Project Report 1 of 2

for the activities regarding the two granted outgoing mobilities (July/August 2019; 2 postdoctoral researchers)

Project number:	**ASEA 2019/ BOKU/ 2**
Project title:	**Sustainable Soil Management on Ex-Mining Area to Ensure Food Security and Soil Carbon Sequestration**

Involved researchers:

BOKU Vienna, Austria (outgoing mobilities)

- PD.in Dr.in Katharina Maria Keiblinger, BOKU Vienna, Institute of Soil Research katharina.keiblinger@boku.ac.at
  Dr. Keiblinger has a background in technical chemistry and soil research has been working at the Institute for Soil Research since 2008. She specializes in soil microbiology and chemistry. Dr. Keiblinger has been working in the present research project on soil rehabilitation since 2017 and has published several peer-reviewed articles on soil amendments.
- Dr.in Rosana Maria Kral, BOKU Vienna, Centre for Development Research rosana.kral@boku.ac.at
  Dr. Kral has a background in chemistry and molecular cell biology and has been working at the Centre for Development Research since 2015. She focuses on sustainable management of natural resources in cooperation between farmers, extension agents, researchers and other stakeholders of rural value chains. She has been working in the present research project since 2017.

  Besides publishing for a scientific audience, Drs. Keiblinger and Kral both place emphasis on outreach to the general public and on dissemination of results and methodological approaches to relevant stakeholders. Several video documentaries of their work are available online at the YouTube channel of BOKU Vienna.

BOKU Vienna (without mobility)

- Project lead Ass.Prof.Dr. Axel Mentler, BOKU Vienna, Institute of Soil Research axel.mentler@boku.ac.at
  Dr.Mentler has a background in technical chemistry and agriculture. He has been working at the Institute of Soil Research for more than three decades. In his work, he has focused on three pillars: besides being an outstanding expert of describing and evaluating soils in the field, he has developed and improved analytical methods, e.g. ultrasound applications to measure soil aggregate stability, while at the same time aiming to connect farmers, teaching and academia. He has been leading the present research since its inception and has published numerous peer-reviewed scientific articles, as well as several video documentaries on his work.

Universitas Gadjah Mada (UGM), Yogyakarta, Indonesia

- Dr. Murtiningrum, Department of Agricultural and Biosystem Engineering, Faculty of Agricultural Technology, tiningm@ugm.ac.id

Dr. Murtiningrum has a background in irrigation engineering. She has been a driving force of the present project since its inception. Her work with students in the area has paved the way for the present research. She will benefit from one of the two incoming mobilities of this grant, bringing with her samples for further specialized analysis at BOKU's Institute of Soil Research.

- Dr. Ngadisih, Department of Agricultural and Biosystem Engineering, Faculty of Agricultural Technology, ngadisih@ugm.ac.id
  Dr. Ngadisih has a background in soil and water conservation engineering. She has been involved in the present project for several years, both in the field and in laboratory work. Dr.Ngadisih has also facilitated many of the meetings with officials in the area, a task in which she was supported by Rizki Maftukhah.
- Rizki Maftukhah, STP., MSc., Department of Agricultural and Biosystem Engineering, Faculty of Agricultural Technology, maftukhah.rizki@ugm.ac.id
  Mrs Maftukhah has a background in agricultural biophysics and has been involved in the present project since the beginning. She has been involved in all field work activities, and she is also involved in all laboratory analyses. She has been supporting Dr.s Murtiningrum and Ngadisih in official meetings with local representatives, but is also responsible for farmer meetings and for facilitating interviews in Indonesian and Javanese for documentation purposes. She is also involved in much of background research that is only possible in Indonesian.

Project description and activities linked to the granted outgoing mobilities 2019

The present project links to a previous project that benefitted in 2018 from mobilities under funding through ASEA Uninet. The activities are part of efforts spanning several years and cropping cycles and destined to re-habilitate soil functions in a former mining area. The present ecosystem and natural resources are under increasing pressure, if agriculture is to remain (and increase in importance) as a livelihood option for the local population, urgent action to rehabilitate soils is needed.

In the proposal to the present activities we described the workplan as follows:

> Field experiment
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> We will set up a demonstration plot in this area with rice grown under SRI production. The experiment is planned to be conducted on a longer-term scale (18 months) following the cropping calendar of rice cultivation in Bangka Regency.
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> The existing conventional rice field and the newly set-up plots will be used for plant yield estimations and soil samplings.
>
> Data measurement
>
> During experiment, we will measure:
>
> a. Soil biophysical properties: soil aggregate stability, and nutrient availability, and heavy metal contamination, infiltration rate measurements
>
> b. C-sequestration: total Carbon, dissolved organic carbon (DOC), organic Carbon, amino sugars as an indicator for microbial necromass that is suggested to be a major fraction of SOC.

Using these first two outgoing mobilities, we have first finished harvesting of the previous cropping year (see pictures on cassava harvest). Yields have been documented for both, below ground and above ground biomass. Soil samples and samples of plant material have been taken for later analysis

in the laboratory at the Institute of Soil Research at BOKU Vienna. Currently, the samples are being dried and prepared for import to Austria. The samples will be brought to Austria upon customs clearance by our Indonesian colleagues, using at least one of the incoming mobilities granted to the present project. Our Indonesian colleagues will also be involved in laboratory analysis as described in the proposal upon arrival in Vienna.

In the project phase for which the two outgoing mobilities have served, Dr.Murtiningrum has led an outreach activity involving the local Department of Agriculture to share findings from the first year and to introduce work planned for the upcoming cropping year. Dr.s Keiblinger, Kral and Ngadisih, as well as Mrs.Maftukhah, S.T.P., M.Sc., have shared preliminary findings, farmer feedback and future work plans with local agricultural research and extension. Activities for the upcoming cropping year were discussed, as well as, challenges, possible synergies with research and government activities at various level (regency, provincial, national).

Local media covered the research activities in print and online, and the research team was received by the new governor of Bangka regency, where the experimental site is located, who expressed interest and support. Farmer feedback was positive, interest in continuation of the project is high. The experimental site is located at the border of two villages and received several visits by both village heads, also while the research team was present in July/August. Continued support not only from farmers, but also from local authorities is assured.

In preparation for the upcoming cropping year, Dr.s Keiblinger and Kral have prepared the experimental site with Dr.Ngadisih and Mrs.Maftukhah, STP, MSc., as well as the local farmers who provided the space to set up the test field. In accordance with farmer wishes and pedological considerations, the research team opted for another short cropping cycle with a legume before introducing rice. Several bean species were discussed, preference was given to mung bean by both research team and farmers, as the next legume. Planting was completed for the entire experimental site. The current set-up was completed by adding on a low-cost experiment for the investigation of organic matter decomposition with tea bags (see pictures).

All activities were documented on video as extensively as possible to allow for sharing with a wider audience. The material will be used to produce a short documentary film which will be made available online at the Youtube channel of BOKU Vienna. The video is intended for use as teaching material or to support extension, for donor agencies involved in development work, but also for discussion with a lay audience.

The upcoming steps include transfer of all samples from Indonesia to Austria and laboratory analyses, as well as work on the video material to produce a short documentary on the project activities. The second report, due after use of the incoming mobilities, will detail the procedures and some preliminary findings, should these be already available.

AUS PROPOSAL (finde ich zu lang, ab hier bis „Pictures“ würde ich alles streichen, wenn ihr auch dafür seid)

Background

In Indonesia, 90% of the population uses rice as a staple food (Kurdianingsih and Legowo, 2012). Population growth has a significant effect on the demand of rice production. Increased demand of rice is also associated with the increase of water demand in the world. Competition among

alternative uses for surface and ground water are beginning to affect the agricultural sector in many countries at the beginning of this new Century. Uphoff (2010) reported that, as the largest agricultural consumer of water, the rice sector is coming under increasing pressure to economize water use. Recently, the System of Rice Intensification (SRI) is being promoted as an alternative cropland resource management strategy for rice-cultivation to increase rice yields with less external input and focus on water and nutrient use efficiency (Stoop et al., 2002; Krupnik et al., 2012). Grain yields under SRI are reported to increase (Maftukhah et al., 2015), delivering a direct benefit to both subsistence economy and semi-commercial farming households. SRI methods are widely believed to increase the productivity of two key inputs: water and seeds. Consequently, this system is thought to be more accessible and affordable to poor and marginalized communities and farmers facing water scarcity.

The aim of our project is to implement this new technology on an Indonesian island that has been subject to intensive land mining of tin for the IT sector, Bangka island, where large-scale commercial, as well as individual and uncontrolled digging activities by local people are practised. Before the extraction process, the vegetation cover is removed by burning forests and tin is mined manually with shovels. The separation process is conducted by sieving, and floating. Highly weathered kaolinite is sedimented in small basins scattered across the landscape filled with water during the rainy season, even in the agricultural production area.

These activities have a devastating impact on the environment, such as land degradation and impaired ecosystem functions (Asmarhansyah, 2016; Inonu, 2008). More specifically, in mining activities cause (1) changes in texture especially reduced levels of clay, changing levels of organic matter and cation exchange capacity (CEC); (2) increasing the volume of sediment transported into the water stream/river; (3) imbalances or changes in the water System; (4) changes in river flow patterns and the formation of pits; (4) increasing the value of total suspended solids (TSS, Total Suspend8dSolid) of river water; (5) change land topography and morphology; (6) loss of ground cover leading to increased surface runoff water from the inability of land to hold the rainwater; (7) lose modify, or even eliminate the composition and structure of Vegetation, as well as, loss of Vegetation diversity (8) loss or change the function of wildlife habitat. Land abandoned after tin mining has very little soil fertility and consequently is unsuitable for plant growth and agricultural use (Asmarhansyah et al., 2017; Howell &Mackenzie, 2017; Inonu, 2008; Naeth, Chanasyk, & Bürgers, 2011).

To ensure food security through integration System of rice and livestock (Subardja et al., 2011), the physical, chemical, and biological properties has to be improved. This can be accomplished through application of organic amendments such as manure and compost since they will increase the content of soil organic carbon, as well as, soil physical, chemical, and biological properties (Asmarhansyah et al., 2017; Howell & Mackenzie, 2017; Masciandaro et al., 2013; Mitsui & Jos, 2017).

Recreation of ex-mined area for agricultural use needs to be addressed with technologies that are economically viable and environmentally friendly.

This project aims to study the potential for recreation of the ex-mining area for agricultural use, to ensure food security for the future in Bangka Island, especially by cropping staple food such as rice. The introduced method of SRI rice is a potential strategy to be implemented on Bangka Island to ensure food security. With local scientists, and the agricultural research center we intend to set up demonstration plots for the cultivation of SRI and conventional rice on ex-mining land. We will characterize crop yields and soil properties with special emphasis on C-sequestration and crop nutrition of ex-mined. Carbon Sequestration (Lal 2008: Lal 2004) on highly degraded soil is of paramount importance to provide the base for (sustainable) agricultural production.

Hypotheses

H1: The use of local resources such as livestock manure and compost, and charcoal can be used to create soil properties for SRI and conventional rice cultivation on ex-mining area.

H2: SRI cropping system is expected to increase yields due to improved soil structure and nutrient inputs by intercropping possibilities, and hence increases food security.

H3: We hypothesize that the improved soil structure enhances long term C Sequestration, by covering SOC in aggregates.

Materials and Methods

Experimental Site

Bangka Regency has tropical climates type A with variation of rainfall between 21. 50 to 183.90 mm/month for 2015. with the lowest rainfall in July and the highest rainfall in February. The average temperatures range from 26.9°C to 27.8°C. In 2016, the average air humidity varied between 61 % and 97 %. Then, solar radiation intensity ranges 24.9% in December up to 57.1% in July. A conventional rice field established in previous mining area in Bangka regency was set up 3 years ago. In addition, close by an SRI demonstration plot will be established.

Field experiment

We will set up a demonstration plot in this area with rice grown under SRI production. The experiment is planned to be conducted on a longer-term scale (18 months) following the cropping calendar of rice cultivation in Bangka Regency.

The existing conventional rice field and the newly set-up plots will be used for plant yield estimations and soil samplings.

Data measurement

During experiment, we will measure:

a. Soil biophysical properties: soil aggregate stability, and nutrient availability, and heavy metal contamination, infiltration rate measurements

b. C-sequestration: total Carbon, dissolved organic carbon (DOC), organic Carbon, amino sugars as an indicator for microbial necromass that is suggested to be a major fraction of SOC.

Data analysis

Statistical models will be applied to evaluate the effects of recultivated ex-mining area on soil properties and food security.

Outlook

For the future of the island it is crucial to ensure food security, as there is already a transition from miners to fishermen and (due to ongoing off shore mining activities) further transition to farming. The agricultural sector and farming of ex-mining area, with food safety is of high importance for the local community.

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Publications:

Pictures:

Figure 1. Dr.Keiblinger and one of the farmers implementing the experimental set-up for measuring organic matter decomposition. (Copyright: Rosana Kral)

Figure 2. Dr. Kral and one of the farmers seeding mung bean seeds for the coming second year of cropping. (Copyright: Katharina Keiblinger)

Figure 3. Dr. Ngadisih and three of the farmers harvesting cassava, the main crop of the first cropping year. Yield was separated according to above-ground and below-ground biomass. In addition to soil samples, also plant material and samples of the tubers were taken for later laboratory analyses. (Copyright: Katharina Keiblinger)

Figure 4. Dr.s Ngadisih and Kral weighing harvested cover crop. Farmer Nunuk sorting plant material. (Copyright: Katharina Keiblinger)

Figure 5. Dr. Keiblinger showing improved soil structure with more aggregates in one of the supplemented plots. (Copyright: Rosana Kral)

Figure 6. Soil sampling in the experimental field site. (Copyright: Katharina Keiblinger)

Figure 7. Farmers and research team after finishing preparations of the field site. Dr.s Ngadisih (second from left), Kral (third from right), Keiblinger (second from right) and Mrs Maftukhah, S.T.P., M.Sc. (first on the right) (Copyright: Dedi)

Figure 8. Group picture of farmers and research team with both village heads and local media representative in the experimental field site during a break from field preparations. (Copyright: Dedi)

Planned activities:
Interactive Workshop at Eurosoil 2020 Conference in Geneva of one UGM and one BOKU member of the project. Presentation of scientific project at EGU 2020 Conference in Vienna (poster and/or oral presentation, depending on selection by session committees).

Expected publications:

In cooperation with Universitas Gadjah Mada, we envisage the dissemination of results and techniques through community services. Furthermore, we plan to present our work at an international scientific conference, as well as publish a scientific article in a SCI-listed journal. Video (siehe Antrag)

c) Fließtext (Umfang: 1-4 Seiten): Beschreibung des Projekts ev. samt erklärender Einleitung, angestrebte / erreichte Ziele,…

d) eine Liste der aus dem Projekt hervorgegangenen Publikationen

f) Zu erwartende Ergebnisse und (eingereichte) Publikationen.* Nachreichungen der Publikationen (als PDF) ganzjährig an barbara.karahan@oead.at erbeten.**