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World Water Quality Alliance

Rokel River Basin Citizen Science for SDG 6.3.2 Report

November 2022

Background

The present project is aimed at testing the potential for citizen science based monitoring to support and complement agency in situ monitoring, for the purpose of river catchment management and SDG 6.3.2 reporting. The project is a partnership between Earthwatch Europe and the Sierra Leone National Water Resource Management Agency (NWRMA) with the support of UNEP's Global Environment Monitoring System for Freshwater (GEMS/Water). The project represents an opportunity to expand the impact of citizen science on global SDG reporting, as well as a case study to explore novel and unconventional approaches of data collection methods to improve the management and monitoring of river water quality in Sierra Leone.

Citizen Science is the involvement of the non-academic public in the process of scientific research, where members of the community dedicate time and energy to support the collection, analysis or description of scientifically valid data. Citizen science is based on involving communities to take active role in understanding and managing their environment: to contribute to a more participated sharing of common resources, and can have positive impacts on societal openness, inclusion and empowerment and education (ECSA Policy Brief on Citizen Science and Open Science).

The present report addresses the activities that were performed to meet the overall objectives of the project. We evaluate each activity with respect to its expected outcome and identifying areas of improvement and requirements for further research and development. These activities are addressed below:

1. Co-design of monitoring protocol to complement Agency monitoring activities and meet SDG 6.3.2 reporting objectives
2. Training of Agency staff for recruitment, training and support of citizen scientists
3. Identification of participating communities and recruitment of citizen scientists from each community
4. Training and equipping of citizen scientists
5. Citizen scientist monitoring and quality control
6. Collaborative data analysis
7. Feedback and consultation with citizen scientists
8. Integration of citizen scientist generated data with Agency data for SDG 6.3.2 reporting

Co-design of monitoring protocol to complement Agency monitoring activities and meet SD 6.3.2 reporting goals

The study catchment chosen for the present study was the Rokel River basin in Sierra Leone. The Rokel River is the second largest river in the Republic of Sierra Leone, with a catchment of more than 8000 km2. The catchment extends from the Loma Mountains and runs southeast to the Atlantic Ocean, with a length of 386 km. It has a highly seasonal river flowrate, reaching 1900 m3/sec (Akiwumi 1997).

The basin population of 1,300,000 (Sierra Leone Statistics 2015) is spread across 25 administrative chiefdoms. There are a range of activities that are directly and indirectly impacting the river water quality. These include mining activities for both iron and gold, agriculture, logging and fisheries.

Agriculture is the largest activity for extension and participating population (Kamara et al., yet to be published). Agricultural activities include subsistence and intensive, including large scale sugar production for ethanol. Mining is the second most important activity in the basin with particularly impactful artisanal activities. Logging is a major activity in the Koinadugu district (Kamara, 2022) which has led to deforestation. Fisheries is the prime activity in the Tonkolili district.

Project co-design began through online workshops between Earthwatch Europe, NWRMA and GEMS/Water in July and August 2021. Site selection within the basin based on land use, presence of nearby villages and ongoing NWRMA monitoring locations. A total of 27 sites were chosen (Figure 1) involving 24 communities. Monitoring parameters were basic hydrological and riverbank characterisation together with the measurement of turbidity, water colour, nitrate and phosphate, more closely related to SDG 6.3.2 reporting.

Monitoring frequency was set to monthly to capture seasonal changes as well as changing land and river resource use over the course of the year.

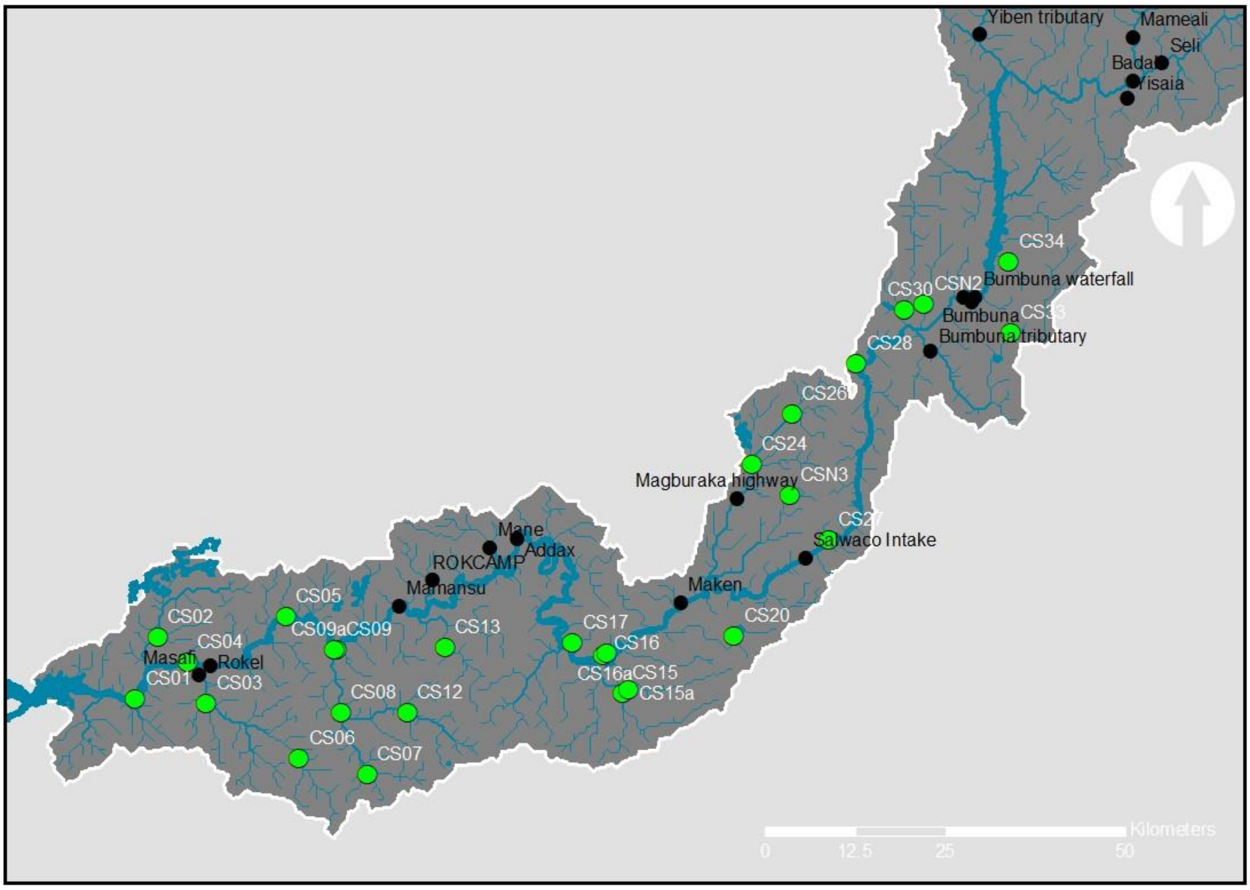


Figure 1. Co-designed sampling sites (27) for the Rokel River basin monitoring programme. Green dots are the new citizen science monitoring sites

Lessons learned towards best practise:

The selection of sites was an iterative process, balancing an optimal maximum number of sites (largest spatial coverage) with the capacity to manage and support a reasonable number of citizen scientists. Spatial coverage was directed at covering major tributaries and land use variations within the catchment, aiming to monitor both unimpacted and as well as impacted areas of the catchment. One learning point for similar projects should be to ensure there is sufficient time for the co-design activities of monitoring sites, allowing for multiple rounds of consultation with partners.

Identification of participating communities and recruitment of citizen scientists from each community

Participating communities were selected based on their geographical position in the basin to ensure a well-balanced spatial coverage with respect to ongoing Agency monitoring, their access to safe monitoring and sampling positions on the river and their willingness to become involved in the programme. Each community was visited by Agency staff in August 2021 during which community members were consulted and citizen scientists were recruited and selected based on their interest in the project, capacity to influence the community and availability to participate in the training and regular monitoring. Local leaders participated in the selection process, leading to a final selection of 24 citizen scientists, with the majority being young men between 25 and 34 years of age (Figure 2).

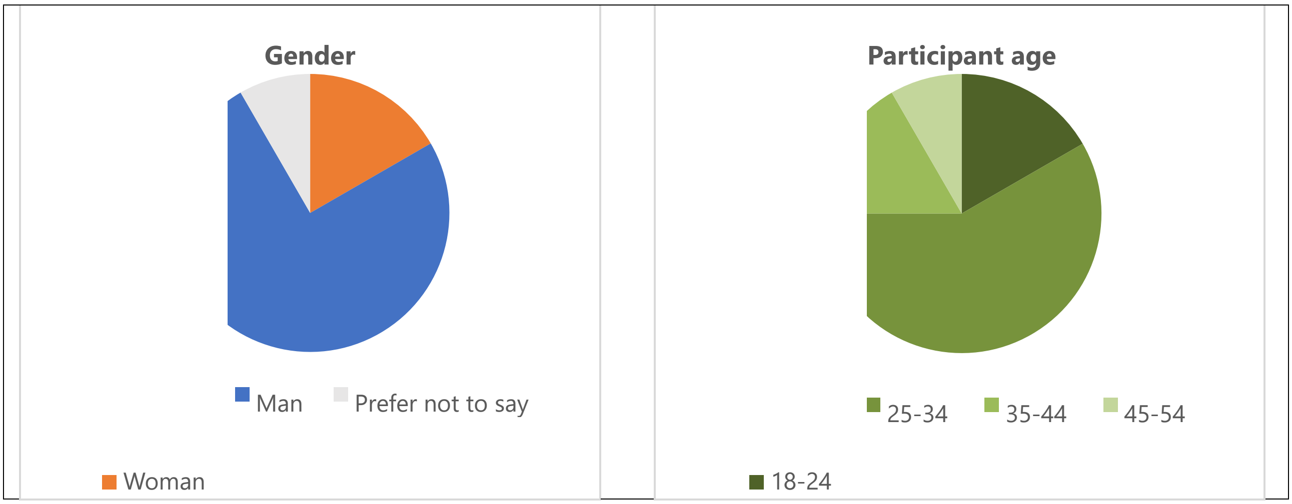


Figure 2. Participant self-reported gender and age

Participant motivations for joining the programme, were qualified through the survey completed on the training day. The majority of the selected citizen scientists participated for relatively altruistic reasons (Kragh 2016), as they were related to the quality of life in their community and supporting national goals (Figure 3). Aspects of learning, curiosity, and self-improvement were also part of the motivations of the participants.

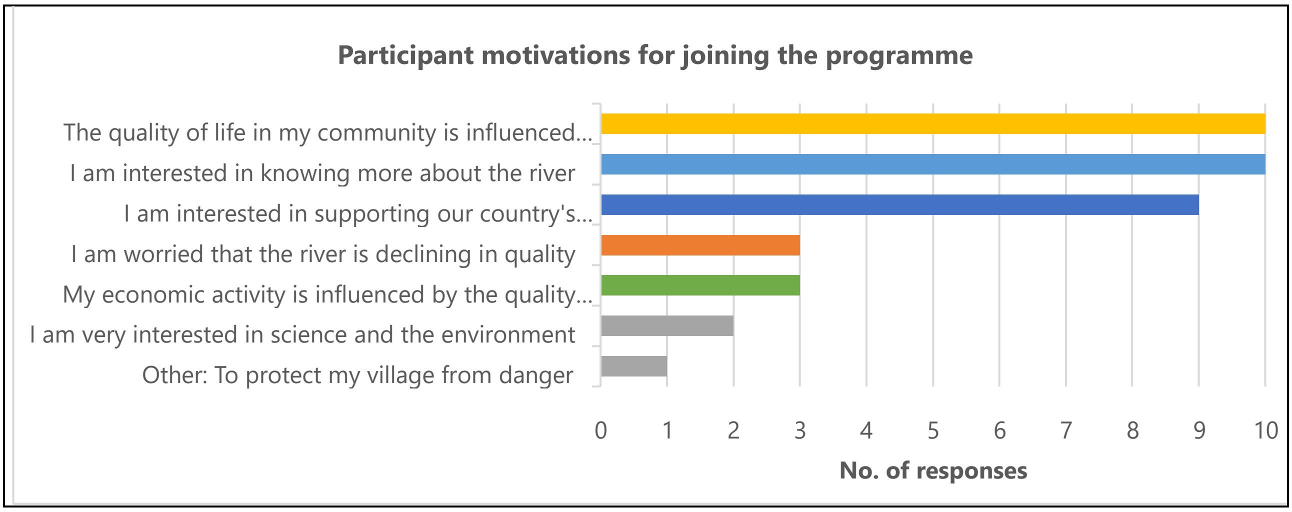


Figure 3. Participant self-reported motivations (multiple options were allowed)

Most participants did not have prior experience in monitoring or river management, although a number are part of a local environmental group (Figure 4). Taken together, nearly half had some prior experience in environmental or river-related matters.

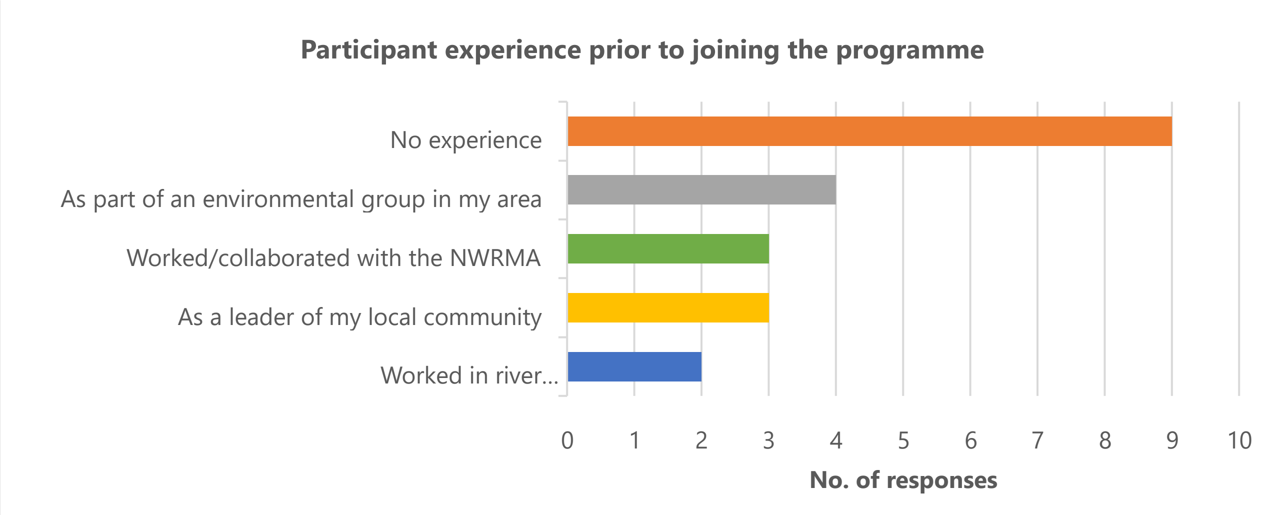


Figure 4. Participant prior experience in water quality monitoring, river management or environmental management

Participants came from communities that ranged from under 200 people to more than 3000, with the majority of the participants coming from communities of between 500 and 1000 people. The dominant economic activity of these communities was farming, followed by fishing.

Citizen scientist participants were asked to think about the condition of the Rokel River prior to beginning the monitoring programme, and to identify perceived drivers to the loss of water quality, both locally and across the river basin. The majority of the participants viewed that the conditions of the river were poor or problematic (Figure 5).

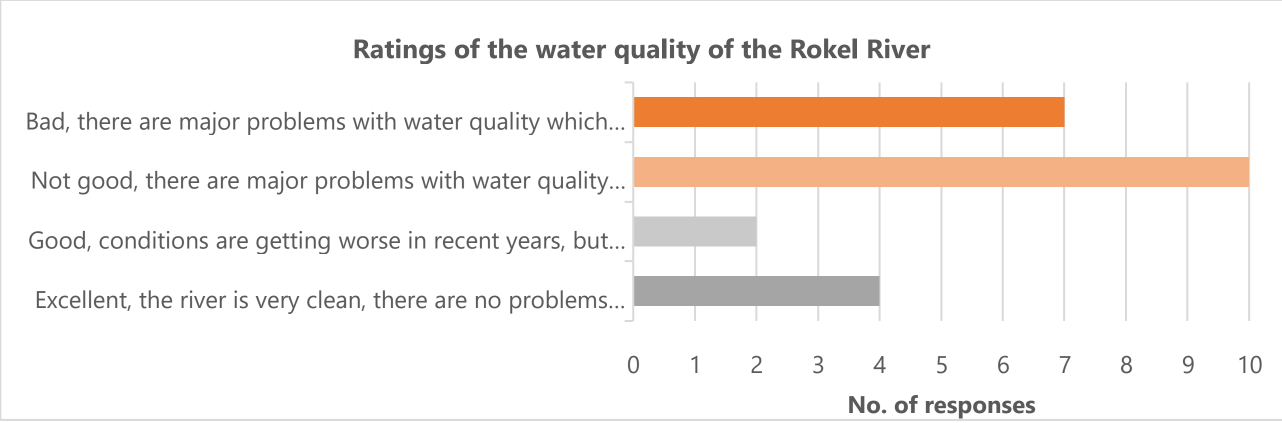
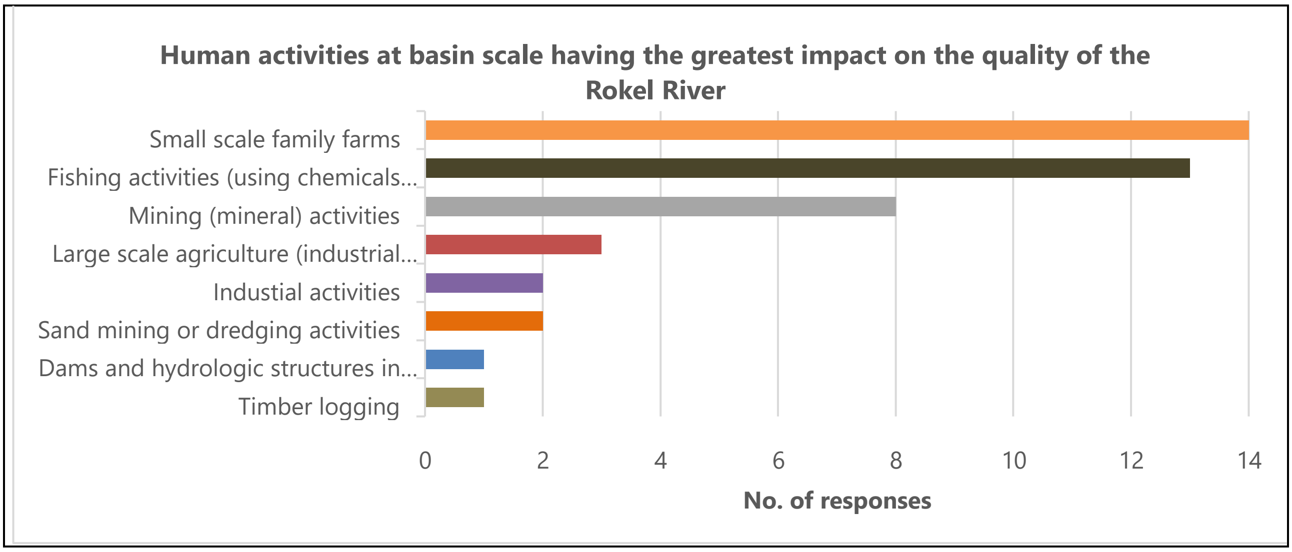


Figure 5. Perceived quality of the Rokel River, prior to monitoring activities

The participants also identified potential basin-scale and local (community) scale activities that have the potential to impact the river water quality. Small scale farming rated as highly impactful on both the local and catchment scale. This follows from the dominance of this economic activity within the catchment, as identified by the participants in an earlier question. Other major local impacts were identified as domestic washing activities, small industrial activities and waste disposal (both solid waste and wastewater) (Figure 6).



On a catchment level, participants suggested that the major drivers of water quality degradation were fishing (using chemicals or dynamite) followed by mining activities. Large scale agriculture was not considered as a major source of pollutants to the river (Figure 7)

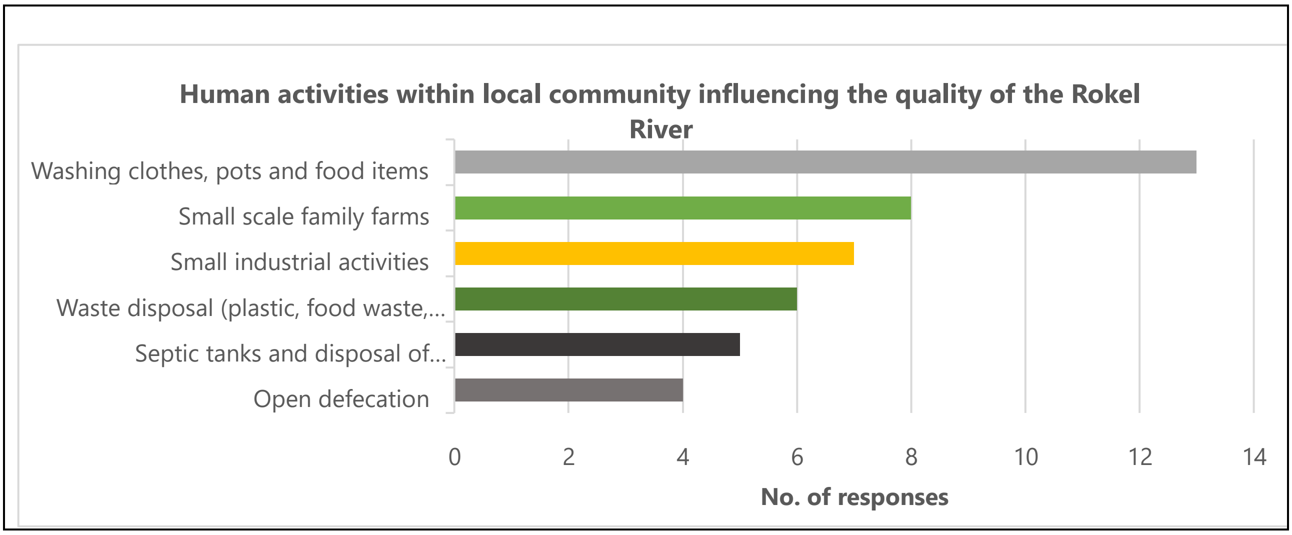


Figure 7. Basin (a) and local scale (b) activities that participants identified as having impact on the water quality of the Rokel River

Lessons learned towards best practise:

The recruitment and selection of citizen scientists to participate in the programme was based on local community dynamics and governance structures with attention to avoiding potential power and gender bias. Recent studies (Moshi et al. in review) have shown that socio-demographic characteristics of community members are key factors in individual willingness to participate in citizen science activities. In particular, local community members with families, head of households and individuals with low monthly income are often the most willing participants. Future projects should identify community dynamics that allow for a more gender balanced participation in monitoring or data interpretation activities.

Training of Agency staff for recruitment, training and support of citizen scientists

The approach adopted was that of "Train the Trainer", where Earthwatch Europe scientists trained staff of the NWRMA (Hydrological Unit), using virtual training tools. The trained staff then acted as trainers for the community members of the 24 communities participating in the Rokel River basin monitoring.

The Train the Trainer session was held with National Water Resource Management Agency scientists Mohamed Juanah, Ismail Kamara, Abu Bakar Kamara, Grace Kainessie, Emdee Soko and Earthwatch Europe staff scientists, Steven Loiselle and Eline Koelman, together with GEMS/Water scientist Stuart Warner, on August 26, 2021. The training programme addressed the following aspects from both the theoretical and practical point of view: Introduction to citizen science

- Introduction to freshwater monitoring approaches using citizen science
- Freshwater monitoring geographical and temporal objectives
- FreshWater Watch method theory
- FreshWater Watch method practical
- Logistics (kits, app, portal)
- Quality control
- Data analysis

The field practical was not possible due to the virtual nature of the training however, an extended discussion of practical aspects was conducted at the conclusion of the Train the Trainer session.

Lessons learned towards best practise:

The Train the Trainer was highly successful due to the support of the NWRMA director and the enthusiasm of the participating staff. While the training was performed online, due to Covid and budget restrictions, in presence training would have allow for practical demonstrations and a more fluid knowledge exchange.

Training and equipping of citizen scientists

The Field Training event was held on 15 November 2021, after the arrival of the kits and the final selection of the monitoring sites, participating communities and participating citizen scientists. The training was held in Makeni, in the local hotel. This location could be reached by public transport from most of the 24 communities.

One citizen scientist from each community (24 communities involved) was invited to participate. The trainers were scientists from the National Water Resource Management Agency, led by Mohamed Juanah, Ismail Kamara, Abu Bakar Kamara, Grace Kainessie and Emdee Soko (Figure 2). Training included both theoretical and field-based training (Figure 2). Theoretical aspects were reinforced with videos, presentations and paper-based information.

The agenda was as follows:

Introduction and welcome	10:00
FreshWater Watch monitoring method (video)	10:15
FreshWater Watch method slides and discussion	10:30
Lunch	
Download and How to use the app	13:00
Liability form to sign	13:30
FreshWater Watch method practical (in the field)	14:00
Logistics (kits, app, portal)	16:00
Health and safety	16:15
Study sites - discussion	16:30
Analysing data	17:30
Participant survey	17:45
End	18:00

The following training materials were prepared and used on the Field Training day:

Videos:

- Field Training video for FreshWater Watch

- How to video for FreshWater Watch app

PPTs:

- Rokel River monitoring sites, maps and geographic context
- FreshWater Watch training presentation

Forms:

- Liability waiver
- Participant survey

Printed material

- Health and Safety instructions
- Monitoring instructions
- Monitoring datasheet

Figure 8. Rokel River basin citizen scientist training by NWRMA scientists in Makeni, Sierra Leone

All participants completed a participant survey at the conclusion of the training day. The results indicate that 70% of participants gave a rating of four or five (very good or excellent), and 17% of participants gave rating of one or two (not good or poor). Comments to improve the training were focused on extending the training across multiple days (20% of the participants made this or similar suggestions). Another suggestion was that the proponents (Agency and Earthwatch Europe) provide ongoing support to the participants in their engagement with the local community. The materials used for trainer were rated by 88% of participants as very good or excellent, while the training facilities (location, food) were rate by 77% as very good or excellent. Most importantly, 96% of participants reported that they feel confident to monitoring the Rokel River within the programme. One participant did not respond to this survey question.

Lessons learned towards best practise:

The training process, both the Train the Trainer, as well as the Field Training of the citizen scientists achieved the intended results, with participants increasing their understanding of the river, the need for monitoring water quality and their confidence to perform monitoring activities. However, some areas of improvement were identified:

1. To support the role citizen scientists within each community, the development of Rokel River citizen scientist/World Water Quality Alliance (WWQA) dissemination material should be developed. This should include written and infographic material directed at all community members to increase understanding of the monitoring objectives and water quality results
2. To improve the visibility of the citizen scientists within the community, some official form of recognition and identification should be provided to trained citizen scientists to improve community support for their activities and knowledge exchange.
3. More than 1 citizen scientist should be trained for each community, to ensure continuity and local support. This was not possible in the present project due to budget limitations.

Citizen scientist monitoring and quality control

Data collection was initiated in November, 2021 by the 24 citizen scientists and has continued to date. Due to the limited number of participants with smartphones (2 citizen scientists), data acquisition was performed on standard paper datasheets. This approach has been used in a projects across the globe, but presents a number of challenges to quality control (data cannot be immediately checked) and data security (if datasheets are not stored properly). To overcome these challenges in the present project, a dedicated folder for storage of the datasheets was provided. External quality control was also performed after the datasheets were collected by the Agency scientists and by Earthwatch Europe. Data sheet collection was performed every 3 months, allowing for the possibility that some data could be recorded incorrectly or lost over this period.

As of October 2022 (data to September 2022), 205 datasets were obtained, compared to the expected 243 datasets. Loss of data occurred in one site following the departure of the trained citizen scientist in February 2022. In two sites, data loss occurred when the datasheet folder was damaged byrats and, water.

Quality control was performed by NWRMA staff and Earthwatch Europe. Measurements that were perceived to be potential outliers were checked with citizen scientists and local experts. Modifications were made to the online database to reflect corrected values. The most common errors were related to mis-interpretation of the turbidity scale and the lack of geo-location on the dataset (due to the lack of smartphone recording). Having a clearly identified geo-location for each site allowed for correction of incomplete datasets. Nitrate and phosphate measurements were compared to Agency data for the nearest stations and for internal consistency.

Lessons learned towards best practise:

Data recording on paper datasheets in not a new process. However, for large scale projects, the provision of low-cost smartphones, a SIM card for data and top up coverage for data usage would provide for better management of data, including a more immediate process of quality control. If limited coverage or budget does not allow for this, more robust datasheet storage approaches should be followed. Similarly, having multiple citizen scientists in each community would ensure continuity in cases where participants are no longer available to continue monitoring. In the present project, new citizen scientists were trained in October 2022 to replace those that had departed.

Collaborative data analysis

Scientists at the NWRMA and Earthwatch Europe, supported by GEMS/Water met regularly in August, September and October to quality control and analyse the data. The objectives were to identify geographic and temporal trends in water quality in the basin. The average number of measurements for all the stations was 6.4. Full datasets for the Kiamokakolo, Mafomba, Magbosie, Mahera, Makotha, Matanko, Robunth, Rogbunka, Rosanda and partial datasets for the remaining sites were used to analyse basin hotspots for nitrate, phosphate and turbidity, in relation to identified pollution sources and hydrological conditions.

The distribution of nitrate concentrations shows several hotspots, in particular in Kiamokakolo, Madimbor, Rofai, Rogbunka, Tonkololo, where elevated concentrations (greater than 1.0 mg/L) occurred for most or all of the monitoring period (Figure 9). Combining these measurements with citizen scientist observation of local conditions and potential pollution sources, no significant differences between nitrate concentrations with respect to nearby land uses were evident ($p > 0.05$). Regarding potential pollution sources identified by the citizen scientists, no differences for sites that had agricultural discharges compared to residential discharges were observed. Identified water colour and nitrate concentrations were also well associated, with "brown" waters having the highest nitrate median ($p < 0.01$). No relation with river flowrate was observed.

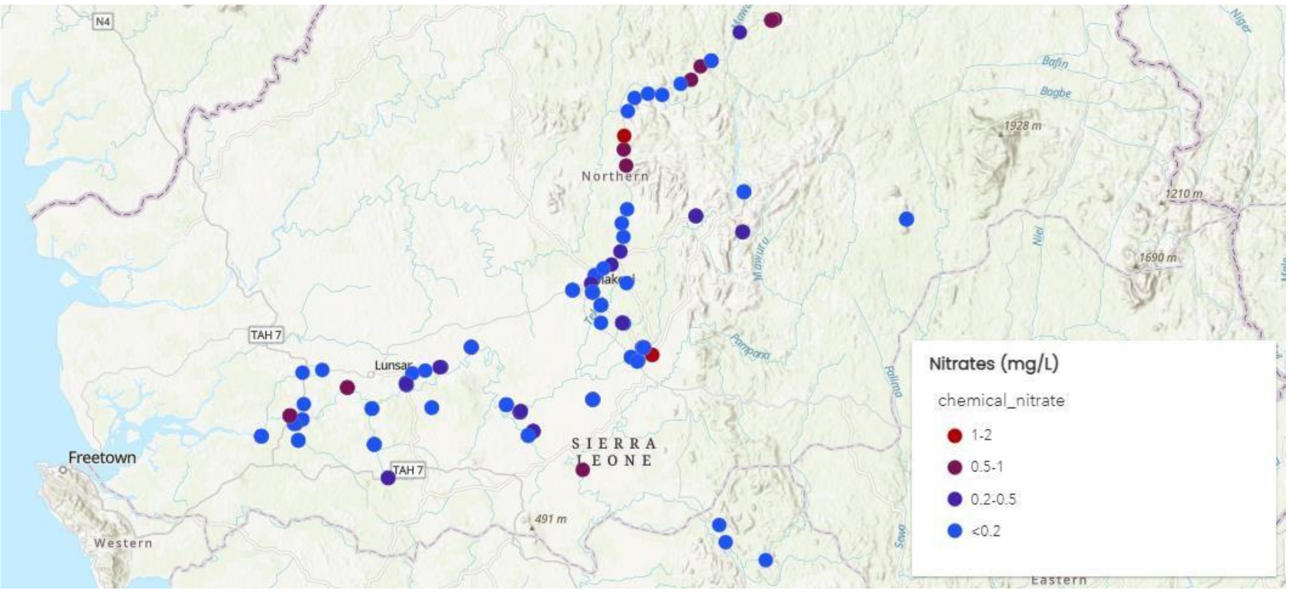


Figure 9. Spatial distribution of citizen scientists measured nitrate concentrations along the Rokel River from November 2021 to September 2022

Sierra Leone has two major seasons, the rainy season that is begins in May, and reaches its maximum in July and August and the dry season that lasts from December to April. The overall seasonal changes in nitrate show an overall increase in nitrate at the end of the dry season (Figure 10), with a clear dilution effect during the months of highest rain, with significant difference in nitrate concentration between July/August and March, April and May. The month of May is the end of the dry season and was one of the months with the highest nitrate concentration.

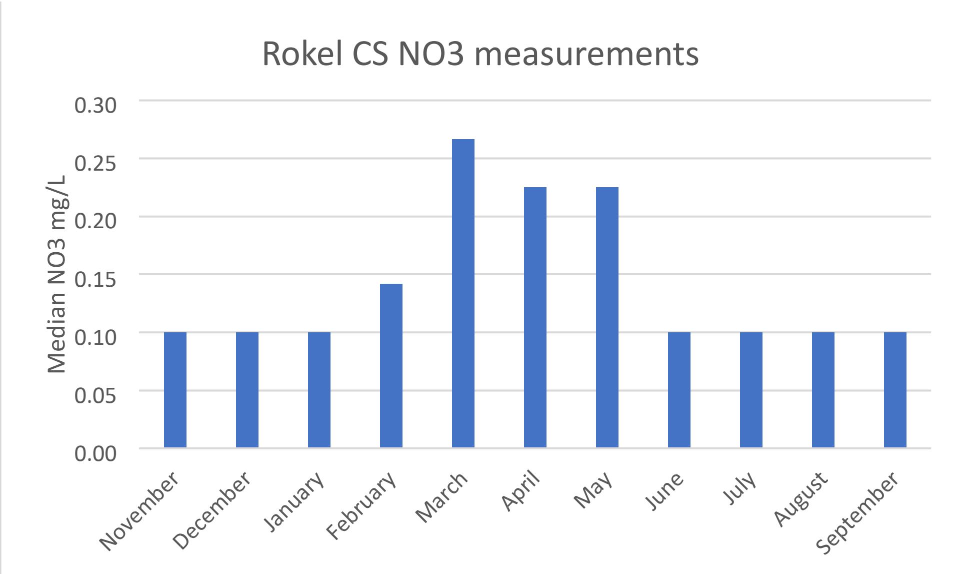


Figure 10. Median concentrations from all citizen scientist monitoring stations, from November 2021 to September 2022

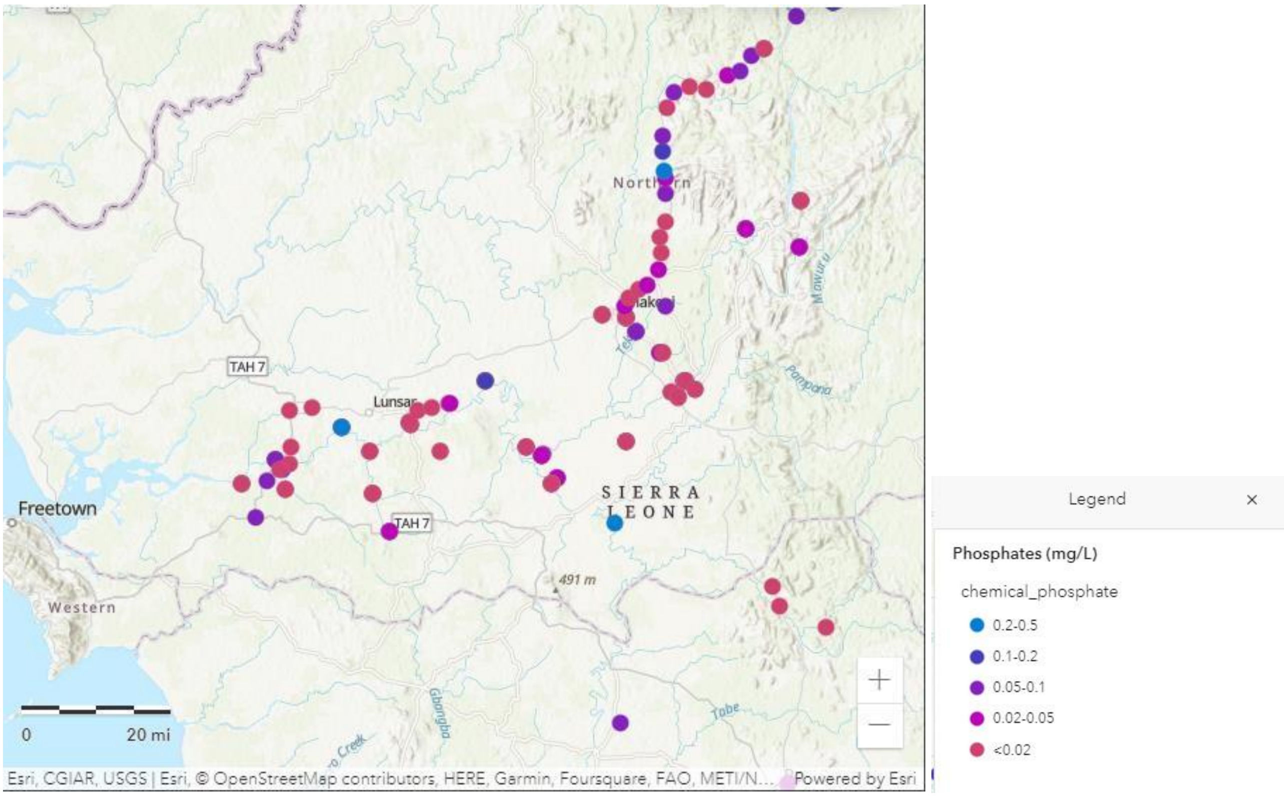


Figure 11. Spatial distribution of citizen scientists measured phosphate concentrations along the Rokel River from November 2021 to September 2022

The distribution of phosphate concentrations shows several hotspots, in particular in Kiamokakolo, Mabanta, Madimbor, Magbosie, Rosanda, Robunth, Taindokom, Tonkololo, where elevated concentrations (greater than 0.05 mg/L) occurred for much of the monitoring period (Figure 11). Concentrations above 0.1 mg/L occurred in Kiamokakolo, Madimbor, Magbosie, Rosanda, Robunth and Taindokom. Combining these measurements with citizen scientist observed local conditions, areas there were no significant changes in median phosphate concentrations between areas that were predominantly agricultural compared to forested or more populated areas ($p > 0.05$). Phosphate concentrations were significantly higher during periods of low flow with respect to periods of high flow ($p = 0.01$).

Overall seasonal changes in phosphate show an increase from January to June (Figure 12), with a clear dilution effect during the months of highest rain, with a significant difference in phosphate concentration between July/August and January, February, March and April.

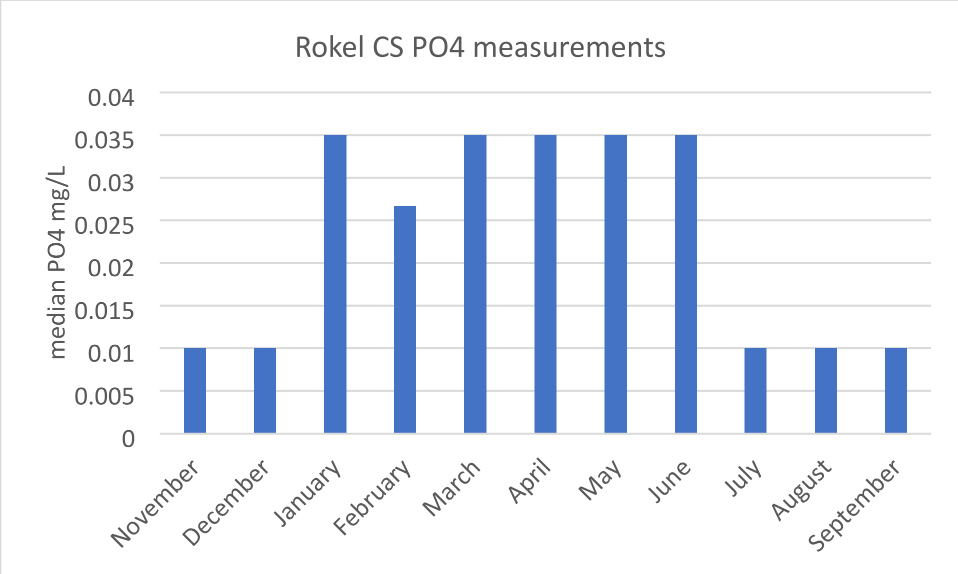


Figure 12. Median concentrations from all citizen scientist monitoring stations, from November 2021 to September 2022

The distribution of turbidity shows that more than half sites had turbidity above 40 NTU, with many above 80 NTU (Figure 13). Many of these sites with elevated turbidity are located in the upper part of the catchment, where logging and agricultural activities are more extensive (Kamara, 2022). Combining these measurements with citizen scientist observed local conditions, there was no clear difference between areas identified as agricultural or population centres, but there was a clear increase in areas where runoff from villages and houses were identified. Identified water colour and turbidity were also well associated, with "brown" waters having the highest turbidity ($p < 0.01$). No relation with river flowrate was observed.

Overall seasonal changes in turbidity show an increase in April that continues to June (Figure 14), with a clear dilution effect during the months of highest rain, with significant differences in turbidity between July/August (lower) with respect to April, May and June.

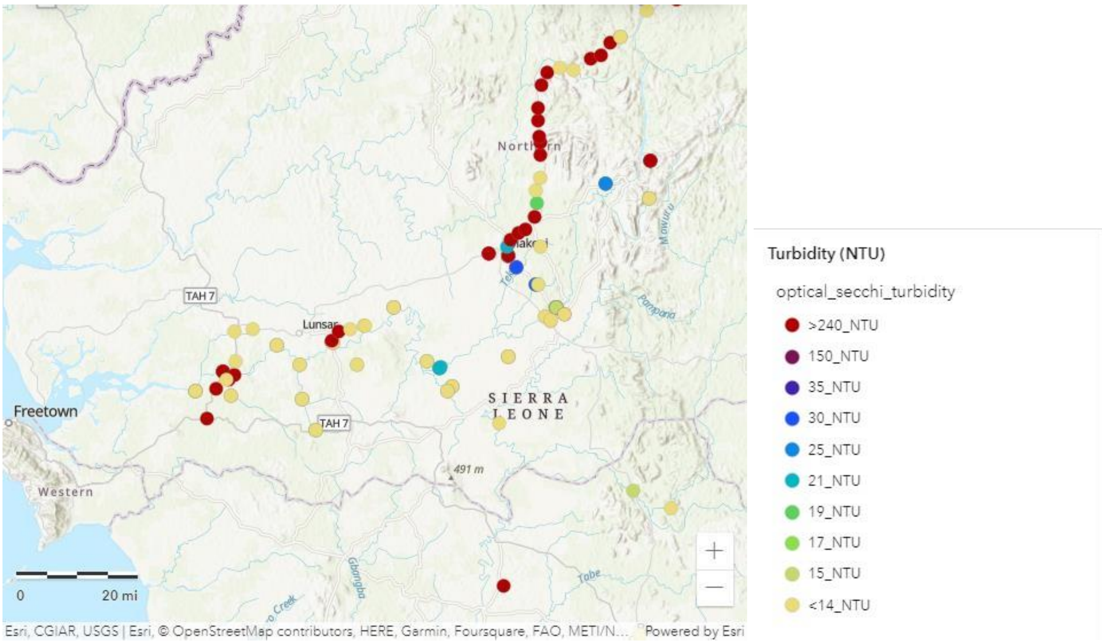


Figure 13. Spatial distribution of citizen scientists measured nitrate concentrations along the Rokel River from November 2021 to September 2022

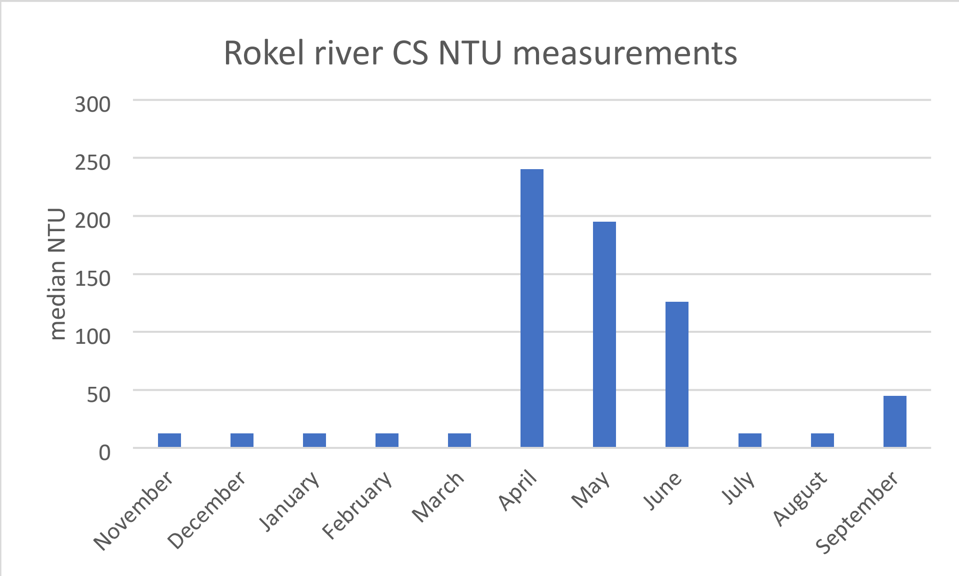


Figure 14. Median concentrations from all citizen scientist monitoring stations, from November 2021 to September 2022

Lessons learned towards best practise:

Monitoring by citizen scientists provided a strong indication of areas of the catchment that require improve management and mitigation to improve water quality. In the coming months, this information will be used to develop an Integrated River Basin Catchment Management plan, expected to be initiated in January 2023 with stakeholders from different areas of the catchment. Citizen science based monitoring will play a central role in monitoring developments of the stakeholder-based initiatives.

Nitrate, phosphate and turbidity values showed clear spatial and temporal differences within the catchment. These differences are likely to be strongly related to spatial changes land use as well as precipitation. Observed hydrological and land use variables provided important insight to these changes in water quality. However, the availability of a catchment wide land use/cover data, showing yearly trends over the last decade, would provide needed information to support an improved catchment management and better contextualise the spatial differences in water quality. Furthermore, gauge information or river discharge information would help to estimate overall sediment and nutrient loads. Citizen scientists have been successful gauge readers in multiple programmes and could be further trained to record this valuable information. Finally, given the scale and impact of mining activities in the catchment, there is a clear opportunity for citizen scientists to support better management of these activities. By integrating measurements that could be proxies or direct measurements of mining activities into the monitoring programme, improve temporal and spatial information could be used to improve management of mining activity impacts on water quality.

The citizen science water quality data allowed for un unprecedented spatial and temporal coverage of the Rokel river catchment. Challenges around participant continuity and quality control were well met through an inclusive participatory training by trained and dedicated scientists at the NWRMA. However, reducing the delay between measurement and data upload should be considered by providing low cost smartphones and data packages to the citizen scientists.

Feedback and consultation with citizen scientists

In October 2022, feedback and re-training workshops were held in three locations in the basin, Lunsar, Makeni and Bumbuna (Fig. 15). These towns have been chosen since they lie within a maximum radius of approximately 20km from the set of monitoring stations for which each scientist is representing. A media officer and three technical staff from NWRMA well experienced in the “training of the trainer” conducted by FreshWater Watch together with three directors including the Director General visited all of these locations and participated in the engagement meeting

During these workshops, citizen scientists shared experiences and observations with the NWRMA scientists, highlighting interesting observations and challenges in their monitoring activities. Datasheets were reviewed and uploaded to the online platform by NWRMA scientists. Ten citizen scientists were trained for 5 new sites (Figure 16) and new citizen scientists were trained for those sites where the original citizen scientists were no longer available.

During the workshops, citizen scientists were provided with WWQA/SDG/GEMS/EW T-shirts and caps for local recognition and for motivation to ongoing and new citizen scientists (Fig. 17). In addition, certificate of participation for each scientist were printed in an A4 size hard card.

The workshops were opened by the Director of Hydrological Services, followed by the Director General of the Agency, who gave a brief talk on the importance of community ownership and having the citizen scientists take the lead in monitoring the quality of their local water sources. The Manager of Hydrological Services did a presentation of the theoretical aspect of the FreshWater Watch training, explaining the different aspects of the data sheet and showing them some pictorial evidence as well. The Hydro technician also summarized a video explaining the steps involved in the citizen science monitoring process. She did the explanation and summary in the local language (Krio) to foster better understanding of the content of the video. The GIS Officer also took the citizen scientists through the ArcGIS Survey123 app, which they will be using and showed them how to fill it out.

During the engagement and refresher training, filled out data sheets were collected and new ones along with reagents for the next five months were also distributed to citizen scientists to ensure the continuation of the monitoring.

Feedback focused on providing the citizen scientists with the basin wide context to understand their measurements. A summary infographic was provided to allow each citizen scientist to disseminate the results of their monitoring efforts to their local community (See Appendix 2).

Figure 15. Rokel River basin citizen scientist feedback and refresher training by NWRMA scientists at Makeni, Lunsar and Bumbuna in October 2022.

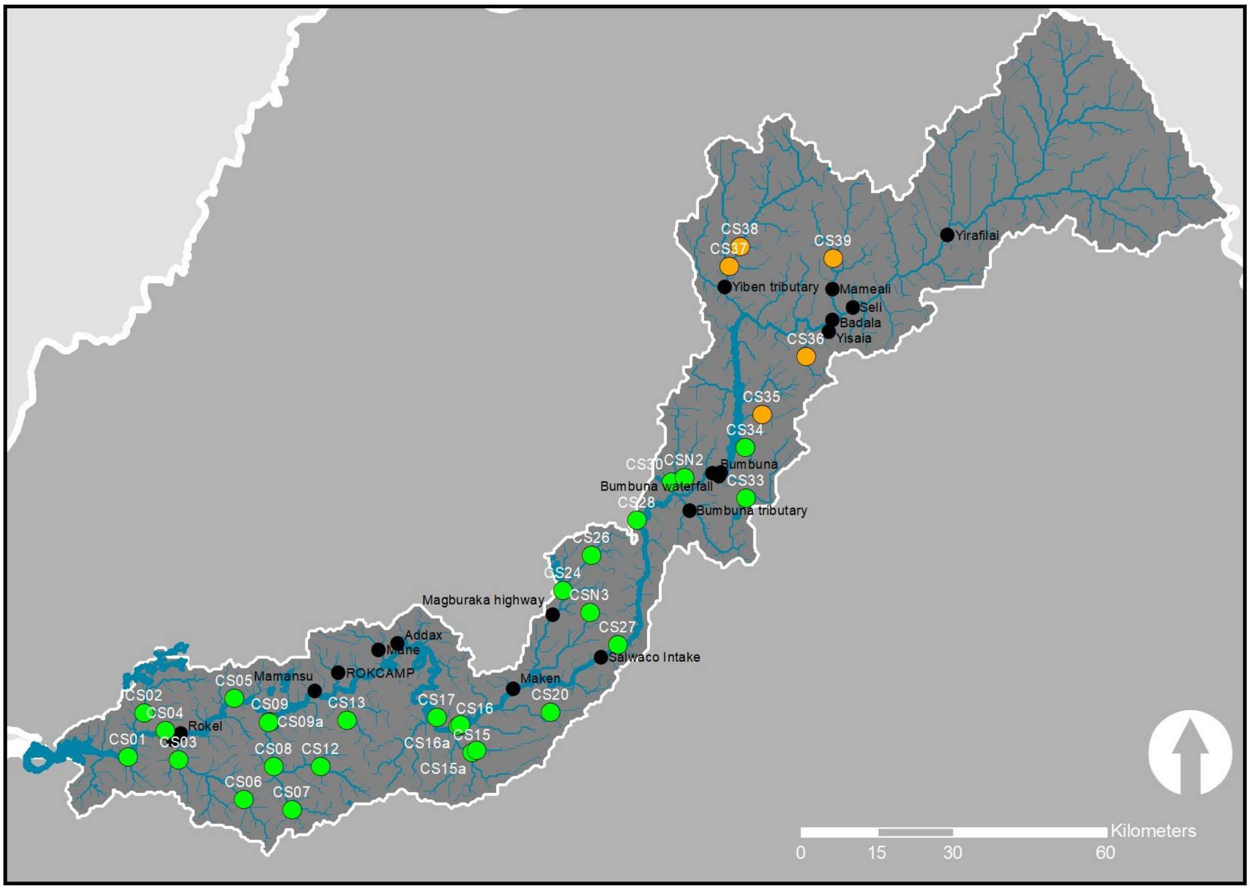


Figure 16. New (orange) and ongoing citizen science monitoring sites in the Rokel river basin

Figure 17. Back and front of the citizen scientist shirts provided to the active citizen scientists in the Rokel River basin

Lessons learned towards best practise:

The feedback and re-training sessions provided an important opportunity to consolidate and build the knowledge exchange between the citizen scientist participants and the participating scientists from NWRMA and Earthwatch Europe. The efforts to highlight the contribution of the citizen scientists to catchment management, as well as recognise their efforts were appreciated.

Lessons from the initial training, increasing the number of citizen scientists in each village were taken on board for upscaling the citizen science monitoring to cover the upper catchment.

In the future, ideally feedback should be built in every six months, as longer-term datasets are created.

Integration of citizen scientist generated data with Agency data for SDG 6.3.2 reporting

In readiness for Sierra Leone's 2023 report on SDG indicator 6.3.2, this project which provides data with improved spatial and temporal resolution has created an important opportunity to analyse different methods of combining citizen data with regulatory data, with the overriding objective to define the most suitable data integration method.

As part of this analysis, the underlying data and the indicator scores generated (and their associated metadata) will be compared. This will involve assessments that draw upon Agency data alone, citizen data alone, and various scenarios of data combination. For example, testing whether it is better to aggregate citizen measurements statistically over different time periods and then compare this median value against a target value, or whether, each citizen measurement should be considered separately. Also, with the improved spatial distribution of data, this will provide an opportunity to test whether creating more granular information is possible and whether the current waterbody delineation, and hence waterbody classification is appropriate or whether smaller hydrological units could be defined leading potentially to more targeted management measures.

This project will provide the first "official" and most robustly tested combined submission for this SDG indicator and will lead to further development replication in other countries looking to expand their monitoring capacity whilst simultaneously improve citizen engagement around water resource management.

References

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Kamara, I.,2022. Identifying Pressures on the Water Quality in the Rokel River Basin to Inform a River Basin Management Plan, MS Thesis. UCC (available upon request)

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Appendix 1. Average concentrations per site and percentage of measurements above indicated concentrations in mg/L.

Study site	Avg P-PO4	PO4 >0.05	PO4 >0.1	Avg NNO3	NO3 >1.0	Avg NTU	NTU >80	NTU >40
Gbolia	0.02	0%	0%	0.10	0%	**240**	**100%**	**100%**
Gbulaia	0.02	0%	0%	0.10	0%	**126**	**60%**	**60%**
Kadala 2	0.03	0%	0%	0.35	0%	25	0%	20%
Kadala 1	0.02	0%	0%	0.17	0%	**164**	**60%**	**60%**
Kegbema Junction	0.03	0%	0%	0.35	0%	12	0%	0%
Kiamokakolo 2	**0.05**	**50%**	0%	**1.70**	**25%**	**185**	**50%**	**50%**
Kiampkakolo 1	**0.07**	**60%**	**20%**	**1.77**	**40%**	**210**	**60%**	**60%**

Mabang 1	0.02	0%	0%	0.10	0%	12	0%	0%
Mabang 2	0.01	0%	0%	0.10	0%	59	17%	17%
Mabanta	0.03	**25%**	0%	0.19	0%	**98**	**50%**	**50%**
Madimbor	0.03	14%	14%	**0.34**	**14%**	29	0%	14%
Mafomba	0.02	0%	0%	0.23	0%	69	22%	22%
Magbosie	0.03	10%	10%	0.33	0%	**88**	**20%**	**20%**
Mahera	0.01	0%	0%	0.13	0%	**194**	**56%**	**56%**
Makotha	0.02	10%	0%	0.17	0%	56	10%	10%
Matanko	0.01	0%	0%	0.10	0%	50	11%	11%
Robang Village	0.01	0%	0%	0.10	0%	12	0%	0%
Robunth	**0.10**	**100%**	**33%**	0.10	0%	**240**	**100%**	**100%**
Rofai	0.01	0%	0%	**0.45**	**25%**	**126**	**30%**	**30%**
Rofeyea Village	**0.05**	**25%**	**25%**	0.10	0%	**69**	**25%**	**25%**
Rofullah	0.01	0%	0%	0.35	0%	NA	NA	NA
Rogbunka	0.04	0%	0%	**1.46**	**36%**	12	0%	0%
Rosanda	**0.25**	**80%**	**80%**	0.20	0%	12	0%	0%
Rotharon	0.02	0%	0%	0.29	0%	**92**	**20%**	**20%**
Taindokom	**0.06**	**57%**	**14%**	0.10	0%	**164**	**29%**	**29%**
Teko River	0.01	0%	0%	0.10	0%	NA	NA	NA
Tonkololo	**0.08**	**100%**	0%	**0.79**	**40%**	30	0%	0%

Appendix 2 . Feedback infographic


ROKEL RIVER MONITORING PROGRAMME
The Rokel River basin in Sierra Leone extends from the Loma Mountains to the Atlantic Ocean. The basin covers 10,00 km² with an overall river length of 240 km.
Mining, intensive agriculture (sugarcane plantations), and subsistence agriculture have impacts on the river basin.
24 Citizen Scientists from 24 villages have collected monthly measurements
106 citizen science water quality measurements in 6 months
AREAS WITH LOCAL AGRICULTURAL ACTIVITIES HAVE HIGHER NITRATE CONCENTRATIONS.
NITRATE INPUT FROM FERTILISERS APPEAR TO HAVE AN IMPACT ON RIVER QUALITY NEAR AGRICULTURAL LAND.
BASELINE PHOSPHATE CONCENTRATIONS FROM BEDROCK GEOLOGY MAY HAVE AN IMPACT ON THE ROKEL RIVER ECOLOGY.
TURBIDITY IS LIKELY TO BE LINKED TO RAINFALL-DRIVEN SEDIMENT FLOWS AND BY AGRICULTURAL RUNOFF.
13% of water measurements have high phosphate levels (>0.05 mg/l) which indicate poor water quality
6% of water measurements have high nitrate levels (>0.5 mg/l) which indicate poor water quality
POOR WATER QUALITY IS THREATENING BIODIVERSITY.
There are more than 35 bird species in the basin, with important wader species that spend the winter in the basin, making up 1% of their world population.
IMPACTS OF CLIMATE CHANGE
First results indicate that changes in the rainy season affect nutrient and sediment flows in the basin, showing that climate change may impact the Rokel River environment.
SUSTAINABLE DEVELOPMENT GOALS
Through a co-design process with NWRMA staff and local communities, this project gathers information on pressures to water quality. Data is useful for SDG indicator 6.3.2 reporting requirements, as it describes the proportion of bodies of water with good ambient water quality.
The National Water Resources Management Agency (NWRMA) has the mandate to manage and safeguard water resources at local, national and transboundary levels in Sierra Leone.
WANT TO HELP?
JOIN US
Visit freshwaterwatch.org to find out more about the work we do all over the world.