01/04/2023

Report to funders SNAPP (Project SNP052 CORRESTOR) and Newcastle University (UKRI allocation of funds to reinvest in GCRF and Newton Fund projects (Project AgrisysTanzania RES/9404/0001/160)

Title of workshop:

Capacity training workshop 'Training in ecological monitoring: from designing a research project to reporting

Location and Dates:

Mang'ula: field-based part from 20th to 22nd February 2023

Sokoine University of Agriculture: data analysis part from 23rd to 27th February 2023

1. Context: The report outlines key impacts achieved in the workshop. The workshop builds on evidence and knowledge generated in two complementary projects, implemented in the study landscape in the Kilombero Valley. These are (1) the CORRESTOR project: What evidence is required for wildlife corridor restoration interventions in human-inhabited landscapes, and how do we include these in the restoration management process? (2) The Agrisys Tanzania project: What to plant, when and where? - designing integrated forest-agricultural landscapes to enhance multiple livelihood benefits to and from agriculture. Both were led by PI Dr Marion Pfeifer (TROPS lab, SNES, Newcastle University).

The Agrisys Tanzania project produced evidence and knowledge from ecological and social data and subsequent analyses co-created in the study landscape with multiple stakeholders, from small-holder farmers, to industry, local government authorities (TANAPA, Water Regulation Body), and NGOs to international NGOs (IUCN, AWF). Identifying natural capital benefits (and costs) to farmers and their food securities, we have worked with funding by SNAPP to implement workshops to outline pathways for impact and identify challenges associated with the process of restoration in human modified rural tropical landscapes.

The main goal of the workshop was to exchange knowledge and experiences on ecological monitoring and to empower participants with knowledge on restoration actions on agricultural/farmed land and protected areas in the Kilombero landscape.

2. The workshop objectives were defined based on task 2 outcomes in CORRESTOR workshop 4 (held in Morogoro, October 2022). 'Agenda item 2: Identification of capacity strengthening requirements to meet stakeholder needs (focus on approaches, funding and time lines)'.

- Indicators and proxies for monitoring restoration interventions looking for outcomes for people and biodiversity, general
- Identifying sources for data availability and discuss constraints of data accessibility
- Feedback and knowledge exchange: stakeholder communication and engagement
- Data analyses and reporting: from objectives to sampling design and visual display of key messages
- Training to be targeted at KSC, TANAPA, government and SUA students

3. Participants: This training workshop included government institutions (Sokoine University, TANAPA and TARI) and Non-Government institutions (UICN, Reforest Africa, STEP, UEMC and Associazione Mazingira.

Participants for the first part of the workshop training included 5 students and new employees of the Sokoine University of Agriculture and others from conservation and institutions including Udzungwa Mountains NP (TANAPA) 3 participants, Reforest Africa2 participants, and International Union for Conservation of Nature (IUCN) 1 participant, Udzungwa Ecological Monitoring Centre (UEMC) 1 participant, Southern Tanzania Elephant Program (STEP) 2 participant, Tanzania Agricultural Research Institute (TARI) 1 participant and Associazione Mazingira 1 participant.

The second part of the workshop involved 7 students and new employees of the Sokoine University of Agriculture, 6 students and new employees of the Sokoine University of Agriculture and others from conservation institutions including Udzungwa Mountains NP (TANAPA) 3 participants, Reforest Africa2 participants, and the International Union for Conservation of Nature (IUCN) 1 participant, Udzungwa Ecological Monitoring Centre (UEMC) 1 participant, Southern Tanzania Elephant Program (STEP) 2 participant, Tanzania Agricultural Research Institute (TARI) 1 participant and Associazione Mazingira 1 participant.

4. Implementation of workshop:

This workshop training focused on imparting participants with vast knowledge, from designing a research project to data collection, data management, data analysis and finally to presenting results and writing a project report and publication in scientific journals. With this knowledge, participants will be able to monitor and assess the effectiveness of the restoration actions that some of them undertake and advice on environmental friendly including best farming practices that can help to adapt to the effects of climate change and so benefit community livelihood. The expected outcomes of the workshop were to equip the participant with knowledge on designing research questions, sampling design, methods for data collection, managing data collation, entry and storage from the first part of the training and also data management using R, data analysis in R, spatial analysis in QGIS, presenting results, report and publication authorship from the second part of the workshop.

Session 1 – Field and theory sessions. Location: Mangula (next to Udzungwa MtS NP)

- Biodiversity indicators for forest biodiversity. Theory and daily visit to the park to monitor the endangered Udzungwa Crested Mongabey
- Bioindicators in freshwater habitats: riverbanks, erosion and water quality
- Biodiversity indicators for landscape and farm diversity and ecosystem services & disservices. Implementing bird surveys within the boundaries of the park and outside the park. Mammal surveys and camera traps.
- The theory of invasive species and their management (including manual removal of some invasive species recorded in the landscape as problematic)
- Discussion and testing use of tools/equipment: Standard rain gauge, Camera traps, Hemispherical camera for canopy structure assessments, Automatic weather station, Modes of fire alerts using real-time Arc GIS, Patrol data to monitor

Session 2 – Field and theory sessions. Location: Mangula (next to Udzungwa MtS NP)

- COCOBA – **Community Conservation Banking**: a microfinance initiative to teach the community to open small and environmentally friendly businesses.
- Sourcing and supply chains of tree seedlings and monitoring their survival

- Income-generating activities support, including tourism (monitoring values including via Visitor scan and QR questionnaire, Using comment books to monitor and solve challenges in tourism activities of the park

Session 3 – Field and theory sessions. Location: Mangula (next to Udzungwa MtS NP)

- STEP: the goals and methods of the Southern Tanzania Elephant Program NGO
- Theory and practical challenges of human elephants co-existence
- Mitigation and prevention of conflict: testing and trialling different approaches including bee hives, solar lights, metal strips
- Practicalities of monitoring: GPS, Cobo-collect, Camera traps along 4 main transects, Quick response to animal attack/invasion to reduce human-elephant conflicts, Surveys and interviews, Pre and post assessment

Session 4 – Field and theory sessions. Location: Mangula (next to Udzungwa MtS NP)

- The IUCN Sustain program– aimed at addressing livelihood inequality, ecosystem degradation and agricultural challenges in key growth corridors in Tanzania.
- ASSOCIAZIONE MAZINGIRA: Agroforestry. Working with communities including school on tree planting –distribution of tree seedlings to the community and monitoring survival rates. They collaborate with Udzungwa Mountains NP in this community education about tree planting and environmental conservation by having Park visit trips for students/pupils
- The mud stove intervention initiative
- Introducing community groups and highlight needs to supporting them in conservation activities education
- The activities of the Udzungwa Ecological Monitoring Centre: Ecological monitoring (camera trap networks, bird surveys), Facilitation of biological research
- REFOREST AFRICA and their restoration objectives: planting trees in a process of restoration of native forests; supplying tree seedlings to the community for planting , conducting forest recovery and biodiversity research

Fig. 1: Sessions 1 - 4 Participants. Participants from various conservation, agricultural and education institutions attended the Ecological monitoring training workshop at the Udzungwa Ecological Monitoring Centre. Were trained by demonstrations on the methods of ecological data collection in the field

Fig 2: Activities during the workshop, sessions 1 – 4. (A) The Udzungwa Mountains National Park Chief Park Warden, Abel Mtui gave the opening remarks on the first day of our workshop at the Udzungwa Ecological Monitoring Centre in Mang'ula. **(B)** Dr Deo Shirima of the Sokoine University of Agriculture gave a talk to participants on the opening day of the training workshop. Focussed on ecological monitoring, our Agrisys Tanzania research project and the ecological monitoring training workshop. **(C)** Dr Laura Braunholtz (Newcastle University) explained to participants the points to focus on data collection, what

data to collect and how to collect them depending on the design of the research project. In this case, focusing on the assessment of the degraded riparian habitats. We looked at the small river in the Udzungwa Mountains National Park that also extends outside the park into the farmed lands. **(D)** Dr Zarah Pattison (Newcastle University) explains about uses of some of the state-of-the-art equipment in determining water quality and soil properties in disturbed river systems. This was done inside the Udzungwa national park, a short distance from the main road.

Session 5 - Field and theory sessions. Location: Mangula (next to Udzungwa MtS NP)

The second day involved recap of day 1 discussions before demonstrating the field sampling protocol developed by the Agrisys Tanzania team. The participants discussed drabwacks and benefits from the sampling design and methods and then discussed alignment and differences with methods used by their own institutions, again discussing drawbacks and benefits. We looked at the advantages and disadvantages of using some methods mentioned by participants.

Then we discussed and demonstrated mammal sampling using camera traps. We set 4 camera traps in the UEMC surroundings which we retrieved the next day, outlining practical steps of set up, settings on the device for different purpose, data read out and storage in databases.

Table 1 DATA COLLECTED, METHODS AND LIMITATIONS

METHOD	PRONS	CONS
CAMERA TRAPS, Mammals and ground dwelling birds	->allows the nocturnal survey -> simple and doesn't need you to be in the field ->no disturbance to wildlife -> easy to compare sites -> easy to capture real x-tics of animals/objects -> can capture different behaviour of animals -> can capture a wide range of information	-> theft -> expensive especially when you are starting -> unexpected malfunctions -> lots of wrong assumptions involved during the analysis -> high environmental costs -> wasted data -> ethical issues
TRANSECT and point counts, Mammals and bird surveys	➔ It's cheap ➔ Allows direct observation ➔ Doesn't need specialised equipment ➔ Its more selective ➔ Standardised method for ➔ Can cover more area	➔ More selective ➔ Need equipment for certain metrics ➔ Limited in terms of scope ➔ More time and labour expense ➔ Causes disturbance ➔ It's biased ➔ Higher risks of safety

Fig 3 Evodius Ishengoma (SUA - RA) talked and demonstrated to participants the sampling of various habitat parameters (NDVI, Canopy cover, LAI, Vegetation structure, etc.) in ecological research; Sharing knowledge on how these can be used to monitor changes in ecological systems**.**

Fig 4 Moments captured during session 5. **(A)** Petro Nnyiti (R.A), giving a short talk to participants on the social part of the Agrisys Tanzania research project. We then discussed with participants the need to also look at the social well-being of the community when we are emphasising the restoration of degraded ecological habitats. **(B)** Dr Deo Shirima (SUA) talked to participants about ecological monitoring and how to formulate research projects on the restoration of the degraded forest-agricultural landscape. He gave room to participants to brainstorm on what they thought are the ecological challenges in the Kilombero landscape that need to be researched and solved. (**C + D**) Participants during the group discussion about degraded riverine habitats and restoration ideas on the degraded Kilombero landscape. We suggested some

research problems and then split them among groups of participants who discussed how they could go on researching and solving these problems.

Fig 5 Group presentations. We had short presentations from each group on how they would go through with designing and carrying out their research. We wanted to know from each group the type of data they would collect, the expertise they needed to accomplish that, how they would access their study area and data and the time it would take to complete the research. We got a lot of information and there was some variation depending on the research problem a group was discussing.

Fig 6 Impressions from the course during session 5. (**A)** Dr Shirima (SUA) talking about soil sampling. **(B)** SUA student demonstrating soil sampling methods to participants. (**C + D)** Dr Zarah Pattison (Stirling University) talked to participants about degraded river habitats in Kilombero valley and necessary restoration actions. Showing signs of degradation/erosion on that river bank, and telling their relationships to farming activities done close to the river.

Session 6 – Data analyses and project write up. Location: Mororogo (Sokoine University of Agriculture)

The second part of the training workshop was based mostly on data management and analysis with R and RStudio, and visualization and processing of spatial data using the freeware Quantum GIS. The course was basic, introducing participants to the tools that could be available to them. We started from scratch by understanding what is R and why is it important to learn to use it, how powerful it is in the management of data, manipulation of data, visualization of data, analysis of data and plotting good graphs using R and RStudio, also spatial analysis using R.

Fig. 7 First day in the computer lab. Dr Braunholtz (Newcastle University) delivering training on data management and analysis with R to participants at Sokoine University of Agriculture

Over the four days, participants practiced use of tools and the last day was used by Dr Zarah Pattison to outline professional reporting results and writing scientific papers and publishing in scientific journals, followed by reflections and discussions of all participants on the process of scientific writing.

Fig. 8 Dr Zarah (Newcastle University) talked about writing a scientific report and publishing papers in scientific journals

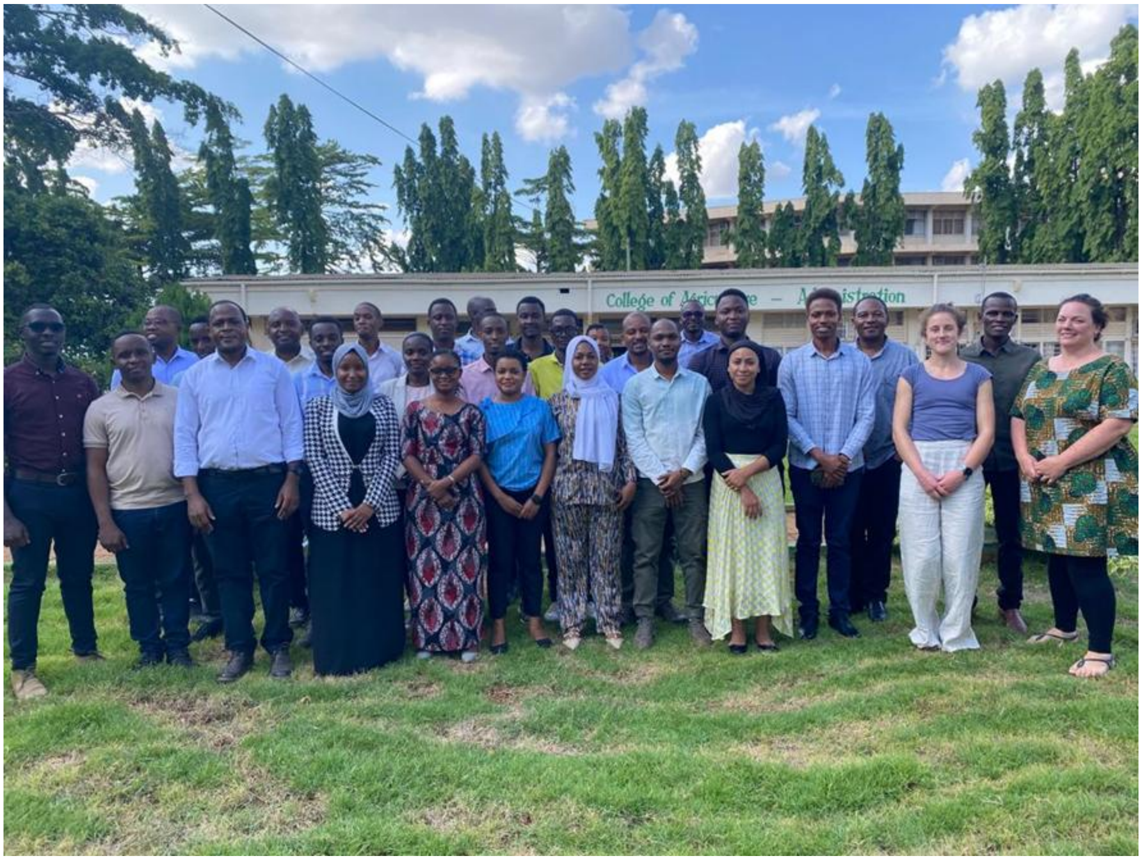

Fig. 9 Participants in a group photo after attending a training workshop on data management and analysis with R and report writing at the Sokoine University of Agriculture, SUA in Morogoro. We got more participants from the University for the second part of the workshop who joined the data management and analysis part of the workshop. Some of them knew about working with R and RStudio and some knew nothing about data analysis with R.

5. Feedback on the workshop and critical reflections of course leaders

21 participants completed the survey providing feedback on the course (> 90 %). 17 considered the training 'very useful', with one 'useful' and three 'NAs'. 12 (> 50%) considered the course as 'too short' and would like to engage in further capacity strengthening activities that are directly related to sampling design, data collection and in particular data analyses and writing. Favourite aspects listed by participants were very diverse. Key messages for improvements focused around 'need for more time', whether that related to questions on critical thinking about sampling design, data collection needs and analyses.

There is an urgent need to provide enhanced training in basic statistical analyses and data visualization skills, in particular using R statistical software. Staff delivering the training adapted the course in the first days to allow for more time recognizing the value participants can bring to the table when thinking about data collection and monitoring within the constraints of their institutional rules and capacities. Overall, they felt that the engagement was great and participants showed improvements in the use of R, technical skills and confidence in using R. Networking and connecting different groups of people with an interest in the people and biodiversity of the landscape was greatly facilitated by the course activities as well.

What should be done next?

- Structural frameworks: longer term planning -> is it worth thinking about longer programmes or do they not work and would it be better to integrate scientists in their organsiations

- The background of participants was perhaps too wide: future activities may want to add specific sessions to a subset of participants focused on single instiutiton's needs

- Focus on restoration of rivers: not sufficiently focused. Needs to be more specific and needs definitely smaller groups

- There is perhaps an opportunity to strengthen commitment of organisations in more depth: hierarchy of staff and what they can and cannot do

- There would be a need for a platform for longer term learning and knowledge exchange, perhaps with six monthly meetings, discussion groups and training sessions. This was already identified as urgent in workshop 4 of CORRESTOR.