Progress Report

Update: Early May 2023

Project title: Development of a community-based approach of protection of fish and crab's biodiversity from disastrous effects of mining activities in DR Congo

Name of the project leader: WASSO SHUKURU Dieudonné

Other team members:
Dr. Akilimali Itongwa Justin (PhD)
Mutewa Wakandwa Clement
Dr. Patrick Baenyi (PhD)
Prof Ayagirwe Basengere (PhD
Prof Daud Kassam (PhD)

I.   Background.

As mining activities expand in DR Congo, especially in South Kivu province/Mwenga territory, impacts on fish habitats and their biodiversity will become increasingly prominent. Additionally, since waterbodies polluted by these ores and heavy metals are connected to lakes, this may result in a global impact on aquatic biodiversity and human health. This project is being conducted in South Kivu province, located in the Eastern part of the Democratic Republic of Congo. From a hydrographic point of view, South Kivu has two lakes (Lake Kivu and Tanganyika) and large rivers including Zalya, Elila, Ruzizi and Ulindi, and many others that form part of the Congo basin. The South Kivu province was selected for this project owing to its enormous mineral potential, its important hydrographic network with fishing and fish farming being practiced in waterbodies surrounded by mining sites. This project intends to develop community-based management strategies that will enable the protection of the freshwater fish and crabs' biodiversity from disastrous effects of mining activities in South Kivu province, DR Congo. Specifically, the project intends to inventory the freshwater fish and crab species available in Mwenga territory, South Kivu province, DR Congo; to assess the effect of mining activities on the biodiversity of crab and fish species available in Mwenga territory, South Kivu province, DR Congo; to determine the population perception about the effect of mining activities on the fish and crab's yield and biodiversity as well as on the revenue of farmers/fishers; and finally to develop and vulgarize community-based strategies that will enable the protection of the fish and crabs' biodiversity.

II.   Planned and achieved activities.

The project was officially launched on 1st February 2023 for 12 months of implementation with the involvement and participation of all stakeholders. Table 1 presents the project activities planned and the ones already achieved.

Table 1: Planned and achieved activities with their associated results.

| Planned activity	Target	Achieved result	Achievement rate %	Observations
Fish and crabs' sample collection	45 fish and 45 crab samples from 15 water bodies	90 fish and 60 crab samples collected from 45 water bodies	100%	The collection of fish and crab samples was conducted for a period of 2 weeks (From 25th February to 10th March 2023). Fish were collected using nets.
Identification of fish and crab species based on	Identification of 45 fish and 45 crab samples	-So far 7 fish species identified phenotypically	50%	This is an ongoing activity and final results will appear in the next progress report.

identification keys		-So far 2 crab species identified phenotypically		
Laboratory work (DNA extraction, amplification of marker genes through PCR and sequencing)	Genetic characterization (Identification) of at least 30 fish and crab samples	-DNA extraction of 45 fish samples achieved. -Reagents for the amplification of marker genes have been ordered.	30%	Ordered reagents are expected to be received in the next two weeks. Meanwhile the extraction of crab sample DNA will be on going.
Histopathology analysis	25 samples to be analyzed	-Macroscopic analysis of 25 samples done -Microscopic analysis is on going	50%	Microscopic analysis of internal organs is going.
Assessment of the effect of mining on the biodiversity of fish and crabs	The impact of mining activities on the biodiversity of fish and crab was assessed.	The activity is yet to be conducted	0%	This activity is expected to be conducted in June-July 2023
Interviews and focus group discussions to evaluate fishers and farmers perceptions	-Interview of 90 fishermen, 90 farmers and 90 individuals from the local community. -60 participants in focus group discussions	The contact with fishermen and fish farmers is already done	10%	This activity is expected to be conducted in August 2023
Development of community-based management strategies and stakeholders' empowerment	-Empowerment of 50 stakeholders -Development of community-based management strategies	The contact with stakeholders (fishermen, mining operators, environmentalists, government representative and local communities) is already done.	10%	This activity is expected to be conducted in September 2023
Vulgarization of the defined community-based management strategies	-Development of community-based management strategies and their vulgarization in the community	Not yet achieved	0%	This activity is expected to be conducted in October 2023

III.   Key results

3.1. Fish and crabs sample collection: Field trip was organized for 2 weeks, and consisted of sites identification, waterbodies selection, collection of water parameters for the different selected waterbodies and collection of fish and crab samples. In total 45 waterbodies have been selected based on their location (They are surrounded by mining sites), species that they host (The project focuses on fish and crab species) and their accessibility. In each waterbody fish and crab samples have been collected. In total 90 fish and 60 crab samples were collected and stored in cooler boxes. Collected organs (for 25 fish only) have been stored in 10% formol (As this required killing the fish/crab we could not kill so many for biodiversity preservation purposes). The sample collection was scattered across the whole Mwenga territory (Mwenga center, Kamituga, Kibe and Kitutu). These areas have also a high hydrographic potential (Lubyala River, Zalya River, Elila River, Ulindi River, etc.), most of which are affluents of the Congo River with fish farming as one of the main activities conducted by the local population. Some figures related to this project activity are below presented.

Figure 1: Chinese mining site near Zalya river
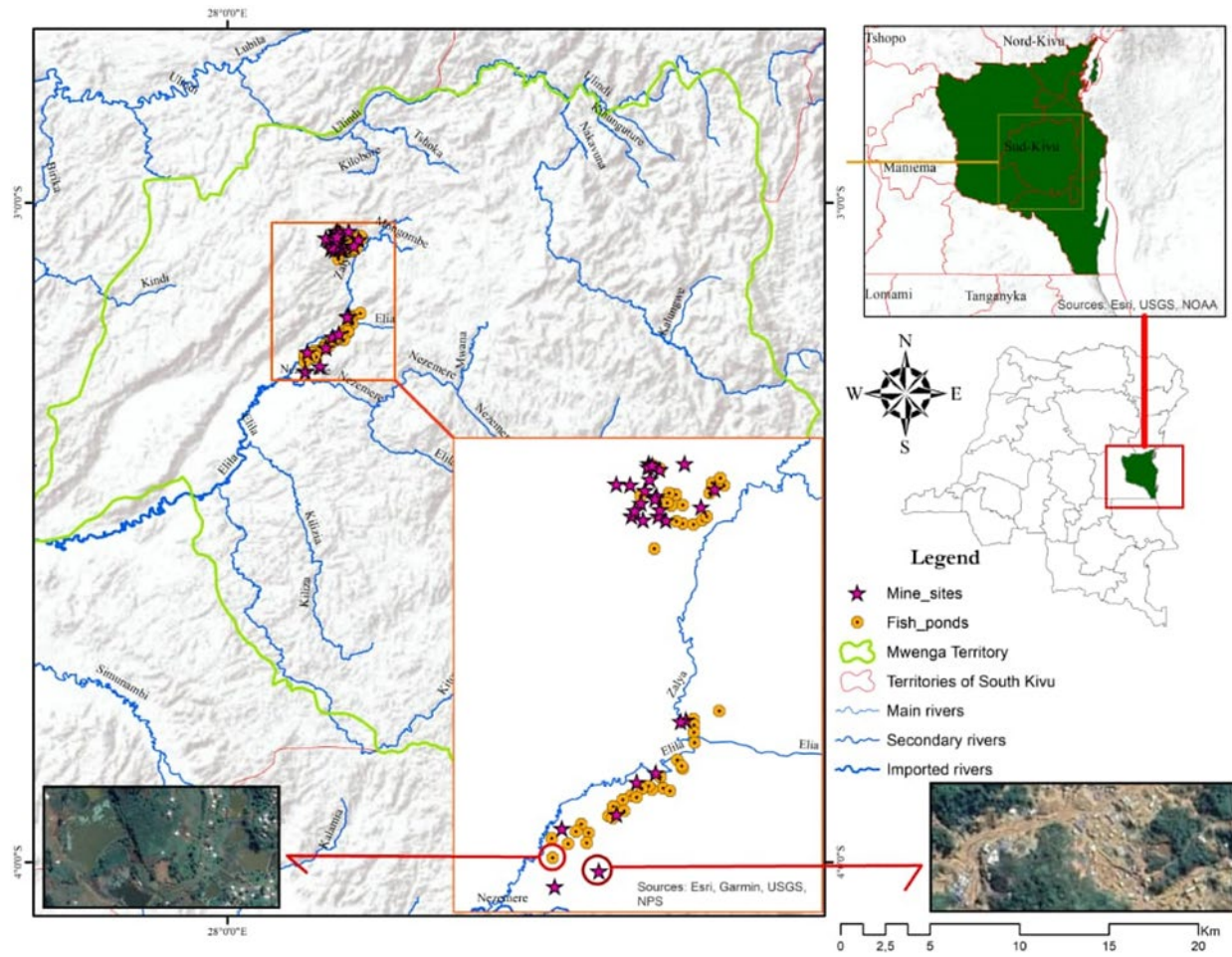
Figure 2: Map of mining sites and surrounding waterbodies in Mwenga territory, South Kivu, DR Congo.

Figure 3: (Left) Water parameter collection using a multiparametric probe. **Figure 4: (Middle & Right)** Collection of fish in ponds.

Figure 5: Children looking for gold in water canalizations near ponds.

Figure 6: (Left) Fish blood collection. **Figure 7: (Right)** Fish organs preserved in 10% formol.

Figure 8 shows that waterbodies located in Kitutu have the lowest pH (acidic pH) and temperature. However, the lowest conductivity was observed in Mwenga territory. The lowest pH observed in

Kitutu could be explained by the fact that there are so many mining sites in the area and most of them are interconnected with waterbodies in which fishing and/or fish farming are practiced.
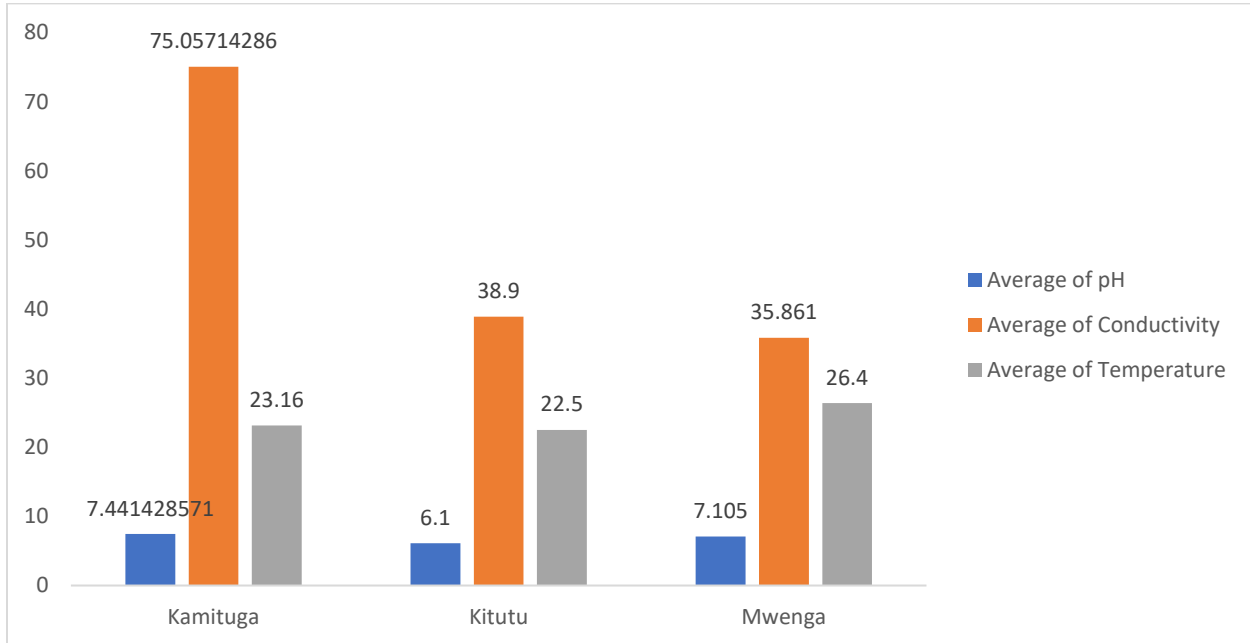

Figure 8: Averages of water parameters for waterbodies sampled in Mwenga territory, South Kivu, DR Congo

3.2. Identification of fish and crab species based on identification keys.

This activity is ongoing. We are using identification keys to identify the collected fish and crab samples based on phenotypic features (Appearance and morphometric features) and this will be followed by genetic characterization. The morphometric characterization of collected fish samples has been already done. This was done first of all on Nile tilapia which represents the mostly farmed fish species of Mwenga territory and also the most frequent in natural waterbodies (rivers). 22 morphometric parameters were collected for every fish. All collected data were subjected to multivariate analysis. Principal component analysis (PCA) and discriminant analysis function (DFA) were then used to analyze the data using the R software. Preliminary results are shown in the below figures.

The below figure shows separation between a group of Nile tilapia fish sampled at Kamituga and those from Mwenga, Kibe and Kitutu (Rivelila). Individuals from these different sites partially intersect with each other by overlapping.
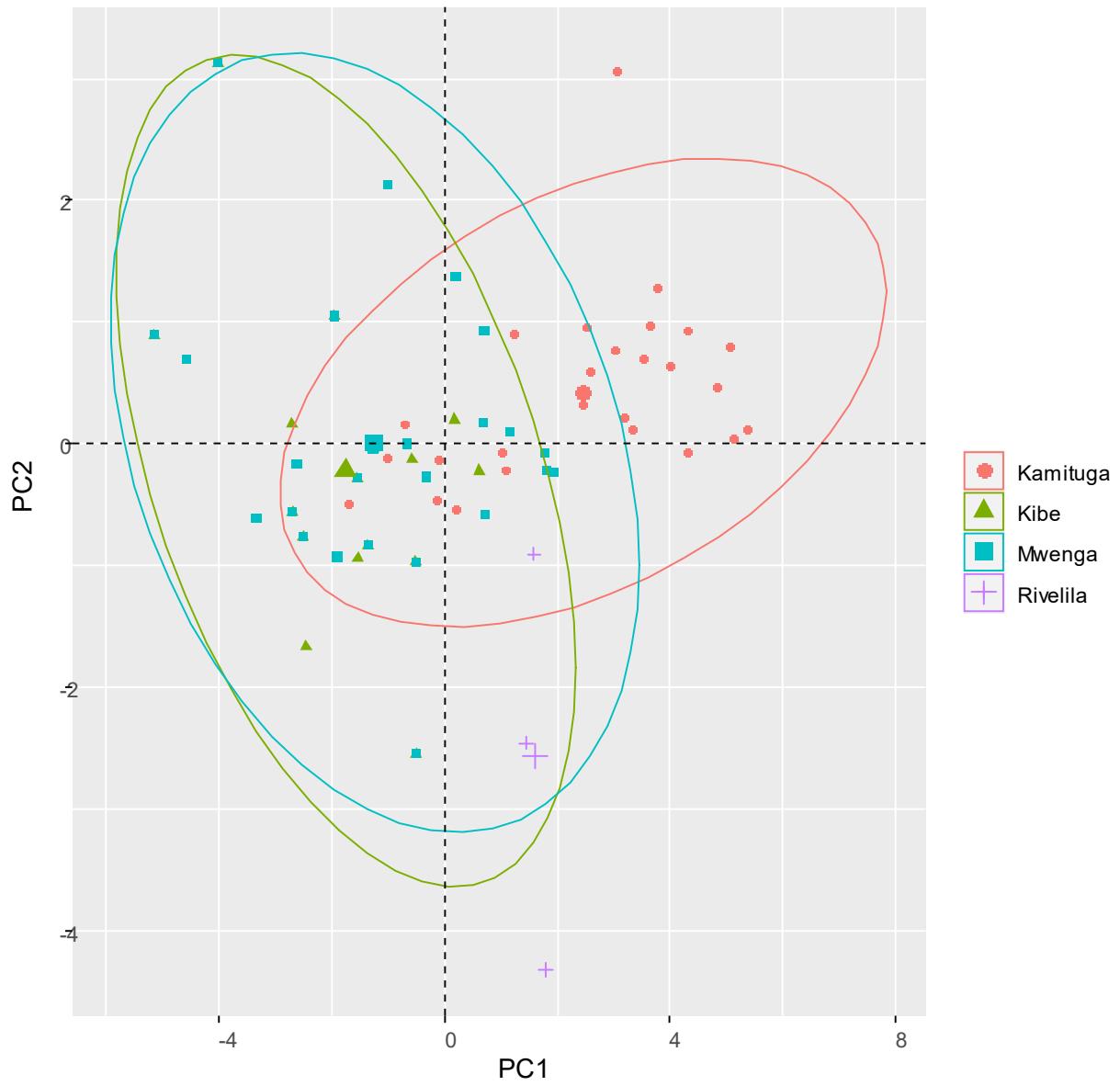
Figure 9: Principal Component Analysis of morphometric data of Nile tilapia sampled in Mwenga territory, South Kivu province, DR Congo.

Figure 10: Diversity of collected fish species.

Figure 11: (Left & Middle) Diversity of collected fish species. **Figure 12: (Far Right)** A fish found dead in mercury residues from a nearby mining extraction site.

Figure 13: Diversity of crabs collected.

3.3. Histopathology assessment of collected internal organs.
This activity is ongoing. Macroscopic analysis of the different collected internal organs has been done successfully. The microscopic analysis is ongoing.

Figure 14: Ongoing histopathological assessments.

IV.   ADDED VALUE

❖ One MSc student and two BSc students are doing their theses under the current research project. Generated data will be validated in two papers that will be published in peer review journals under the Elsevier platform.

❖ Five BSc students spent their internship under the project for a period of 3 weeks: They have been trained on the development of data collection tools, how to conduct surveys, the collection of different types of data on the field (Fish and crab samples, blood, internal organs, geographical coordinates, water parameters, etc.), and morphometric data analysis using the R software.

V.   ENCOUNTERED DIFFICULTIES

1. Degraded condition of the roads leading to the study site.
2. Delay in the supply of the ordered reagents.
3. Insufficient funds to cover supplementary activities that were suggested by reviewers.

Appendix 1: Zalya river water polluted by artisanal mining activities conducted nearby.

Appendix 2: Collection of water parameters in Lubyala river.