Grant Recipient Details	
Your name	Deogratias Ladislaus Lihepanyama
Project title	Human activities – a possible cause of cyanobacteria blooms affecting lesser flamingo (*Phoeniconaias minor*) population in Momella Lakes, Tanzania
RSG reference	31046-1
Date of this report	13 September 2024

1. Please indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
To assess LULC change over the past 30 years on the eastern side of Momella Lakes due to human activities (farming activities and settlement) using remote sensing.			■	There were significant shifts in LULC due to agriculture (1989-2019) that have been observed, which put the lakes at risk of water pollution. Land cover maps showing the trend from 1989 to 2019 have been produced. Coexistence programs and integrated conservation strategies involving local communities are urgent.
To examine the amount of soil Nitrogen and Phosphorus in soil sediments in the Momella Lakes' watershed.			■	Soil phosphorus concentration was above the allowable limit in the lake's watershed, where agriculture is practiced. Training on sustainable land use for the local community residing in the lake's watershed is critical.
To assess the amount of water Nitrogen and Phosphorus in surface runoff that feeds into the lakes from the Momella Lakes' catchment area.			■	P and minimal N enrichment through runoffs from the watershed, with P concentration above allowable limits, can trigger eutrophication. There is an urgent need to train the local community on the importance of riparian buffer zones to lessen N and P losses through catchment area runoffs.
To determine the time of the year when watershed nutrients (N, P) promote the rapid algal biomass development in the Momella Lakes.			■	N and P significantly influenced algal biomass temporal variations. It could be due to N and P enrichment from the non-permanent runoffs. Urgent need for conservation of riparian buffer zones to lessen N and P losses through catchment area runoffs.
To investigate the temporal patterns between lesser flamingo numbers and algal biomass in the Momella Lakes.			■	Lesser flamingo numbers increased as algal biomass increased but sensitive to threshold. Monitoring water N and P can predict algal bloom risk periods that might affect lesser flamingo presence in soda lakes. A study on species identification and *Arthrosporic* density determination during high algal biomass peaks is urgent to provide valuable insights into water quality for the lesser flamingos.

| To assess local communities' socio-economic activities, their understanding of water pollution, and their attitude towards lesser flamingo conservation in the lakes. | | | | Residents depend on subsistence crop farming and livestock keeping. The use of synthetic fertilizers, free-range grazing, and limited technical support put the lakes at risk of water pollution. Negative attitude towards lesser flamingos in the lakes was also evident, which can impair conservation efforts. Urgent need for educational training on sustainable farming practices and the importance of lesser flamingos in the lakes to the local community. |

2. Please explain any unforeseen difficulties that arose during the project and how these were tackled (if relevant).

During the study period, I faced two major problems;

a) The COVID-19 pandemic which led to the suspension of classes and lab work for three months. That interrupted the data collection schedule, lab analyses, and interview sessions as direct interactions were restricted.

b) I also fell victim to the pandemic, which further interrupted my research schedule since I was out of campus for again three months to recover and be allowed to interact and resume activities.

Minor difficulties include;

a) Research Permit. A delay in obtaining the research permit from the Tanzania Commission of Science and Technology (COSTEC); an authority responsible for issuing research permits in the country. This problem was overcome by obtaining a temporary permit from Tanzania National Parks (TANAPA) after having shown all the details for the application.

b) Access to the study area for data collection. Since the study area was within the protected area of Arusha National Park (ANAPA), we were not allowed to enter the study area without a Park Ranger, who could not easily be allocated for that purpose. This was overcome by requesting the ANAPA Park Ecologist to assign me a permanent Park Ranger for that purpose on the days of data collection.

c) Bad weather. Rains and strong winds on some days brought a great disturbance while sailing with a canoe in the lakes for water sample collection and during lesser flamingo counting. This was overcome by either changing the hours for water sample collection and lesser flamingo counting or days that the weather seemed to be conducive without affecting the monthly data collection schedule.

3. Briefly describe the three most important outcomes of your project.

From our investigation on whether human activities contribute to N and P enrichment in the Momella Lakes which is demonstrated by the frequent occurrence of cyanobacteria blooms affecting the lesser flamingos foraging, we have identified the following;

a) Due to increased human activities in the watershed, a strategy beyond remotely detecting human land use change is needed, which must consider intensifying agricultural activities on-site and provide training for sustainable farming practices to the local community (Figure 1 (a) & (b)) that border the lakes and reinforce implementation of Strategic Land Use Plans near protected areas to enhance sustainable land use practices to reduce the risk of water pollution.

b) There is also an urgent need for training the local community on the importance of riparian buffer zones to lessen N and P losses through catchment area runoffs. In addition, by monitoring N and P concentrations, algal bloom risk periods can be detected, which is important in improving nutrient control strategies.

c) Educational programs and extension services to raise awareness about the environmental impacts of fertilizers and guide sustainable agricultural practices are inevitable. In addition, there is an urgent need to educate the local community on the ecological and economic importance of lesser flamingos in the lakes to enhance the species conservation efforts.
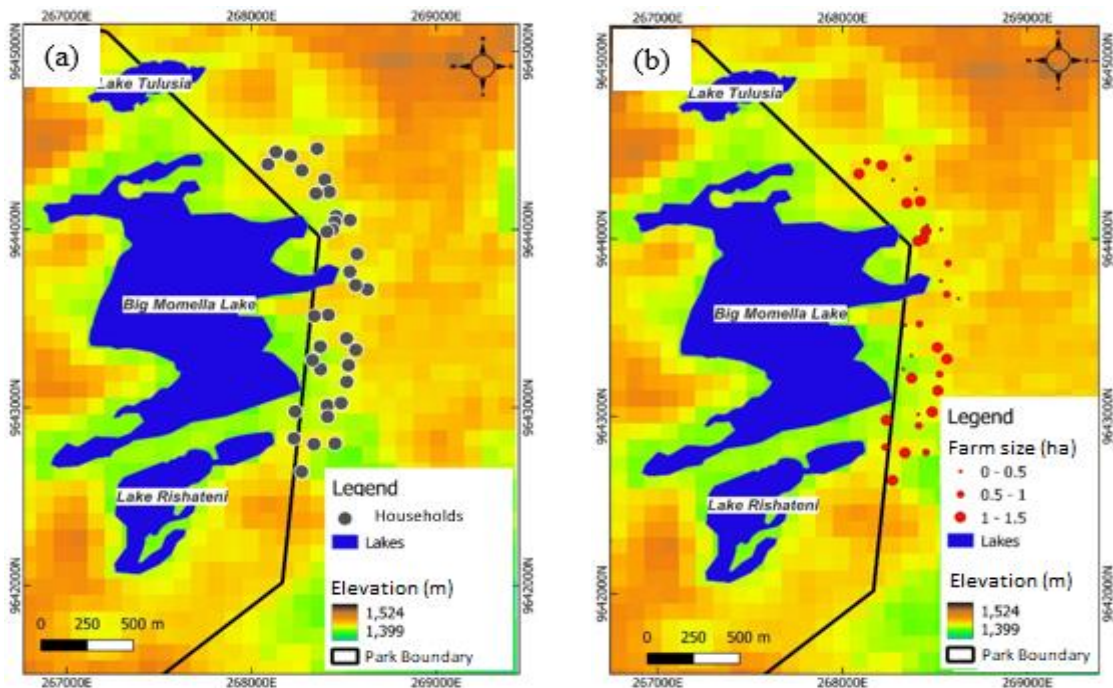

Figure 1: Map showing (a) households surveyed (b) farm size (cropping area) owned by a household in Miririny village on the eastern side of the Momella Lakes, Tanzania.

4. Briefly describe the involvement of local communities and how they have benefitted from the project (if relevant).

Our research was meant to be participatory by involving the local community in addressing the problem of cyanobacteria blooms and protecting the lesser flamingo population in the Momella Lakes. This research involved the local community that bordered the lakes, who were mainly subsistence farmers and livestock keepers. The local community appeared excited and felt concerned with their surroundings by sharing the problems they experienced in farming and livestock keeping. They also shared insightful experiences about the lakes and the lesser flamingos that visit the lakes for forage. Due to limited funds, we are yet to do much on the dissemination of our findings which are intended to create a sense of ownership, and awareness, increase conservation success, and provide economic, educational, and environmental benefits to the local community and at the same time to enhance lesser flamingo conservation efforts in the Momella lakes.

5. Are there any plans to continue this work?

Yes, based on our research findings we have plans to continue with our project. We have a plan for monitoring surface runoff in the watershed, particularly in the human-dominated area, and explore other factors that are likely to affect lesser flamingo presence in the lakes. We also have a plan for seasonal monitoring of algal biomass, identification of algal species, and determination of *Arthrosporic* density during high algal biomass peaks to provide valuable insights into water quality for the lesser flamingos. To foster co-existence initiatives, there is a plan to train the local community that borders on the importance of creating buffer zones to reduce nutrient influxes and the ecological and economic importance of the lakes and the lesser flamingos in the lakes.

6. How do you plan to share the results of your work with others?

Our results have already been shared through seminars, conferences, ResearchGate, and social media. We had an opportunity to share the findings through seminars six times based on the objectives covered in the project at the school level in my institution, which is normally attended by senior experts. In addition, we have shared our findings twice through International Scientific Conferences, namely; The 14th TAWIRI International Scientific Conference, held from 6 – 8th Dec. 2023, and the Nelson Mandela – African Institution of Science and Technology International Conference, held from 17 – 19 July 2024. Furthermore, we intend to disseminate our findings to other relevant parties, such as the Arusha National Park (ANAPA) and government representatives with the mandate to oversee the region. In addition, we have also planned to disseminate the research findings through social media. Another manuscript for publication on soil nutrient status in the Momella Lakes watershed is underway.

7. Timescale: Over what period was The Rufford Foundation grant used? How does this compare to the anticipated or actual length of the project?

We conducted this project for almost three years rather than the planned time of two years due to the COVID-19 pandemic which led to suspending classes and lab work for three months. In addition, I fell victim to the pandemic, which further interrupted my research schedule since I was out of campus for again three more months to recover before being allowed to interact and resume activities. All these interrupted the data collection schedule, lab analyses, and interview sessions as direct interactions were restricted. Apologise for any inconvenience that might have been caused.

8. Looking ahead, what do you feel are the important next steps?

Based on the findings on land use land cover change for the last 30 years (1989 – 2019), it appears that human activities have noticeably increased and that agricultural activities are not performed sustainably. Thus, there is more need of monitoring nutrient (Nitrogen and Phosphorus) runoff from the agricultural areas to understand the magnitude and be able to propose suitable nutrient control strategies. In addition, there is also a need for seasonal identification of algal species in the lakes, and during high algal biomass peaks, which will provide more insight into the availability of food for the lesser flamingos in the lakes. Co-existence programs that will aim at creating awareness and a sense of ownership are also vital in enhancing conservation efforts of the lakes and the lesser flamingos.

9. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did The Rufford Foundation receive any publicity during the course of your work?

Yes, all of our posters, fliers, brochures, posters, and presentations had the Rufford Foundation logo to increase the publicity of the foundation and the good job done by the foundation in funding nature conservation projects and programs around the world. We would also appreciate having more of your support in disseminating our results through International Scientific Conferences.

10. Please provide a full list of all the members of your team and briefly what was their role in the project.

Masumbuko Msongo: field assistant during water sample collection from the study lakes.

Joel Efraim: assisted in data analysis.

Hamza Kawawa: Arusha National Park ranger, assisted during data collection.

Sarikiaeli Mbise: Supported the project as a field research assistant in interview sessions

Yohana Magangali: Supported the project as a field research assistant.

Deogratias Ladislaus Lihepanyama: conducted most of the research activities including data collection, data analysis, presentations, results dissemination, and outreach activities.

Prof. Patrick P. Ndakidemi: assisted in designing the methodology for soil data collection and co-supervised

Dr. Janeth Jonathan Marwa: checked all field activities and co-supervised

Prof. Anna Treydte: My immediate supervisor monitored the progress of each stage of the research.

11. Any other comments?

On behalf of the team, I would like to take this opportunity to thank the Rufford Foundation for the grant. I am sincerely grateful as, without this grant, I would not have been able to carry out this project. The funds have enabled us to accomplish our research project, and we feel that the local community and other stakeholders have benefited and will continue to benefit through the outcome of this project. This project has been a significant learning experience in growing as a conservation scientist because I have gained invaluable skills in project management, community engagement, and analytical skills. The problem addressed in our project regarding the lesser flamingos and their habitat is crucial in enhancing conservation efforts for this near-threatened species because of the escalating human activities.