of oil palm empty fruit bunch

Background and Methods

The expansion of oil palm plantations strongly reduces the quality of ecosystem functions provided such as severe reductions in organic carbon stock in above ground biomass and below ground (i.e. soil carbon stocks). This consequently reduces soil microbial biomass and soil nutrient retention efficiency, changes nitrogen cycling and changes trace gas fluxes. To counter these effects organic matter addition is needed. It would be especially useful if the organic matter came from oil palm residues. This study therefore aimed: 1) to measure the decomposition rate and micronutrient release from oil palm empty fruit bunches (EFB), and 2) to assess soil organic carbon and total nitrogen after the application of oil palm residues. For the FIRST OBJECTIVE, we set up field research in smallholder oil palm plantations (HO3) by using litter bags. The fresh EFB (~16 tonnes ha^{-1}) was put into the litterbag and then the litterbags were spread on soil surface and buried in the top soil (0-10cm deep). The litter bags were then collected monthly from September 2017 and the dry weight and micronutrient concentrations (i.e. Fe, Mn, Zn, B) were measured. For the SECOND OBJECTIVE, we conducted laboratory experiments to assess the dynamics of soil organic carbon and total nitrogen after addition of oil palm residues. We collected two soil types from smallholder oil palm plantations which were different in soil texture (i.e clay and sandy loam acrisol soils). The clay soil was collected from Bukit Duabelas (BO4 plot and the sandy loam soil was taken from Harapan (HO3 plot). The soil was air-dried, ground, weighed (~ 400g oven dry) and placed in plastic bags. Three treatments of organic matter from oil palm residues were applied to each soil type. The treatments included fibre, EFB, and mixed (fibre and EFB) with doses equal to 10 tonne ha^{-1}. Each treatment was replicated three times. We added ionic water until field capacity to each bag. Then we measured soil organic carbon and total nitrogen at 0, 4, 6, 8, 10, and 12 weeks after incubation.

Results and discussion

Decomposition rate and micronutrient release from oil palm empty fruit bunches

EFB decomposed slowly as indicated by the loss of dry weight being less than 20% over 17 weeks of measurement (figure 103A). In addition, applying EFB on the soil surface led to higher amounts of Mg and B remaining (P≤0.05) compared to when material was buried in the top 10cm of the soil. The amounts of Zn and Fe remaining were not significantly different between the two locations. The higher amounts of nutrient remaining (i.e. Mg and B) when EFB is spread on the soil surface than when it is buried in the soil indicated that the decomposition rate of EFB tends to

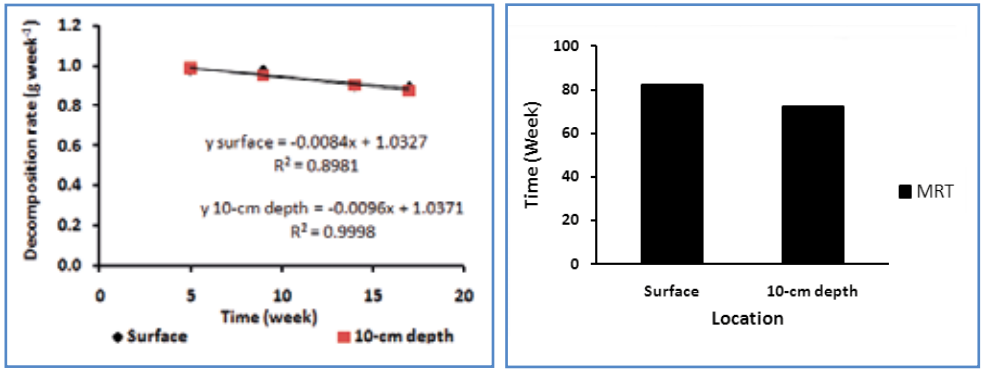

Figure 103. Decomposition rate (A) and mean residence time (B) of oil palm empty fruit bunches during 17 weeks in the field.

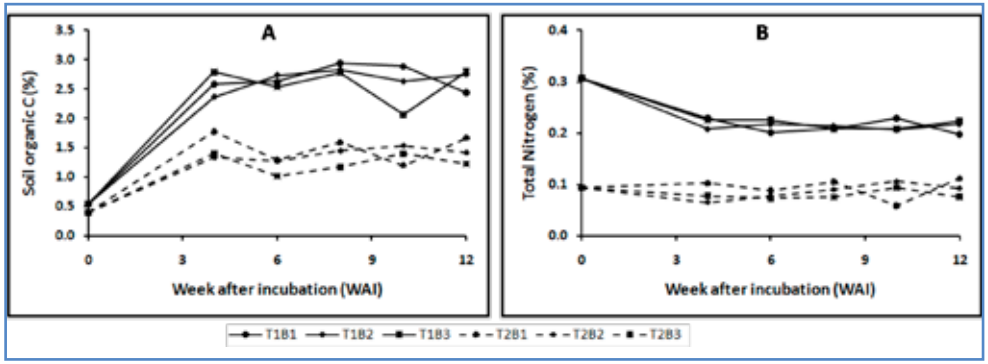

Figure 104. Soil organic C (A) and total N (B) in clay (solid line) and loam (dash line) acrisol soils after application of oil palm residues (i.e EFB = B1, fibre = B2, and mix = B3) during 12 weeks incubation.

be lower on the soil surface than it is actually in the soil. This finding is supported by the higher mean residence time (MRT; figure 103B) of EFB in the soil surface (83 weeks) than in the soil (72 weeks).

Soil organic carbon and total nitrogen dynamics by application of oil palm residues

Overall, the study showed that application of oil palm residues (i.e EFB, fibre, and mix) during 12 weeks resulted in higher soil organic carbon and total nitrogen in the clay than in the sandy loam ($p<0.01$). However, in each soil type, the study was unable to detect significant differences of soil organic carbon and nitrogen ($p>0.05$) among different oil palm residues (figure 104A and 104B). In addition, total nitrogen in the soil (especially in the clay acrisol) from all treatments during 12 weeks incubation tend to be lower than in the beginning (before organic matter addition), probably due to nitrogen immobilization by soil microbes.

Sri Rahayu Utami	**A05**	Macronutrient release from oil palm empty fruit bunch

Background and Methods

The oil palm industry produces huge amounts of waste. One of the main waste products is empty fruit bunch (EFB). Every tonne of EFB that goes to the mill produces 20-25% EFB (Abubakar et al., 2011) or 23% on average (Omar et al., 2011). Nevertheless, EFB contains some essential macronutrients such as 0.44% N, 0.144%P, 2.24% K, 0.36% Mg and 0.36% Ca (Menon et al., 2003). Applying EFB as a nutrient source would therefore provide benefits such as improving soil fertility and reducing the use of chemical fertilizer. This research was an attempt to study the mineralization of macronutrients (C, N, P, K, Ca, Mg) from EFB. The EFB was put into litter bags (nylon mesh bags with 2mm mesh), then placed on the soil surface or buried at 10cm in the soil in smallholder oil palm plantations. The EFB from each litter bag was collected every month, rinsed, oven-dried at 60°C to constant weight (at approximately 3 days), and ground so as to pass through a 0.5mm screen. The resultant powder was then analysed for macronutrients.

Results and discussion

Carbon and nitrogen release

The carbon and nitrogen content of EFB declined during the 135 after application (figure 105). During the 140 days, the amount of organic carbon fell to 50% of its original value and that of nitrogen to 75%. The content of the two nutrients in EFB put at 10cm was slightly lower than that for EFB on the soil surface. However, the percentages were similar after 135 days from application. The C/N ratio increased over time, indicating that the proportion of carbon relative to nitrogen decreased, reflecting the maturity of the organic matter applied.

Phosphorus, Potassium, Calcium and Magnesium release

The results showed that P mineralization from EFB was more slowly released into the soil than carbon and nitrogen (figure 106a). After 135 days from application, the P content in EFB still remained about 50% of the initial level. Potassium mineralization, however, was the most rapid, releasing 75% of the initial level. Hence, only 25% remained in EFB after just 35 days from application (figure 106b). Potassium mineralization rate was much higher in the 35 days after application, but the rate decreased thereafter. There was no significant difference in the amounts of these minerals between EFB applied on the soil surface and that buried at 10cm.

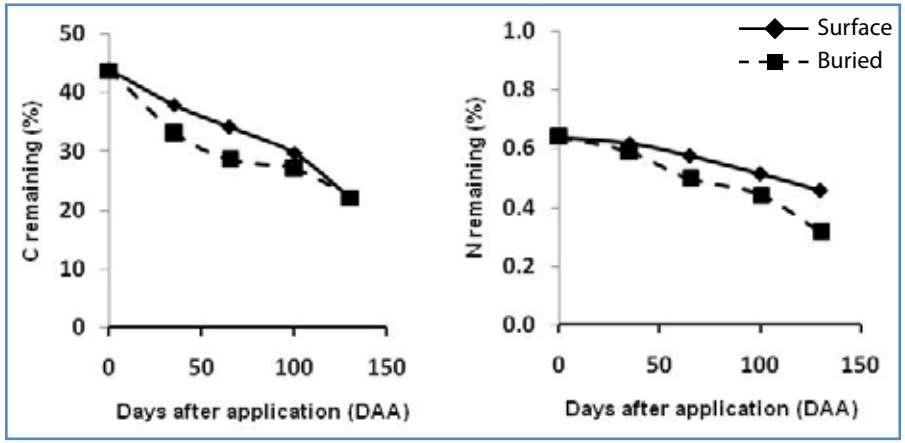

Figure 105. Carbon (left) and nitrogen (right) content in EFB during 140 days after application.

The pattern of calcium mineralization was similar to that of potassium, rapidly at first and relatively slow from 35 days after application (figure 106c). After 135 days from application EFB applied on the surface still contained 57% compared to 71% for EFB at 10cm. On the contrary, Mg content decreased rapidly between 35 to 135 days after application. In summary, Mg and K would thus be readily available for the period after 35 days from application (figure 106d).

Conclusion

Oil palm EFB is potentially used as a nutrient source in oil palm plantations. However, the rate of mineralization should be taken into account if EFB is to be used as fertilizer. The mineralization rate was rather low, with release of potassium and magnesium as early as 35 days after application. However, carbon, nitrogen, and phosphorous were released at a rather slow rate. An additional source of P is therefore necessary to speed up plant growth. A significant difference between EFB applied at the soil surface and at 10cm depth only existed for N release.

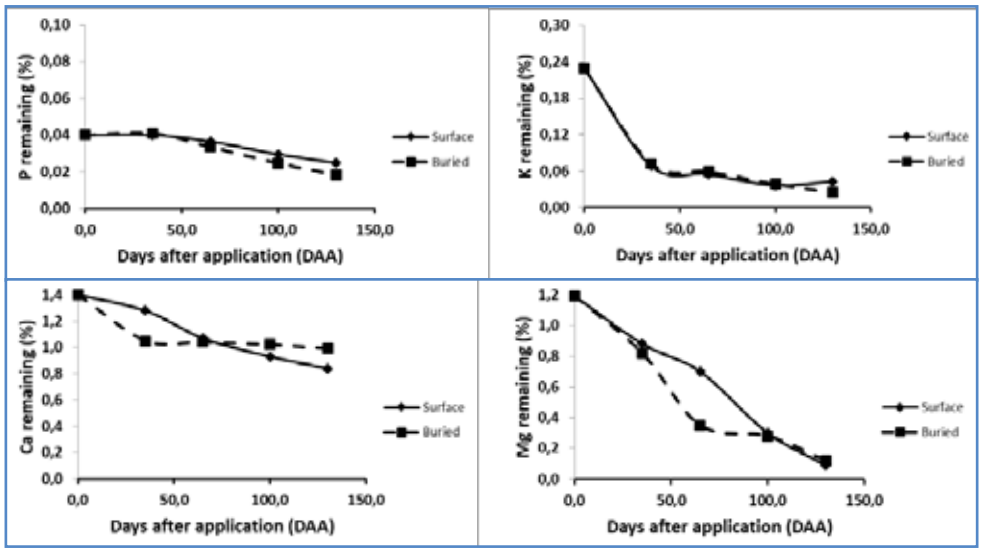

Figure 106. Phosphorus, potassium, magnesium and calcium content of EFB for the 140 days after application.

Nur Edy	**B07**	Rot disease caused by Ganoderma in land use change of Sumatra

Background and Method

Ganoderma sp., is a fungal pathogen of plants that causes stem and root rots. It is the most devastating pathogen, capable of infecting and killing most economically important trees and perennial crops including forest, oil palm and rubber trees. OBJECTIVES of the study were to (i) investigate the distribution and disease incidence of stem-rot disease in Jambi, (ii) to collect fungal samples from the infected trees and from control samples, and (iii) to identify the fungal isolates and determine the extent of *Ganoderma* sp. among them.

This research was conducted in the core plots of EFForTS in Jambi. Observations of disease incidence were based on symptom diagnostics. We collected the basidiocarps of *Ganoderma* and identified the morphological and molecular phylogeny of the species.

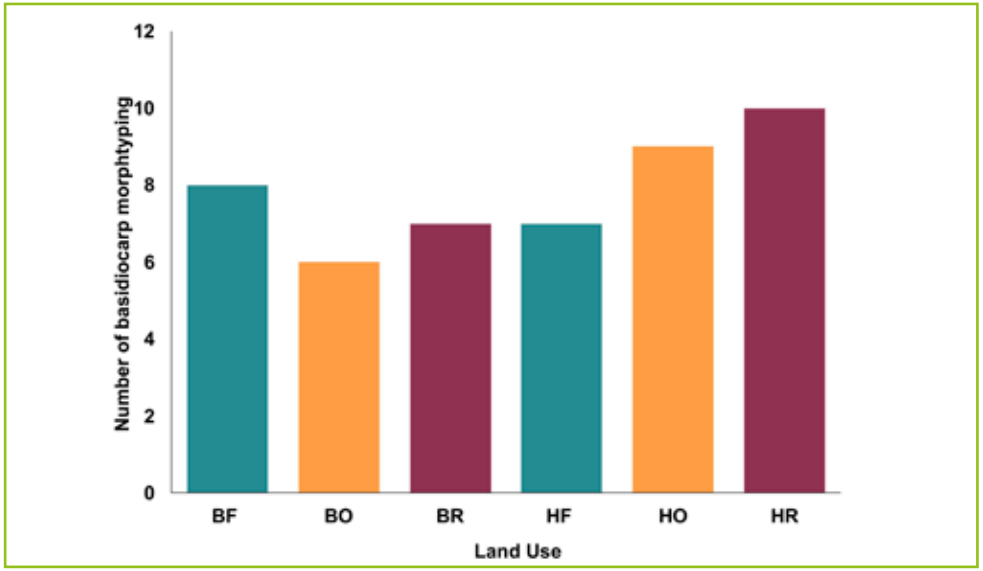

Figure 107. Number of basidiocarp morphotypes in Bukit Dua Belas and Harapan rainforest transformation systems.

Results

The basal stem rot disease was highest in the forest sites at both the Harapan and Bukit Duabelas landscape (33-34%), followed by rubber plantations (16-19%) and oil palm plantation (2.7%). A total of 828 fruiting bodies of the fungi (basidiocarps) were obtained from infected forest, oil palm, and rubber trees. Of that number, we found 47 different basidiocarp morphotypes (figure 107). All the basidiocarps collected had basidiomes with different morphological characteristics. They were sessile and bracket shaped, had lactate pilei, and were of a wide range of colors (light brown through black). The basidiome margins were also of different shape, color, and thickness (figure 108).

Figure 108. Basidiocarp morphotypes collected from the transformation systems of Bukit Duabelas and Harapan rainforest.

PT Restorasi Ekosistem Indonesia

Research projects of stakeholders funded at PT. REKI

Name	Counterpart	Title
Jomi Suhendri, Elva Gemita	**Z01**	Improving the utilization of homegardens of the Bathin Sembilan Tribe in The Harapan Rainforest for a better food security status

Introduction

Sekolah Lapang (SL) is participatory training that combines agricultural extension techniques and education for adults. An SL consists of a group of farmers residing in the same village / sub-village who regularly meet on the study area and are guided by the field guide. The study area can be a home garden, yard, rice fields or livestock that have been a source of livelihood for farmers. The implementations of SL in addition to introducing the way of cultivation of certain crops to farmers, SL also aims to obtain the farmers ability (capacity) in making decisions how to manage the agricultural resources based on his knowledge and good understanding of the agro-ecosystem is situated. The SL participant farmers are invited to observe, to find, and to combine it with experience on their land regularly, and then decided a proper action is needed to be done. As an adult, every farmer is willing to learn something new when it is directly related to his interest and suit with his needs. There is one phrase that describes how adults can reach knowledge: "What I heard, I forgot. What I saw, I remember. What I do, I understand". Means, the knowledge gained through the learning process from this experience is part of a learning cycle. Eevery new experience needs to be reflected whether it is success or failed.

Result and Discussion

1. KICK-OFF WORKSHOP ON 16 OCTOBER 2017: a workshop on Improving the Utilization of Homegardens of The Bathin Sembilan Tribe was conducted in 16 October 2017, with Keynote speaker from BPTP Jambi, Mitra Aksi and Warsi followed by 14 participants. After that, it continued with comparative study to Mudung Laut, Sebrang Kota Jambi from 17–19 October 2017.
2. COMPARATIVE FILED STUDY FROM 17 TO 19 OCTOBER 2017: a comparative Study on Improving the Utilization of Homegardens of The Bathin Sembilan Tribe conducted on 17 October 2017. Fourteen people participated: 5 people from Sungai Kelompang, 2 People form the Tanding community and 7 people from the SML community. Objectives were to learn about the usage of the community homegardens in Mudung Laut Village.
3. TRAINING WORKSHOPS AND OWN TESTING OF PARTICPANTS (19 OCTOBER TO 14 DECEMBER 2017) – Production of organic fertilizers (liquid and solid ones) and integrated pest management
   - Introduction to composting using rubber leaves, fruit peels, fruits, banana stems, sawdust, livestock manure
   - Introduction into the production of liquid organic fertilizers (POC) based on local resources (livestock manure, water, sugar solution.
   - Introduction to the usage and application of liquid organic fertilizer (nurseries, grown plants)
   - Introduction into the manufacturing of organic pesticides for pest and disease control using natural ingedients (vegetables, the fungus *Trichoderma sp*)
   - Introduction to integrated pest management (IPM): (a) cultivation of healthy plants, (b) usage of biological pest control techniques, (c) monitoring, (d) trinaing of farmers, (e) usage of plant growth promoting rhizobacteria, (f) palnting of lemon seeds by Batin Sembilan.

Conclusion

The training workshops helped to empower the Batin Sembilan in the Harapan Rainforest to establish and utilize homegardens for a better food security status.

Research projects of stakeholders funded at LIPI

Name	Counterpart	Title
Sri Rahayu	**Z01**	Conservation of *HOYA* species in Jambi by means of ex situ conservation and public awareness

Background

Indonesian species of the genus *Hoya* (Apocynaceae: Asclepiadaceae) have the potential of being developed as ornamental plants because of their unique and beautiful flowers. Indonesia has a particularly high diversity of *Hoya* species. And several *Hoya* species are known to occur in Jambi forests as they are listed in the Jambi diversity inventory. Despite this listing, local people know little of *Hoya* or of its potential. Therefore, *Hoya* should be conserved using *ex situ* methods and knowledge on their sustainable utilization shared with local people. The aim of this project is to empower local communities through *Hoya* planting, providing training in cultivation, and also by arranging internet marketing. These activities were included in a workshop "Introduction to the diversity of *Hoya* species in Jambi, conservation and sustainable utilization", held at the University of Jambi on November 22nd 2017. The workshop included training and *Hoya* planting (figure 109).

Figure 109. Welcome speech of Dr. Sri Rahayu (left) and participants of the workshop "Introduction to the diversity of Hoya species in Jambi, conservation and sustainable utilization" held on 22 November 2017 at UNJA (right).

Result

The workshop was fruitful and those attending took away not only useful knowledge but also *Hoya* plants to grow in their homes. Representatives from the Orchid Gardens Jambi (Pemprov) and from PT WKAS would also like to conserve Hoya in their conservation areas.

Development of DNA barcoding techniques to identify *Hoya* has continued. Two more loci i.e. ITS1 and *trn*H *psb*A were included in this research. The genes *rbc*L and *mat*K were used previously but these did not provide the best results. In this research, we identified ITS1 as the best barcoding locus for identifying *Hoya* species. *Trn*H *psb*A worked only at the genus level.

Research projects of stakeholders funded at BKSDA, the Ministry of Forestry

Name	Counterpart	Title
Marwa Prinando	**Z01**	Preservation valuation of Hutan Bakau Pantai Timur Nature Reserve Area

Background and Methods

Hutan Bakau Pantai Timur Nature Reserve area lies along the east coast of Jambi province. Administratively it extends over two regions, Tanjung Jabung Barat and Tanjung Jabung Timur. Ecologically, economically, and social culturally, this area is important for the lives of those living around the area. The reserve contains a variety of forest structures, species diversities and environmental services. It is hoped that this variety will provide great environmental benefits for the community around the reserve. The purpose of this research was to estimate the preservation value of Hutan Bakau Pantai Timur Nature Reserve at Nipah Panjang Resort in Tanjung Jabung Timur District. The data was collected by interview using a questionnaire. There were 90 respondents.

Results

The survey results showed that the willingness to pay for existence (Existence Value) of the Hutan Bakau Pantai Timur Nature Reserve area was Rp. 5000 500,000. Of the 90 respondents, only 78 expressed a willingness to pay for the existence of the reserve. The total value of WTP for a year was Rp. 5,010,000. The median value was Rp. 30,000. The total value of WTP for a year was estimated from the existence value of the nature reserve by multiplying the WTP median value per year and the total population of Nipah Panjang I village, Teluk Kijing Village and Pemusiran Village (8757 people). This gave Rp. 262,710,000.

The willingness to pay bequest (here: the bequest value of maintaining eagles in the Hutan Bakau Pantai Timur Nature Reserve – called by us "Eagle value") was about Rp. 5.000-500.000. The total WTP bequest value per year was Rp. 3,145,000. The median WTP value from the respondents willing to pay was Rp. 32,500. Total WTP value in a year was estimated from the "Eagle value" by multiplying the WTP median value and the total population of Nipah Panjang I village, Teluk Kijing Village and Pemusiran Village (8757 person) which gave Rp. 284,602,500. The preservation value is the sum of existence value and bequest value. Thus, the preservation value of this area, especially in Nipah Panjang Resort for 2017, was Rp. 547,312,500. The factors that influenced preservation value were occupation and income level of the respondents.

Elisa Septina Kuswara	**Z01**	Identification of potentional Jernang in Jebak village, Batang Hari district

Background

Jernang (*Daemonorops* sp), the Dragon's blood rattan palm, produces a red resin that is one of the non timber commodities produced from the forest. Jernang resin is used as medicine against diarrhoea, dysentery and asthma, to help heal wounds, and as a dental powder (Waluyo, 2008). The resin is also used as a varnish for ceramics, marble, stone tools, wood, rattan, bamboo, paper, and as paint. Due to the increasing demand the price of the resin is increasing at well. At the farm level in the local market it is as much as Rp. 400,000 800,000 per kilogram (Matangarandan Puspitasari 2012). The price in overseas markets, such as in Singapore, is around US$ 300 per kilogram (Kemenhut 2013). Jernang is used by the Jambi community. The resin is harvested by collecting young fruit from the forest. In Batang Hari district, three villages (Jebak, BulianBaru and Jangga Baru) have implemented agroforestry exploitation of Jernang and rubber. The OBJECTIVES of this study were 1) to know the potential of Jernang available near Jebak village, Batang Hari district, and 2) to obtain data and information about the cultivation of Jernang to be developed in Jangga Baru village in an agroforestry system using rubber and Jernang.

Methods

At each location, 2 to 3 plots of 0.1x0.1km were set up, each containing subplots of 0.01x0.01m, in total 100 subplots. In each subplot the population of Jernang and of other rattan species was counted and assigned to one of four growth stages (after Dransfield 1984; INTAG 1989; Kalima 1991; and Siswanto 1991. Descriptive analysis was used based on interviews with farmers of agroforestry Jernang and rubber to obtain information about the cultivation.

Results

Two types of Jernang were found in the areas: Jernang kemalau (*Daemonorops draco*) and Jernang kelukup / berkarung / kelemunting (*Daemonorops didymophylla*). In the Tahura area 20 trees species and 14 rattan species were found whereas in the Durian Luncuk II Nature Reserve there were 7 trees species and 2 rattan species.

The community of Jebak village and Bulian Baru village has cultivated Jernang in an agroforestry systems with rubber. The combination of these two species is quite beneficial to the community and are in the form of rubber latex and Jernang resin. According to this research, it can be concluded that Jernang can also be developed in Jangga Baru village which is a buffer village of Durian Luncuk II Nature Reserve. Jangga Baru has the same landscape and topography as Jebak and Bulian Baru villages.

Research projects of stakeholders funded at the National Park Bukit Duabelas (TNBD)

Name	Counterpart	Title
Peri Hermansyah	**Z01**	Conflict resolution after encroachment on the Bukit Duabelas National Park Pematang Kabau village, Air Hitam Sub-District-Sarolangun-Jambi

Background

Bukit Duabelas National Park is managed according to a zoning system with principles of protection, preservation and utilization. The zonation design has been criticized and rejected by some villagers in New Village, Semurung, Jernih, Lubuk Jering, Pematang Kabau and Bukit Suban in Air Hitam subdistrict in Sarolangun Regency. Their criticism emerged because the zoning design does not accommodate the interest the villagers have in managing the rubber plantations that existed in the Park before it was established. This research is based on a participatory survey of community gardens in the village of Pematang Kabau. This village covers 475.25 hectares and has a total population of 253 people.

Result

OCCURRENCE OF ENCROACHMENT CONFLICT

In 2009 the process of improving the zoning design was carried out, starting with field surveys, zoning design and discussion. The discussion of zonation design at the field level contained proposals from the villagers of New Village, Semurung, Jernih, Lubuk Jering, Pamatang Kabau and Bukit Suban in Air Hitam subdistrict Sarolangun District which are incorporated in the Bukit Duabelas Buffer Village Association together with the NGO Rubber Plantation KKI Warsi. However, Bukit Duabelas National Park could not accommodate the proposal because the garden was the result of illegal encroachment.

CONFLICT RESOLUTION - SETTING UP THE NATIONAL PARK ZONES

The zoning of Bukit Duabelas National Park was passed on June 1, 2014 and then the conflict ended because the zoning designs accommodated the community proposals for managing the rubber plantation in Bukit Duabelas National Park as a special zone (figure 110).

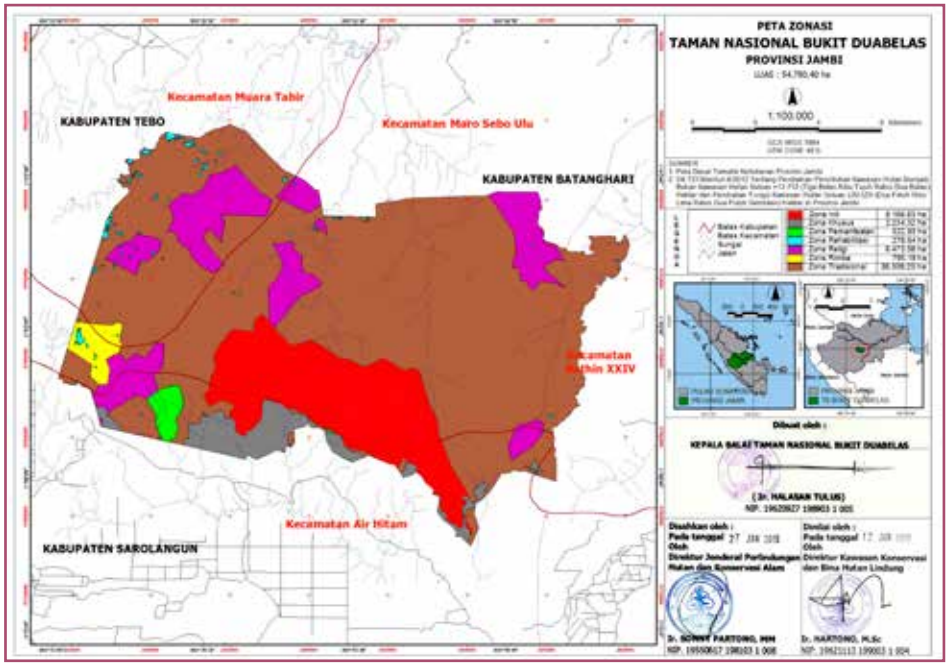

Figure 110. Zoning Map of Bukit Duabelas National Park.

FOREST AND LAND REHABILITATION

To improve the quality of the area and the number of plant species in specific zones, forest and land rehabilitation activities were carried out by enrichment with endemic plant species and multipurpose tree species. These activities were carried out by the Sustainable Forest Farmers Group in the form of planting and maintenance activities. The enrichment activities in Pematang Kabau Village were

Figure 111. Forest and land rehabilitation with endemic plant and multipurpose tree species.

completed in 2016 and covered 100 hectares. Investigations in the field showed that forest and land rehabilitation activities were growing well (figure 2).

COMMUNITY ECONOMIC EMPOWERMENT

To bring about a balance between sustainability and the prosperity of the people around the area, there are integrative, participatory and comprehensive community empowerment activities. The village Pematang Kabau is a place of Community Economic Empowerment activities in the form of economic business improvement. Community empowerment activities, in the form of provision of economic business equipment in accordance with the needs and activities of the group (e.g. hand tractor, rice milling, Jernang seeds).

Asri Buliyansih, Asep Agus Fitria	**Z01**	Identification of the bioactive compounds of medicinal herbs in Bukit Duabelas National Park

Background and Methods

A special purpose of Bukit Duabelas National Park is to protect, preserve and develop medicinal plants that are living resources of the Orang Rimba (previously nomadic forest dwellers). The "Ekspedisi Biota Medika", conducted by Bogor Agricultural University (IPB) in cooperation with LIPI, the Ministry of Health (MOH) and the University of Indonesia (UI) in 1998 in Bukit Duabelas National Park, identified 101 kinds of medicinal plants, 27 kinds of medicinal fungi and 9 species of animal with medicinal properties. These medicinal herbs are still used by the Orang Rimba, especially those distant from health facilities. Nevertheless, further tests are still needed to confirm the content of bioactive compounds (phytochemical tests). Many of the bioactive compounds already identified are used by the pharmaceutical industry, e.g. alkaloids, flavonoids (painkillers), tannins (anti-bacterial properties), saponins (anti-virus properties), steroids (anti-oxidant properties), quinones and triterpenoids.

Results

Based on phytochemical tests, 29 samples from 28 medicinal herbs contain at least one bioactive compound and were confirmed as true medicinal herbs: Keduduk (*Melastoma malabatricum*), Semasam, Goamgodong (stem), Goamgodong (leaf), Berumbung (*Dillenia excels* (jack)), Akarkopu (*Mimosa pigra* L), Kelebu Gajah Rambutan Rimba (*Nephelium lappaceumL*), Kayu Salok (Knema cinera Worb), Timun Tikus Akar Kancil (*Smilax zeylanica* L), Puar Cacing (*Eltingera* sp), Petaling (*Ochanostachys amentacea*), Ganja Sayur, Rotan Cikai (*Daemonorops melanochaete*), Antuiberbulu, Rumput Keratas, Sirih Kucing (Piper sp), Berisil, Akarsatolu (*Perycamphyllus glaucus*), Bekung, Akar Kuning (*Arcangelisiaflava*), Jelatang Ayam, Kayu Tutup, Cempedak (Arthocarpus integer), Tunggulbuto, Jelatang Api, Akar Keleketai.

Figure 112. Top from left to right: Ganja sayur, Bekung, Akarkopu; bottom from left to right: Goamgodong, Sekeduduk, Rumputkeratai.

1B. COMPLEMENTARY RESEARCH PROJECTS OF COUNTERPARTS AND STAKEHOLDERS IN 2018

In 2018, the Joint Management Board in Indonesia approved 20 research grants in the amount of Rp. 656,000,000 (ca. 40.000 EUR) from counterparts and stakeholders. ABS-project deliverables conform to the new funding scheme regulations by DIKTIRISTEK in Indonesia.

Research projects of counterparts funded at IPB

Counterpart / Associate		Title
Herdhata Agusta	A02	The soil moisture dynamics at riparian zone depending at the various distance to the water body of oil palm plantation in Jambi
Tania June	A03	Micrometeorological-based modelling of oil palm canopy temperature and stomatal conductance: Implication to CO_2 and H_2O Fluxes
Anja Meryandini, Suhartini Evan	B02	Production of manno-oligosaccharide (MOS) prebiotics from palm kernel cake using mannanolytic bacteria from Bukit Duabelas, Jambi, Sumatra
I Nengah Surati Jaya, Tatang Tiryana, Mohammad Zuhdi	B05	Updating the forest and land cover map of Jambi in 2018 : The underlying factors and detecting changes during the last 3 years
Damayanti Buchori, Akhmad Rizali	B09	Long-term monitoring of beneficial insects in oil palm plantation with vegetation enrichment
Rika Rafiudin, Triatmowidi, Windra Priawandriputra	B09	Landuse effect on the foraging of stingless bee *Tetragonula laeviceps* and bee pollen diversity in a rainforest transformation landscape
Yeni A. Mulyani, Novriyanti, Cory Wulan, Kanthi Hardina, Ihsan	B09	Identification of birds potential for seed dispersers of invasive plant species in Taman Hutan Raya Sultan Thaha Syaifuddin (Tahura Senami), Jambi
Noor Farikhah Haneda, Cahyo Wibowo	B13	Soil animal diversity and abundance, and their effects on soil respiration and nutrient cycle in the B11 Biodiversity Enrichment Experiment, Jambi
Nunung Nuryartono, Iqbal Irfany, Muhamad Amin Rifai	C10	The analysis of inequality using carbon footprint approach in Indonesia
Purnama Hidayat, Rawati Panjaitan	Z02	Butterfly diversity (Lepidoptera: Papilionoidea) in the B11 Biodiversity Enrichment Experiment plots, Jambi Indonesia

Research projects of counterparts funded at UNJA

Hesty Riany, Hasnaul Maritsa, Zulkarnain	B02	Actinomycetes from different ecological habitats as biocontrol agents of fungal plants pathogens
Bambang Irawan, Gindo Tampubolon, Hasbi Hasibuan (PT. Humusindo)	B11	Effects of fertilzer regimes and time of planting in a biodiverstiy enrichment experiment within a oil palm landscape (2nd year)
Mirawati Yanita & Zulkifli Alamsyah, Ermawati Hamid	C01	Analysis of rubber price differences in Jambi province
Rosyani & Fuad Muchlis	C02	Socio and cultural transformation of rural communities in Jambi province
Edison & Ira Wahyuni	C08	The effect of land conversion on smallholder palm oil production and income in Geragai Sub-District Tanjab Timur District, Jambi Province
Upik Yelianti & Dewi Komariah	Z01	Conservation of indegenous orchids by tissue culture technique from Harapan Rainforest, Jambi province

Research projects of counterparts funded at UNJA and PTPN VI

Zulkarnain, Lizawati & Neliyati (PTPN VI)	Z01	Investigation on micropropagation of oil palm by somatic embryogenesis

Research projects of counterparts funded at UNTAD

Nur Edy Irwan Lakani	B07	The virulence study of Ganoderma along a tropical lowland transformation systems of Sumatra

Research projects of stakeholders funded at LIPI

Siti Meliah, Atit Kanti	B02	Study on soil myxobacteria diversity in lowland rainforest and converted rainforest in Jambi

Research projects of stakeholders funded at the National Park Bukit Duabelas (TNBD)

Asri Buliyansih & Asep Agus Fitria	Z01	Identification and herbarium of medicinal plants in Taman Nasional Bukit Duabelas

2. CAPACITY BUILDING WORKSHOPS (2018)

Methods in Bioclimatology (Dr. Christian Stiegler, University of Göttingen & Dr. Tania June, Bogor Agricultural University – **A03**)

The measurement and analysis of climate and meteorological parameters is diverse and complex which involves knowledge of various disciplines and instrumentation, e.g. basic physical and technical understanding, knowledge of the software systems, programming, and statistical and data analysis. Lack of basic training in these disciplines may result in inconsistent measurement series of climatic and meteorological parameters.

Figure 113. Practical training at the climate tower.

Figure 114. Opening of the training workshop at UNJA. Sixth from left: Dr. Bambang Irawan (UNJA representative of EFForTS), seventh from left: Dr. Tania June (IPB), and fourth from right: Dr. Christian Stiegler (A03, University of Göttingen).

Figure 115. Hand-over of certificates to participants at PTPN VI. Second from left: Dr. Christian Stiegler (A03, University of Göttingen), fifth from right: Dr. Tania June (IPB).

The two-day training workshop was conducted by Dr. Christian Stiegler (University of Göttingen) and Dr. Tania June (Bogor Agricultural University) on May 2 and 3, 2018 at both the EFForTS laboratory at UNJA and the climate tower of A03 at PTPN VI to train EFForTS counterparts and stakeholders in meteorological measurements and climate data analysis (eddy covariance). The workshop consisted of two major parts: 1) visit of the climate tower at PTPN VI for demonstration purposes of the functions and basic principles of the meteorological instruments (figure 113), and 2) hands-on practice of data analysis of the major meteorological parameters.

Eleven participants from PTPN VI, BMKG (Agency for Meteorology Climatology and Geophysics, Indonesia), UNJA and EFForTS took part in the training.

3. CRC-ABS SCHOLARSHIPS FOR TECHNICAL STAFF, MASTER AND DOCTORAL RESEARCHERS

To date, EFForTS awarded ten scholarships to master students (8) and doctoral researchers (2). New / updated funding since October 2017 (newsletter no. 5):

Name of student	Affiliation Indonesia	Affiliation Göttingen	Title / Abstract	Funding period
Amanda Mawan, Doctoral researcher	Damayanti Buchori, IPB	Stefan Scheu & Jochen Drescher – **Z02**	*Diversity, phylogeny and trophic ecology of arboreal collembola communities along a lowland rainforest transformation gradient*	Oct 2017 – Dec 2019
Project summary	Collembola are micro-arthropods, which play a vital role in the leaf litter decomposer system and the formation of humus soil. In the Asian tropics, Collembola are unusually abundant on tree crowns. Dominated by the families Entomobryidae and Paronellidae, they are likely key elements to the formation of soil-filled microhabitats on tree crowns, leaf axles and epiphytic ferns. Studying the arboreal Entomobryidae and the Paronellidae along a transformation gradient from rainforest via extensive jungle rubber to monocultures of rubber and oil palm, we aim to learn about the degree and the pathways in which agricultural systems retain the ability to form humus soil. Specifically, we plan three lines of work: morphological taxonomy, molecular phylogeny and biodiversity analysis, and food web analysis via stable isotopes and fatty acids. The work will be carried out at facilities of the Dept. of Animal Ecology, Prof. Scheu in Göttingen.			
Mazidah Noer Inayah, Master student	Anja Meryandini, IPB	Rolf Daniel – **B02**	*Identification and characterization of Actinomycetes derived from Indonesian soil samples*	Apr & May 2018
Project summary	The Actinomycetes are an order within the Actinobacteria, which are often called Actinomycetes. Actinobacteria is one of the dominant bacterial phyla in soils. Streptomyces and other Actinobacteria are major contributors to biological buffering of soils. They are also the source of many antibiotics. Actinobacteria-derived antibiotics that are important in medicine include aminoglycosides, anthracyclines, chloramphenicol, macrolide and tetracycline. Actinomycetes, one of the most diverse groups of filamentous soil bacteria, are well recognized for their metabolic versatility. Many species of Actinomycetes occur in soil and are harmless to animals and higher plants, while some are important pathogens, and many others are beneficial sources of antibiotics. The bioactive potential of these bacteria facilitates their survival even in distress and unfavorable ecological soil conditions. A multitude of primary and secondary metabolites is produced by Actinomycetes. The aim is to perform an initial identification and characterization of Indonesian Actinobacterial isolates, which are important drivers of microbial soil communities.			
Siti Meliah	Atit Kanti, LIPI	Rolf Daniel – **B02**	*Study of soil myxobacteria diversity in lowland rainforest and converted rainforest in Jambi.*	Two months in the 2nd half of 2018

Riko Fardiansah, Master student	Rahayu Widyastuti, IPB	Stefan Scheu & Anton Potapov – **B08**	*Systematics of Goblin Spiders (Oonopidae) and Armored Spiders (Tetrablemmidae) in rainforest transformation systems on Sumatra, Indonesia*	Mar to Aug 2018
Project summary	Tropical lowland rain forests in Sumatra (Indonesia) have been extensively converted into oil palm plantations. Here, we investigate (1) the effect of different management intensities (two fertilizer input levels, two weeding types) on soil animal communities in oil palm plantations and (2) the effect of enrichment of oil palm plantations with native tree species on above- and belowground invertebrate animal communities (cooperation with B11). Overall, the project aims at identifying conditions allowing to ameliorate detrimental effects of conversion of tropical lowland rainforest into agricultural production systems for the structure and functioning of animal communities and to develop strategies for harmonizing conservation and socioeconomic needs. More specifically, we plan three lines of work: morphological taxonomy, molecular phylogeny, and stable isotope analyses (^{15}N; ^{13}C) for food web analyses. The work will be carried out at the facilities of the Dept. of Animal Ecology, Prof. Scheu in Göttingen.			
Mega Mutiari Master student	Damayanti Buchori & Purnama Hidayat, IPB	Stefan Scheu & Jochen Drescher – **Z02**	*Structural composition of arboreal arthropod food webs across land use change in two seasons using body mass and stable isotopes*	Sep to Dec 2018
Project summary	Many ecosystem functions depend on food web structure, which heavily relies on the biomasses of different trophic groups. However, little is known on how the biomass of arboreal arthropods from different trophic groups responds to agricultural practices in tropical land-use systems and how these responses are affected by seasonality. The aim of the proposed research is to study the structure of arboreal food webs across land use systems, and the impact of seasonality on the food web structure in the land use systems studied by EFForTS. We aim to use body masses, inferred from body length and width, and 15N stable isotope measurements to show how energy fluxes between trophic groups differ among the four land use systems Rainforest, Jungle Rubber, Rubber, and Oil Palm, and how they change within each system between the dry season and the rainy season in Jambi. To do that, we rely on previously collected arthropod samples from the first Z02 canopy fogging campaigns in the dry season of 2013 and the rainy season of 2013/2014. At Bogor Agricultural University, the samples have been taxonomically sorted to order level (some orders even beyond to morphospecies level). Besides, the body lengths and widths of randomly selected and plot-wise replicated individuals were measured. Those individuals will be brought to Göttingen University, where they will be subjected to stable isotope measurements at the Centre for Stable Isotope Research and Analysis (Kompetenzzentrum Stabile Isotope, KOSI). Using standard biometric equations earlier developed in EFForTS, we will estimate biomasses of 12 arthropod orders with previously ascribed trophic guilds, and the energy fluxes between them. The predictions resulting from that will be compared to the results of the stable isotope measurements, which also estimate trophic positions. The projected output of this study is a joint publication discussing the structure of food webs across land use systems, and the influence of seasonality on food web structure, involving authors from Bogor Agricultural University and Göttingen University.			

Rawati Panjaitan, Doctoral researcher, IPB	Purnama Hidayat, IPB	Stefan Scheu & Jochen Drescher – **Z02**	*Diversity of Butterflies (Lepidoptera) across rainforest transformation systems in Bukit Duabelas and Harapan Forest, Jambi*	May 2017 to Dec 2019
Project summary	Butterflies (Lepidoptera) play an important role in fundamental ecosystem services such as pollination. By studying the species richness, diversity and community composition of members of a key Lepidopteron superfamily, i.e. Papilionoidea, we aim at estimating the degree by which agricultural intensification has influenced the ability of butterfly communities to carry out pollination services. Adding molecular data will aid in the building up of a genetic library for both common and rare species, and will support metagenomics' approaches with the aim to detecting unknown species in mixed bulk samples of larva. We will link our data to that of the canopy arthropod monitoring in Z02 in order to understand to which degree Lepidoptera are sedentary across their life cycle (larva vs. imago) and their role in the food web (herbivorous vs. nectarivorous).We will further compare our findings with insights from vegetation and soil analyses to shed light on the interaction between adult butterflies and their environment. Being a significant source of protein for birds, we will also compare our data with bird counts across the transformation gradient.			
Mayanda Lia, Master Student	Damayanti Buchori & Purnama Hidayat, IPB	Stefan Scheu & Jochen Drescher – **Z02**	*Diversity of canopy spiders (Araneae) assemblages along a transformation gradient in Jambi Province, Indonesia*	Sep 2018 to Feb 2019
Project summary	Arthropod assemblages respond quickly to habitat disturbance and are thus a reliable and often-used indicator of environmental change. Spiders, in particular, are frequently used to assess environmental change in terms of habitat type, habitat structure, wind and temperature exposure. Showing pronounced responses to changes in biotic and abiotic parameters on small scales, spider assemblages show dramatic changes to landscape level conversions of natural habitats to agricultural land. In Indonesia, where large areas of natural lowland rainforest have been and still are converted to agricultural systems such as rubber and oil palm, changes in biodiversity and community composition of arboreal spiders are thus going to be very pronounced. Since spiders are top predators in the invertebrate food web, they have sophisticated effects on agricultural pests and the decomposer system. In turn, spiders are preyed upon by a vast range of birds, reptiles, amphibians, fish and invertebrate parasitoids. Thus, changes in land-use from lowland rainforest to rubber and oil palm plantations are not only going to affect diversity and community compositions of spiders alone, but will entail cascading effects through the entire food web. This, in turn, is likely to have dramatic effects on the ecosystem functions and services of entire agricultural ecosystems. In the proposed research, I will thus study the cascading impact of rainforest conversion on ecosystem services in jungle rubber as well as plantations of oil palm and rubber by focusing on arboreal canopy spider assemblages.			

HIGHLIGHTS / PRELIMINARY RESULTS OF ABS SCHOLARSHIP PROJECTS

AMANDA MAWAN - Z02

To date, a collection of 39.691 specimens from the dry season 2013 collection has been assigned to 38 morphospecies, and taxon expert revision is currently taking place. Our preliminary analysis suggests that springtail species richness in forest and jungle rubber is significantly higher than in rubber or oil palm monocultures, while species diversity is similar (figure 116a). Simultaneously, community composition differs significantly between the land use systems (figure 116 b), with rainforest and jungle rubber communities being much more similar in themselves and with each other, than communities inhabiting rubber and oil palm monocultures. Photographic documentation of morphospecies is in progress (figure 117). Future analytical directions include molecular approaches to resolve arboreal collembola phylogeny and stable isotope measurements to detect dietary shift. Currently, a manuscript focusing on the effects of land use change on Collembola species richness, diversity and community composition is in preparation.

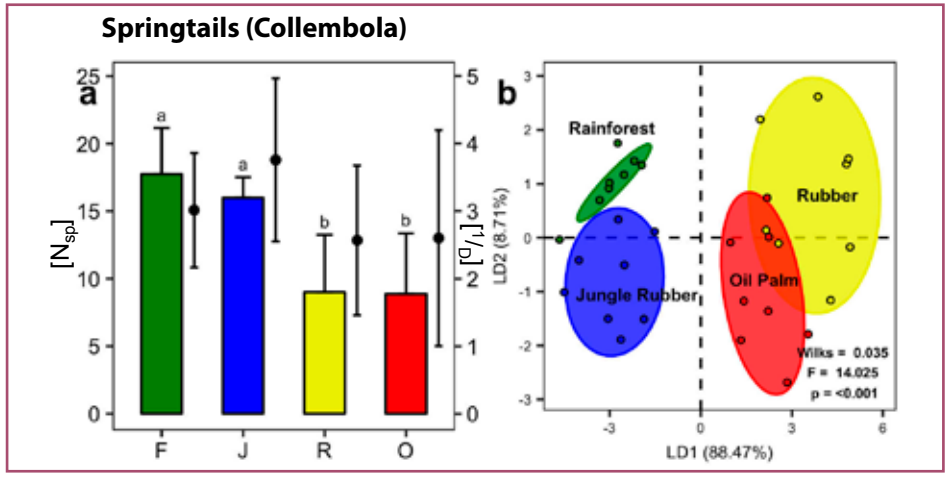

Figure 116. Community measures of arboreal springtails (Collembola) in rainforest (F), jungle rubber (J), rubber (R) and oil palm plantations (O) in Jambi Province. We calculated (a) average species richness Nsp and inverse Simpson diversity $^{1}/_{D}$ and compared averages with ANOVA followed by pairwise t-tests using Holm's correction. Different letters indicate significant differences (all $p<0.0001$). We then used DFA ordination (b) to analyze community composition. P-values below $\alpha=0.05$ indicate a significant discrimination between communities of different land use systems.

Figure 117. Top view of the arboreal springtail Salina saikehi (Collembola: Paronellidae) (by A. Mawan).

RIKO FARDIANSAH - B08

Riko & co-authors submitted a paper entitled "*Description of four new species of armoured spiders (Araneae: Tetrablemmidae) from Indonesia, including the first Brignoliella species from Sumatra*".

Riko Fardiansah, Nadine Dupérré, Rahayu Widyastuti, Anton Potapov, Stefan Scheu, Danilo Harms

Abstract: Indonesia is one of the most biodiverse countries in the world, yet its arachnid fauna remains largely undocumented and almost nothing is known about arachnids in cryptic habitats such as leaf litter. Here we describe five spe-

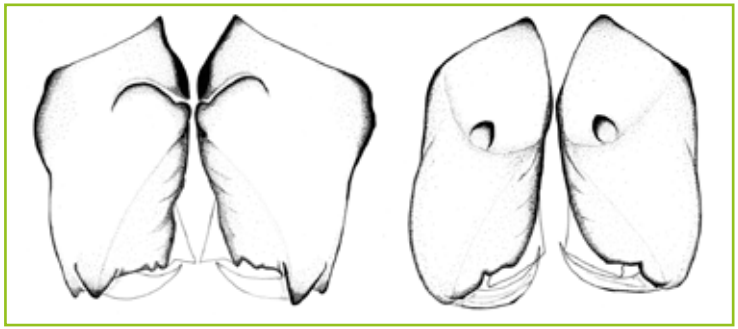

Figure 118. Drawing by Riko Fardiansah of chelicera of two newly described spider species, Ablemma andriana (left) and Brignoliella patma (right).

cies of armoured spiders (family Tetrablemmidae) from moist leaf litter habitats in Sumatra, Indonesia that belong to two genera, Ablemma Roewer, 1963 and Brignoliella Shear, 1978. Four species are described as new species: Ablemma andriana sp. n. (male), Ablemma contrita sp. n. (male and female), Ablemma kelinci sp. n. (male) and Brignoliella patma sp. n. (male and female). The description of the female of Ablemma singalang Lehtinen, 1981 is presented here for the first time. We also establish the first record of Brignoliella for Sumatra.

WINDA IKA SUSANTI - B08

Soil Fauna in the Lowland Rainforest and Agricultural Systems of Sumatra: Changes in Community Composition and Trophic Structure with Focus on Collembola.

Winda started her doctoral research in October 2017 at the Institute of Zoology and Anthropology at the University of Göttingen. Supervisors are Anton Potapov, Stefan Scheu (UGoe) and Rahayu Widyastuti (IPB) – B08 / EFForTS.

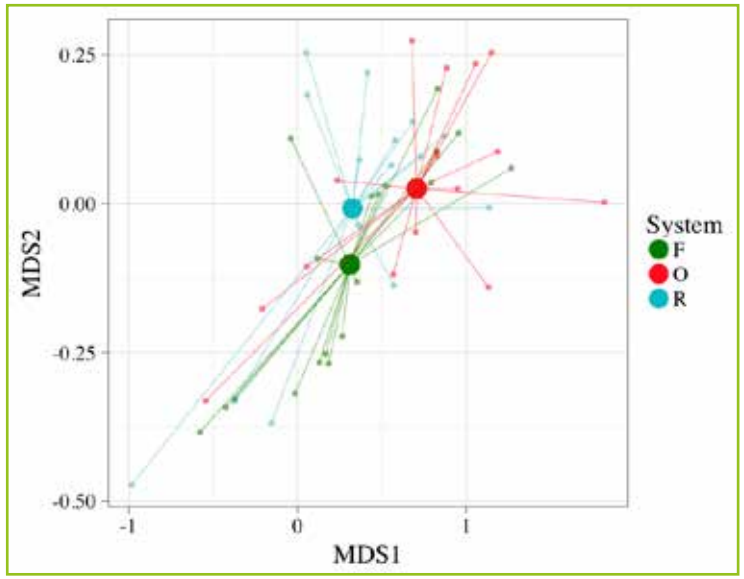

Figure 119. Multidimensional scaling of neutral lipid fatty acid composition in various groups of soil animals from rainforest (F), oil palm monoculture (O) and rubber monoculture (R). Small dots reflect animals and large circles show centroids. Since only trophic biomarkers were used in the analysis, distances between points related to distances in trophic habits between animals.

The outline of the project is summarized in Newsletter no. 5 (Oct 2017).

In brief, the research aims at revealing changes in abundance, community structure and trophic interactions of soil fauna connected with intensive agricultural land-use such as rubber and oil palm plantations in Sumatra, Indonesia. All groups of soil invertebrates will be studied on broad taxonomic level with focus on collembola that will be studied at high taxonomic resolution. To study trophic interactions classical methods of soil animal collecting and microscopic identification will be combined with novel instrumental techniques (DNA barcoding, stable isotope analysis). The figure below depicts multidimensional scaling of neutral lipid fatty acid composition in various groups of soil animals from rainforest (F), oil palm monoculture (O) and rubber monoculture (R) (figure 119).

RAWATI PANJAITAN - Z02

In 2017, Rawati collected 5,171 butterfly specimens belonging to 209 species on EFForTS core plots and riparian sites. Using direct surveys and scan samplings, butterflies were recorded, photographed, and identified in the field. Species unable to be identified on site were caught by sweep netting and preserved for subsequent analysis in the lab. Among the butterflies recorded this way were IUCN protected species such as the Malay birdwing Troides amphrysus and Raja Brooke's birdwing Trogonoptera brookiana (figure 120). There are significantly more species of butterfly in forest (Nsp = 47.1 ± 7.7) and jungle rubber (Nsp = 39 ± 8) than in monoculture rubber (Nsp = 26.1 ± 9.1) and oil palm (Nsp = 33.4 ± 9.7, all values mean ± SD, Fig 2a). Simpson's diversity index declined significantly from forest to the monocultures, with jungle rubber having an intermediate position (figure 121a). The communities were much more similar among all land use systems than in the ants, parasitoids or beetles, while still differing significantly from each other (figure 121b). A likely explanation for this pattern is the presence/absence of host plants for certain butterfly species. Especially for the rare and protected species, there are no suitable host plants in the monocultures, restricting those species to the less disturbed forest of Bukit Duabelas National Park. A manuscript is currently in preparation which focuses on the impact of land use on butterfly species richness and diversity, and which will compare the butterfly communities of riparian sites with those of the

core plots. Rawati Panjaitan will collect specimen in the B11 Biodiversity Enrichment Experiment in late dry season 2018.

Figure 120. Rajah Brooke's birdwing Trogonoptera brookiana (Lepidoptera: Papilionoidea), an IUCN protected butterfly (R. Panjaitan).

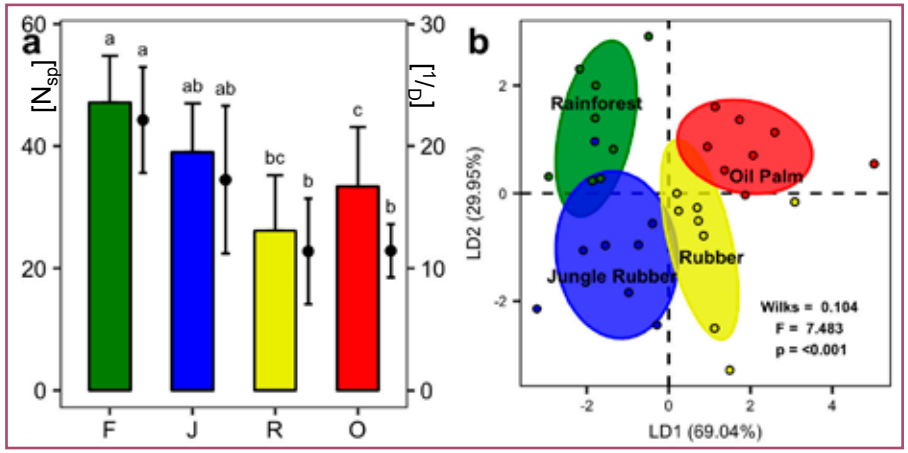

Figure 121. Community measures of butterflies in rainforest (F), jungle rubber (J), rubber (R) and oil palm plantations (O) in Jambi Province. We calculated (a) average species richness Nsp and inverse Simpson diversity 1/D and compared averages with ANOVA followed by pairwise t-tests using Holm's correction. Different letters indicate significant differences (all $p<0.0001$). We then used DFA ordination (b) to analyze community composition. P-values below $\alpha=0.05$ indicate a significant discrimination between communities of different land use systems.

4. SUPPLEMENTARY CAPACITY BUILDING MEASURES

Additional capacity building measures have been supported with university (UGoe) and institute funds of scientific projects:

TRAINING AND FUNDING SUPPORT BY SCIENTIFIC PROJECTS

a) B07 – sampling methods in the field and standard laboratory procedures for soil fungal communities: The Indonesian field assistants from Jambi University were instructed how to independently perform root and soil sampling and proper handling of samples determined for DNA analysis. Further, they were enabled to distinguish tree fine roots by their morphology and assess root health using a stereo microscope.

b) B11 – seed identification: Ms. Handriany and Ms. Herni Dwinta Pebrianti (local staff member) participated in two seed identification workshops at the Royal Botanical Garden, Bogor, Indonesia (3 to 13 August 2017), and at the Herbarium SEAMEO BIOTROP, Bogor, Indonesia (18 to 26 August 2017).

SCIENTIFIC WRITING AND PUBLISHING IN ENGLISH - OUTLOOK

c) Z01. A two-day training workshop will be held in March 2019 for counterparts and stakeholders one each at IPB and UNJA. The courses will be conducted by an English native speaker and certified trainer (Dr. Andrew John Davis).

IV. Publications

1. **Journal articles**
2. **Other Publications**

Scientific publications of EFForTS since the last issue of newsletter no. 5, October 2017

1. JOURNAL ARTICLES

Master student / Counterpart **B08** at IPB	**Fardiansah R, Dupérré N, Widyastuti R, Potapov A, Scheu S, Harms D** (2018) Description of four new species of armoured spiders (Araneae: Tetrablemmidae) from Indonesia, including the first Brignoliella species from Sumatra *submitted*
Counterpart **A05** at UB	**Kurniawan S, Corre MD, Matson AL, Schulte-Bisping H, Utami S, Veldkamp E** (2018) Conversion of lowland forests to oil palm and rubber plantations impacts nutrient leaching losses and nutrient retention efficiency in highly weathered soils in Sumatra, Indonesia *Biogeosciences 15: 5131-5154*
Counterpart **A05** at UB	**Kurniawan S, Corre MD, Utami SR, Veldkamp E** (2018) Soil Biochemical Properties and Nutrient Leaching from Smallholder Oil Palm Plantations, Sumatra-Indonesia *AGRIVITA Journal of Agricultural Science: 40(2): 257-266*
Counterpart **A03** at IPB	**June T, Meijide A, Stiegler C, Kusuma AP, Knohl A** (2018) 'The influence of surface roughness and turbulence on heat fluxes from an oil palm plantation in Jambi, Indonesia *Earth and Environmental Science 149*
Counterpart **B10** at IPB	**Tarigan S, Wiegand K, Sunarti, Slamet B** (2018) Minimum forest cover required for sustainable water flow regulation of a watershed: a case study in Jambi Province, Indonesia *Hydrology and Earth System Sciience 22: 581–594*
B04, A02	**Abou Rajab Y, Hölscher D, Leuschner C, Barus H, Tjoa A, Hertel D** (2018) Effects of shade tree cover and diversity on root system structure and dynamics in cacao agroforests: the role of root competition and space partitioning *Plant and Soil 422: 349-369.*
A05	**Allen K, Hassler E, Kurniawan S, Veldkamp E, Corre MA** (2018) Canopy soil of oil palm plantations emits methane and nitrous oxide *Soil Biology and Biochemistry 122: 1–6*
B02	**Berkelmann D, Schneider D, Engelhaupt M, Heinemann M, Christel S, Wijayanti M, Meryandini A, Daniel R** (2018) How rainforest conversion to agricultural systems in Sumatra (Indonesia) affects active soil bacterial communities *Frontiers in Microbiology, submitted*
C07	**Bou Dib J, Alamsyah Z, Qaim M** (2018) Land-use change and income inequality in rural Indonesia *Forest Policy and Economics 94: 55-66*
C07	**Bou Dib J, Krishna VV, Alamsyah Z, Qaim M** (2018) Land-use change and livelihoods of non-farm households: The role of income from employment in oil palm and rubber in rural Indonesia *Land Use Policy 76: 828-838*
B09	**Darras K, Rahmann D, Sugito W, Mulyani Y, Prawiradilaga D, Rozali A, Fitriawan I, Tscharntke T** (2018) Birds of primary and secondary forest and shrub habitats in the peat swamp of Berbak National Park, Sumatra) *F1000Research 7: 229*

B09	**Darras K, Batáry P, Furnas B, Celis-Murillo A, Van Wilgenberg SL, Mulyani YA, Tscharntke T** (2018) Comparing the sampling performance of sound recorders versus point counts in bird surveys: A meta-analysis *Journal of Applied Ecology 2018: 1-12*
B09	**Darras K, Furnas B, Fitriawan I, Mulyani Y, Tscharntke T** (2018) Estimating bird detection distances in sound recordings for standardizing detection ranges and distance sampling *Methods in Ecology and Evolution 2018: 1-11*
B10	**Dislich C, Hettig E, Salecker J, Heinonen J, Lay J, Meyer KM, Wiegand K, Tarigan S** (2018) Land-use change in oil palm dominated tropical landscapes - An agent-based model to explore ecological and socio-economic trade-offs *PLoS ONE 13(1):e0190506*
B08	**Geisen S, Mitchell EAD, Adl S, Bonkowski M, Dunthorn M, Ekelund F, Fernández LD, Jousset A, Krashevska V, Singer D, Spiegel FW, Walochnik J, Lara E** (2018) Soil protists: a fertile frontier in soil biology research. *FEMS Microbiology Reviews 42(3): 293-323.*
B11	**Gérard A, Wollni M, Hölscher D, Irawan B, Sundawati L, Teuscher M, Kreft H** (2017) Oil palm yields in diversified plantations: Initial results from a biodiversity enrichment experiment in Sumatra, Indonesia *Agriculture, Ecosystems & Environment 240: 253-260.*
B11	**Grossmann JJ, Vanhellemont M, Barsoum N, Bauhus J, Bruelheide H, Castagneyrol B, Cavender-Bares J, Eisenhauer N, Ferlian O, Gravel D, Hector A, Jactel H, Kreft H, Mereu S, Messier C, Muys B, Nock C, Paquette A, Parker J, Perring MP, Ponette Q, Reich PB, Schuldt A, Staab M, Weih M, Zemp DC, Scherer-Lorenzen M, Verheyen K** (2018) Synthesis and future research directions linking tree diversity to growth, survival, and damage in a global network of tree diversity experiments *Environmental and Experimental Botany 152: 68-89*
A04, B04, A03, B08	**Guillaume T, Kotowska MM, Hertel D, Knohl A, Krashevska V, Murtilaksono K, Scheu S, Kuzyakov Y** (2018) Carbon costs and benefits of Indonesian rainforest conversion to plantations *Nature Communications 9: 2388*
A01	**Hapsari KA, Biagioni S, Jennerjahn TC, Reimer PM, Saad A, Sabiham S, Behling H** (2018) Resilience of a peatland in Central Sumatra, Indonesia to past anthropogenic disturbance: improving conservation and restoration designs using palaeoecology *Journal of Ecology 2018, 1-18*
C02	**Hartmann F, Merten J, Fink M, Faust H** (2018) Indonesia's Fire Crisis 2015 – A Twofold Perturbation on the Ground *Pacific Geographies 49: 4-11*
C02	**Hein J, Faust H, Kunz Y, Mardiana R** (2018) The Transnationalisation of Competing State Projects: Carbon Offsetting and Development in Sumatra's Coastal Peat Swamps *Antipode 50(4): 953-975*
B09	**Janra MN, Herwina H, Febria FA, Darras K, Mulyani YA** (2018) First case of Knemidokoptiasis in a wild bird, the Little Spiderhunter (Arachnothera longirostra cinireicollis) in Sumatra, Indonesia *Journal of Wildlife diseases, accepted*
B08, B13	**Krashevska V, Malysheva E, Klarner B, Mazei Y, Maraun M, Widayastuti R, Scheu S** (2018) Micro-decomposer communities and decomposition processes in tropical lowlands as affected by land use and litter type *Oecologia 187: 225-266*
C07, B05	**Kubitza C, Krishna V, Urban K, Alamsyah Z, Qaim M** (2018) Land property rights, agricultural intensification, and Deforestation in Indonesia *Ecological Economics 147: 312-321*
C07	**Kubitza C, Krishna VV, Alamsyah Z, Qaim M** (2018) The Economics Behind an Ecological Crisis: Livelihood Effects of Oil Palm Expansion in Sumatra, Indonesia *Human Ecology 46: 107-116*
B06	**Kusuma YW, Rembold K, Tjitrosoedirdjo SS, Kreft H** (2018) Tropical rainforest conversion and land use intensification reduce understory plant phylogenetic diversity *Journal of Applied Ecology 2018: 1-11*
A03	**Manoli G, Meijide A, Huth N, Knohl A, Kosugi Y, Burlando P, Ghazoul J, Fatichi S** (2018) Ecohydrological changes after tropical forest conversion to oil palm *Environmental Research Letters: 13(6)*

A03	**Meijide A, Badu CS, Moyano F, Tiralla N, Gunawan D, Knohl A** (2018) Impact of forest conversion to oil palm and rubber plantations on microclimate and the role of the 2015 ENSO event *Agricultural and Forest Meteorology (252): 208-219*
B08	**Potapov AM, Klarner B, Sandmann D, Widyastuti R, Scheu S** (2018) Size spectrum of soil invertebrates affects energy fluxes and ecosystem functioning in tropical land-use systems *submitted*
B08, B01	**Potapov AM, Dupérré N, Jochum M, Dreczko K, Klarner B, Barnes AD, Brose U, Widyastuti R, Harms D, Scheu S** (2018) Strong species and trait turnover in litter- and soil-associated spider communities with conversion of tropical rainforest into plantation systems *submitted*
B08	**Potapov AM, Tiunov AV, Scheu S** (2018) Uncovering trophic positions and food resources of soil animals using bulk natural stable isotope composition *Biological Reviews (2018)*
A02, A03, A04, B04, B06, B07, B11	**Röll A, Niu FR, Meijide A, Ahongshangbam J, Ehbrecht M, Guillaume T, Gunawan D, Hardanto A, Hendrayanto, Hertel D, Kotowska M, Kreft H, Kuzyakov Y, Leuschner C, Nomura M, Polle A, Rembold K, Sahner J, Seidel D, Zemp DC, Knohl A, Hölscher D** (2018) Transpiration on the rebound in the lowland Sumatra *Global Change Biology, submitted*
A03	**Sabajo CR, LeMaire G, June T, Meijide A, Roupsard O, Knohl A** (2017) Expansion of oil palm and other cash crops cause an increase of surface temperature in Indonesia *Biogeosciences 14: 4619–4635*
A01	**Setyaningsih CA, Biagioni S, Saad A, Kashima K, Sabiham S, Behling H** (2017) Response of mangroves to sea-level change: palaeoecological evidence from Sumatra, Indonesia *Wetlands Journal, submitted*
A01	**Setyaningsih CA, Behling H, Saad A, Shumilovskikh L, Sabiham S, Biagioni S** (2018) First palaeoecological evidence of Buffaloes husbandry and rice cultivation in the Kerinci Seblat National Park in Sumatra, Indonesia *Vegetation History and Archaeobotany Journal, submitted*
B08, B13	**Schulz G, Maraun M, Scheu S, Völcker E, Krashevska V** (2018) Evaluation of morphological characteristics to delineate taxa of the genus Trigonopyxis (Amoebozoa, Arcellinida) *Protist 169: 190-205*
C07	**Sibhatu KT, Qaim M** (2018) Farm production diversity and dietary quality: linkages and measurement issues *Food Security (9): 1-13*
C03, C02	**Steinebach S, Kunz Y** (2017) Farmers, peasants and pawns: The role of migrants in agrarian conflicts and rural resistance in Sumatra, Indonesia *The Asia Pacific Journal of Anthropology 18(2017): 228-245*

2. OTHER PUBLICATIONS

C07	**Bou Dib J, Krishna V, Alamsyah Z, Qaim M** (2018) Land-use change and livelihoods of non-farm households – The role of icome from employment in oil palm and rubber in rural Indonesia *EFForTS discussion paper series 21*
C02	**Hein J, Kunz Y** (2018) Adapting in a carbon pool? Politicising climate change at Sumatra's palm oil frontier *In: Klepp, S. und L. Chavez Rodriguez (Hrsg.): A Critical Approach to Climate Change Adaptation: Discourses, Policies*
C04	**Hettig E, Lay J, van Treeck K, Bruness M, Asih DN, Nuryartono N** (2017) Cash crops as a sustainable pathway out of poverty? Panel data evidence on the heterogeneity of cocoa farmers in Sulawesi, Indonesia *Courant Research Centre: Poverty, Equity and Growth - Discussion Papers No. 227/2017*
C07	**Kubitza C, Gehrke E** (2018) Why does a labor-saving technology decrease fertility rates? Evidence from the oil palm boom in Indonesia *EFForTS discussion paper series 22*
C08	**Sarwosri AW, Wegmann S, Mußhoff O** (2018) Encouraging rainforest preservation by smallholders: an ex-ante policy evaluation *EFForTS discussion paper series 23*

V. Early Career Support: Education and Promotion of Junior Researchers (update since newsletter no. 5, October 2017)

1. DISSERTATIONS

Table 1. New completed dissertations of Phase 1 – University of Göttingen.

Scientific project	Name	Type of funding	Title of thesis
C04	**Katharina van Treeck**	DFG	The Role of Labor in Sustainable Development (**completed November/2017**)
C07	**Christoph Kubitza**	DFG	Land-use change and rural development in Indonesia: Economic, institutional and demographic aspects of deforestation and oil palm expansion (**completed May/2018)** (Funding: Apr 2015 to Mar 2018)
C07	**Jonida Bou Dib**	DAAD	Effects of oil palm expansion and related land-use changes on non-farm households in rural Indonesia. (**completed May/2018**)

Table 2. Newly started dissertations of Phase 2 - University of Göttingen.

Scientific project	Name	Type of funding	Title of thesis
B08	**Winda Ika Susanti**	Institute Scheu & DFG	Soil Fauna in the Lowland Rainforest and Agricultural Systems of Sumatra: Changes in Community Composition and Trophic Structure with Focus on Collembola (**since September/2017**)
C07	**Nadjia Mehraban**	DFG	Land-use change and livelihood effects among smallholder farmers in Indonesia (**since April/2018**)
C08	**Karina Brenneis**	DFG	Policy incentives for sustainable land use choices (**since September/2018**)
Z02	**Amanda Mawan**	Institute Scheu & DFG	Diversity, phylogeny and trophic ecology of arboreal collembola communities along a lowland rainforest transformation gradient (**since October/2017**)

Scientific project	Name	Type of funding	Title of thesis
Sauer - assoziiert	**Britta Greenshields**	DFG	Impact of transformation of rainforests into oil-palm plantations on silicon pools in soils (**since March/2018**)

Table 3. Newly started dissertations of Phase 2 - IPB, BOGOR.

Name of counterpart	Name of researcher	Title of thesis
Purnama Hidayat - **Z02**	**Rawati Panjaitan**	Diversity of Butterflies (Lepidoptera) across rainforest transformation systems in Bukit Duabelas and Harapan Forest, Jambi (**since May/2017**)

2. MASTER THESIS

Table 4. Master theses at the University of Göttingen – newly started and /or completed since October 2017.

Scientific project	Name of student	Title of the thesis
Completed		
A07	Brananditya Nugroho	Leaf gas exchange measurements of plant species in various land-use systems in Jambi province (**January 2018**)
C02	Imke Rödel	Smallholders´Sustainability Perceptions vs. Performance in the context of Indonesian Palm Oil - How do international sustainability criteria influence local discourses and practices in rural Sumatra? (**April 2018**)
C08	Johanna Meinecke	Adoption of sustainable management practices in oil palm plantations by smallholder farmers in Sumatra, Indonesia (**December 2017**)
Newly started		
B05	Rodrigo Vera Ramirez	Land Use Classification for Jambi Province (**December 2017**)
B06	George Ofori Ankomah	Assessing the leaf area index (LAI) across four land use systems in Jambi Province, Sumatra, Indonesia (**March 2018**)
B06	Biplabi Bhattarai	Tree functional traits related to leaf and wood economics across different land use systems in Sumatra, Indonesia (**March 2018**)
B06	Thakur Prasad Magrati	Effects of land use change on tree ecological traits and strategies in Sumatra, Indonesia (**March 2018**)
B09	Rebekka Blessenohl	Impacts of weeding and fertilization management on insect diversity in oil palm plantations (**May 2018**)
B09	Jonathan Tien-Yi Fung	Oil palm and ecosystem services from native pollinators in Sumatra, Indonesia (**June 2018**)
B09	Sonja Schröck	Impacts of land use on native pollinator diversity and survival in Sumatra, Indonesia (**June 2018**)
B11	Lena Sachsenmeier	The effect of tree planting in oil palm plantations on the structure and diversity of the understory vegetation (**December 2017**)
B11	Johanna Ruth Kückes	Biodiversity enrichment experiment in Sumatra: Comparison of water infiltration capacities (**March 2018**)
B11	Hendrik Lorenz	Determining the effects of light competition on oil palm yield in biodiversity enriched agroforestry (**March 2018**)

Scientific project	Name of student	Title of the thesis
B11	Alejandra Valdés	Biodiversity enrichment experiment in Sumatra: Monitoring of leaf area index (LAI) (**March 2018**)
Z02	Tizian Lang	Investigating community-structure and biodiversity of six parasitoid Hymenoptera taxa along a landuse-transformation-gradient within two regions in Jambi Provence, Indonesia using a combination of morphological classification and metabarcoding (**January 2018**)
Sauer - associated	Laura Pauli	Impact of transformation of rainforests into oil-palm plantations on silicon pools in soils (**April 2018**)

Table 5. Master theses at IPB, Bogor – newly started or completed since October 2017.

Name of counterpart (IPB)	Name of student	Title of the thesis
Damayanti Buchori Z02	Lailatun Najmi	Identification, Diversity and Abundance of Curculionid Beetles in Bukit Duabelas National Park and Harapan Forest, Jambi' (**completed**)
Damayanti Buchori & Purnama Hidayat Z02	Muhammad Syaifullah Hiola	Diversity of staphylinid beetles (Coleoptera: Staphylinidae) in different types of land use and seasons in Jambi (**on-going**)
Damayanti Buchori & Purnama Hidayat Z02	Rizky Nazarreta	Diversity and Identification of Arboreal Ants in Harapan Rainforest and Bukit Duabelas National Park Landscape, Jambi (**completed**)

VI. Central Meetings of EFForTS: Workshops, Retreats, Colloquia, Symposia and Trainings

Central meetings of EFForTS play an essential role for the promotion of scientific exchange between the researchers, for fostering the international collaboration with the partners in Indonesia, and for supporting young academics, for example through the organization of doctoral / postdoctoral colloquia. Moreover, international seminar series are held at IPB (ICESS) and at UNJA (UCESS) for researchers of EFForTS.

Table 6. Central meetings of EFForTS in 2017 and 2018: boards, PIs, counterparts and stakeholders

Event / Venue Date	Topic
Annual retreat of EFForTS – Göttingen 1 to 3 Nov 2017	- The annual retreat of EFForTS was held on 1 and 2 November 2017 in Hann. Münden. About 50 counterparts and stakeholders from Indonesia attended the workshop. Focus was to present disciplinary and interdisciplinary research activities (figure 122). - On 3 November 2017, a stakeholder workshop was conducted at the Paulinerkirche Göttingen. Focus was on stakeholder relations and project-oriented collaboration / activities (RISTEK-DIKTI, BPDP-KS, REKI, and LIPI).
Boards 30 Jan 2018 14 Mar 2018 2 May 2018 11 Jun 2018 3 Jul 2018	- The annual Joint Management Board (JMB) meeting in Indonesia was conducted on 14 Mar 2018 at IPB, Bogor. Focus was the introduction of the new speaker of EFForTS (Pak Prof. Dodik Nurrochmat), the nomination of new JMB members, the introduction of the new coordinator at IPB (Dr. Sunny Reetz), the evaluation of ABS funding (2017 & 2018), and the building of a new guest house at PT. REKI. - Board meetings in Göttingen took place on 30 Jan / 2 May / 11 Jun / 3 Jul 2018: with focus on financial management including ABS measures, research infrastructure, public relations & press releases, international symposium in Bali and preparation for Phase 3.
PT. REKI 19 Mar 2018	- Meeting of EFForTS board members with the management of PT. REKI to discuss future research collaboration.

Figure 123. Meeting of the EFForTS board with the management of PT. REKI on 19 March 2018. Front row from left to right: Yusup Cahyadin, Lisman Sumardjani, Stefan Scheu, Dodik Nurrochmat, Bambang Irawan. Back row standing from left to right: Arief, Jomi Suhendri, Aiyen Tjoa, Sunny Reetz, Elva Gemita, Adam.

Figure 122. EFForTS team at the annual retreat in Hann. Münden on November 1 and 2, 2017.

Ministry of Agriculture (MOA) & Ministry of Research, Technology and Higher Education (RISTEKDIKTI) – Indonesia 21 Mar 2018	Exchange meeting of the management of EFForTS with representatives from MOA & RISTEKDIKTI.  **Figure 124.** Meeting of the EFForTS management with the Director General of the Estate Crops of the Ministry of Agriculture (M.M. Bambang), Indonesia on 21 March 2018. From left to right: Iskandar Z. Siregar, Sunny Reetz, Aiyen Tjoa, Stefan Scheu, M.M. Bambang, Irmijati Rachmi Nurbakar, Anas Fauzi, Indri Hapsari.  **Figure 125.** Meeting of the EFForTS management with the Director for Research and Community Services of RISTEKDIKTI (Ocky Radjasa) on 21 March 2018. From left to right: Stefan Scheu, Ocky Radjasa, Aiyen Tjoa, Iskandar Z. Siregar.

ABS Workshops at IPB and UNJA 22 Feb & 20 Mar 2018	- A one-day ABS workshop took place on 20 March 2018 at IPB. The rector of IPB, Prof. Arif Satria, opened the workshop. About 15 counterparts presented their research work. - On March 20 2018, UNJA hosted a half-day ABS symposium to discuss the results and outcomes of the ABS research projects of counterparts and stakeholders that have been funded by EFForTS. The symposium was opened by Prof. Dodik Ridho Nurrochmat (speaker of the Indonesian University Consortium, IPB) and by Prof. Stefan Scheu (speaker of EFForTS, University of Göttingen). About 60 people attended the symposium.
.	 **Figure 126.** Participants of the ABS symposium hosted by UNJA on March 20, 2018. From left to right: Mr. Peri Hermansyah (TNBD), Ms. Asri Buliyansih (TNBD), Prof. Stefan Scheu (speaker of EFForTS), Ms. Elisa Septina (BKSDA), Mr. Marwa Prinando (BKSDA).

RISTEKDIKTI 5 Jul 2018	- The Directorate Research Strengthening and Development of RISTEKDIKTI hold a national meeting in Jakarta entitled "International Research Partnership". About 200 participants from higher education and research institutions, embassies and ministries - including members of the JMB / EFForTS - attended the meeting (figure 128). - Two invited keynotes were given by Iskandar Z. Siregar (*International Research Management at IPB*) and by Aiyen Tjoa (*Best practices of CRC / EFForTS in Research Management*). Thereafter, six working groups met. Focus was on permit system and one-stop service, research management (chaired by Iskandar Z. Siregar), benefit sharing, data management, publication, and capacity development and partners (chaired by Aiyen Tjoa). - IPB and Riau University were nominated as best universities in international research partnership (figure 127).

Figure 127. Award ceremony at RISTEKDIKTI – nomination of IPB as best national university in international research partnership. Center, from left to right: Dr. Arif Satria (Rector IPB), Dr. Muhammad Dimyati (Director General for Research Strengthening and Development – RISTEKDIKTI) and Dr. Sadjuga (Director of Intellectual Property Management of RISTEKDIKTI).

Figure 128. Participants of the national meeting on International Research Partnership at RISTEKDIKTI, July 5, 2018, Jakarta. From left to right: Jamaluddin Jompa (President of the Indonesian Young Academy of Scoiences), Svann Langguth (Head Division Science and Technology of the German Embassy, Jakarta), Aiyen Tjoa (UNTAD), Representative of the Embassy of the United States, Jakarta, Dodik Nurrochmat & Iskandar Z. Siregar (IPB).

Table 8. Central meetings of EFForTS in 2017 and 2018: Workshops and trainings.

Venue / Date	Event
UNJA Sep & Oct 2017 C01	GUEST LECTURE AT UNJA - From mid-September to mid-October 2017 Tom Kopp gave lectures in the master program "Agribusiness" at UNJA. Tom introduced students to the theory of market integration and price transmission with focus on quantitative methods and their application.

UGoe 27 to 30 Nov 2017 **A07**	TRAINING WORKSHOP ON LAND SURFACE MODELING - Ashehad Ali & Fernando Moyano conducted a three-day training workshop on land surface modeling using the Community Land Model (CLM) at the Department of Bioclimatology, UGoe. - The course introduced modeling processes that control fluxes of carbon, water and energy at the boundary between the land surface and the atmosphere. The participants gained experience with creating simple model code in R as well as with exploring the structure and function of the Community Land Model and using it to conduct site-level simulations.
IPB, UNJA & UNTAD 19 Nov to 09 Dec 2017	SUMMER SCHOOL „INDONESIA SUSTAINABLE PALM OIL" - The three-week course was jointly organized by the Ministry of Foreign Affairs, Indonesia and the Indonesian universities IPB, UNJA and UNTAD. - The objectives of this program were to learn recent concepts in palm oil production (at IPB) and to have practical on-farm experiences (in Jambi). - About 18 participants from university and non-university institutions from Colombia, Germany, Indonesia, Italy, Malaysia and Spain took part in the summer school.
Figure 129. Two junior researchers of EFForTS participated in the summer school. From left to right: Greta Formaglio (doctoral researcher, A05), Aiyen Tjoa (JMB member & coordinator of EFForTS, and lecturer at UNTAD), Tizian Lang (master student, B08).	

UNJA 03 March 2018 **Z01**	FIRST AID COURSE "BEHAVIOR IN THE CASE OF SNAKEBITES" - The first aid training course demonstrated how one shall behave in the case of a snakebite. Snakes are quite common in the rubber and oil palm plantations. The course covered safety measures, treatment of snakebites, and how to give shots / antidotes. The course was taught by Dr. Dr. Sri Maharani, a medical doctor from Jakarta and an advisor to the World Health Organisation (WHO) with strong background in toxicology and pharmacology. About 50 attendees from EFForTS participated: master students, doctoral researchers, local assistants and office staff.
  **Figure 130.** Participants of the first aid course "Behavior in the case of snakebites".	
UGoe 16 & 24 April 2018 **INF**	WORKSHOP "RESEARCH DATA MANAGEMENT" - Peter Pütz conducted a two-day training course on statistics. The course covered basic statistical concepts like unbiasedness, p-values, confidence intervals, and hands-on exercises in R.
UGoe 26 to 28 June 2018 **A03**	WORKSHOP "METHODS IN BIOCLIMATOLOGY" - Christian Stiegler and Heinrich Kreilein from the Department of Bioclimatology introduced students to key methods and instrumentation used in bioclimatological research (meteorological measurements, eddy covariance, chamber measurements).

UNJA 23 to 27 Jul 2018 **Z01**	TRAINING WORKSHOP "REPORT WRITING" FOR PT. REKI - Eddy Pahar Harapap, Albertus Sinaga, Andiopenta, Prianto and Hilman Yusra from the Faculty of Teacher Training and Education at UNJA gave a one-week training course for 25 staff members from REKI on how to write business / scientific reports (figure 131). - The workshop was funded by EFForTS within the framework of capacity building / ABS measures for stakeholders.
Figure 131. Staff members of PT. REKI participating in the training workshop "Report writing" at UNJA.	
UNJA Sep 2018 **C01**	GUEST LECTURE "SCIENTIFIC PROGRAMMING WITH R" AT UNJA - Bernhard Dalheimer will give a four-day course for master students and faculty staff from the Department of Agribusiness.

Table 9. Doctoral and postdoctoral colloquia / symposia at UGoe

11 Apr 2018 **A02**, **B02**	- Florian Ellsäßer / A02: *Deriving evapotranspiration from two-source energy balance models with drone recorded thermal imagery* - Dirk Berkelmann / B02: *How rainforest transformation affects prokaryotic functions in soil*
2 May 2018 **C07**, **C02**	- Jonida Bou-Dib / C07: *Effects of oil palm expansion and other related land-use changes on the livelihoods of rural households in Indonesia* - Fenna Otten / C02: *Transnational networks and agricultural transformations: natural "eco-friendly" rubber*
6 Jun 2018 **B05**, **B07**	- Kira Urban / B05*: Large scale assessment of land cover and influencing factors* - Johannes Ballauff / *B07: Land transformation causes loss of species richness and functional shifts in fungal communities*
4 Jul 2018 **B07**, **C08**	- Aisjah Ryadin / B07: *Root health and functions of oil palm as influenced by plantation management: Results from the field in the Oil Palm Management Experiment* - Katrin Rudolph / *C08*: *Designing policies to promote tree planting in oil palm plantations*
UGoe 3 and 4 Dec 2018	A two-day self-organized doctoral and postdoctoral workshop will be conducted at UGoe with focus on interdisciplinary research, different epistemologies (e.g. positivism, constructivism), intercultural cooperation and communication, public relations, and open access publications.

Table 10. Seminar and lecture series at IPB and UNJA

Speaker / SP	Title of presentation	Venue and date
Jennifer Marten C02	Turning "deep water" into "flood" disentangling the co-production of flood vulnerability in Jambi	IPB 12 Oct 2017
Fenna Otten C02	On the role of social network in agricultural transformation, Jambi	IPB 12 Oct 2017
Pierre-André Waite B04	Hydraulic strategies and drought sensitivity of tropical trees and systems: general methodology and example of the oil palm	IPB 20 Oct 2017
Fenna Otten C02	On the role of social network in agricultural transformation, Jambi	UNJA 16 Nov 2017
Jennifer Marten C02	Turning "deep water" into "flood" disentangling the co-production of flood vulnerability in Jambi	UNJA 15 Dec 2017
Marife Corre A05	Effects of atmospheric nitrogen deposition on tropical forests	UNJA 29 Jan 2018
Kyra Zembold B04	Xylem vulnerability to embolism in 10 tropical tree species	IPB 27 Feb 2018
Kevin Li B09	Investigating pollination in the tropical lowland rainforest transformation in landscape of Jambi, Sumatera	UNJA 2 Mar 2018
Lena Sachsenmeier B11	Tree planting in an oil palm plantation - what is the effect on the understorey vegetation?	UNJA 13 Apr 2018
Johanna Ruth Kückes B11	Water scarcity in oil palm plantation - can trees restore the water cycle?	UNJA 27 Apr 2018
Christian Stiegler A03	Eddy correlation method in measuring H_20, CO_2 and N_2O: Study cases on oil palm plantation PTPN VI Jambi	IPB 17 May 2018
Rodrigo Vera Ramirez B05	Field methodology for land use classification for Jambi Province	IPB 26 Jun 2018
Joyson Ahongshangbam A02	Tree and palm water use assessed by drone	IPB 24 Jul 2018
Kevin Li B09	Investigating wild pollination in the tropical lowland rainforest transformation landscape of Jambi Sumatra	IPB 10 Aug 2018

VII. Public Relation and Knowledge Transfer

August 1, 2018, B11 & Z01 organized an outreach event for an elemtary school in Bungku. During a half-day excursion to the Biodiversity Enrichment Experiment plots, 15 pupils and 2 teachers learned about tree leaves diversity. They participated in games involving leaves sampling and identification, and made colorful drawings of leaf patterns. Their art pieces were used to build scientific posters for their classrooms. Before leaving, teachers and pupils received samples and materials to expand the activities back home and at school.

Figure 132. Clara Zemp (postdoctoral researcher of B11) explains pupils and teachers of an elementary school in Bungku how to collect and identify fallen tree leaves.

Figure 133. Elementary school pupils identifying fallen leaves collected on the floor with the help of an herbarium.

Figure 134. Leaf drawing activity in the project house with Herni Dwinta Pebrianti (B11 assistant).

Figure 135. Rince Muryunika (lecturer at UNJA and counterpart of B11) explaining the benefit of the different tree species for humans.

Figure 136. Organizing team and pupils holding leave expertise certificates, herbariums and colorful scientific posters. Top row, from left to right: Manda (MAPALA SIGINJAI UNJA), Juliandi and Eduard J. Siahaan (B11 plot managers), Rince Muryunika (B11 counterpart), Herni Dwinta Pebrianti (B11 assistant), Clara Zemp (B11 postdoctoral researcher) and Juwendi (school teacher in Bungku).

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Figures 4 and 5. Canopy pictures of rubber plantations – A07 & Z01. Pictures are taken once a week from July to September 2018 to study/document the browning of rubber leaves. Canopies (here: HR2 core plot) are photographed both from the bottom using a fisheye converter lens (figure 4) and from the top using a normal digital camera (figure 5). (Photos: Aiyen Tjoa)

Figures 6 and 7. Tree-stem N_2O flux measurements of A05 in riparian rubber plantations. (Photos: Joost Koks)

Figure 8. Insect pollinator diversity and abundance in oil palm plantations – B09. Flying arthropods are determined using yellow, UV-painted pan traps. (Photo: Kevin Li).

Figure 9. Bird diversity and bat activities in oil palm plantations – B09. Sound recorders are installed at a height of 1.5 m to record stereo sound and mono ultrasound. (Photo: Kevin Darras)

Figure 10. Microclimate tower of A03 at PTPN VI. (Photo: Christian Stiegler)

Figure 11. EFForTS field guest house in Batu Kucing – on the front veranda: wooden reproduction of the logo of the University of Göttingen. (Photo: Jochen Drescher)