World Water Quality Alliance (WWQA) citizen science data integration for Sustainable Development Goal (SDG) 6.3.2: Lessons learned from a South African perspective

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Background

South Africa suffers from severe water quality issues, caused primarily by poor wastewater management and large scale agriculture. These issues affect South Africa's water security, a major problem considering that South Africa is a water scarce country facing ongoing water shortages and projected water supply shortfalls. Water quality issues also have particularly strong negative effects on the most vulnerable sectors of society (i.e., those from disadvantaged, marginalised, and disaffected backgrounds) who rely most heavily on surface water for daily use.

Consequently, it is becoming increasingly important to monitor the status of freshwater across South Africa to inform sensible and effective water resource management strategies. Conventional monitoring by the South African National Government is not adequate to monitor freshwater resources across the country at the spatial and temporal scales required to inform proper management (Figure 1). There is a need to turn to unconventional mechanisms to gather data to assist in monitoring. In South Africa, a Water Research Commission (WRC) project, led by the University of KwaZulu-Natal (UKZN) in collaboration with GroundTruth, termed the citizen science State of Rivers, is researching how to use citizen science for monitoring and reporting on water quality in rivers across the country. The research project aims to assist citizens in identifying river health issues, monitor changes in conditions of the river systems over time, and can allow and facilitate the communities to work together to manage their local water resources. As a result, it was chosen as a prime candidate for studying how to align international citizen science water quality efforts within the World Water Quality Alliance (WWQA) citizen science data integration for Sustainable Development Goal (SDG) 6.3.2 reporting project. To do so, Freshwater Watch kits were sent to South Africa to investigate the opportunities and challenges of integrating different methodologies of citizen science water quality monitoring data into an integrated database useful for national and global monitoring and reporting.

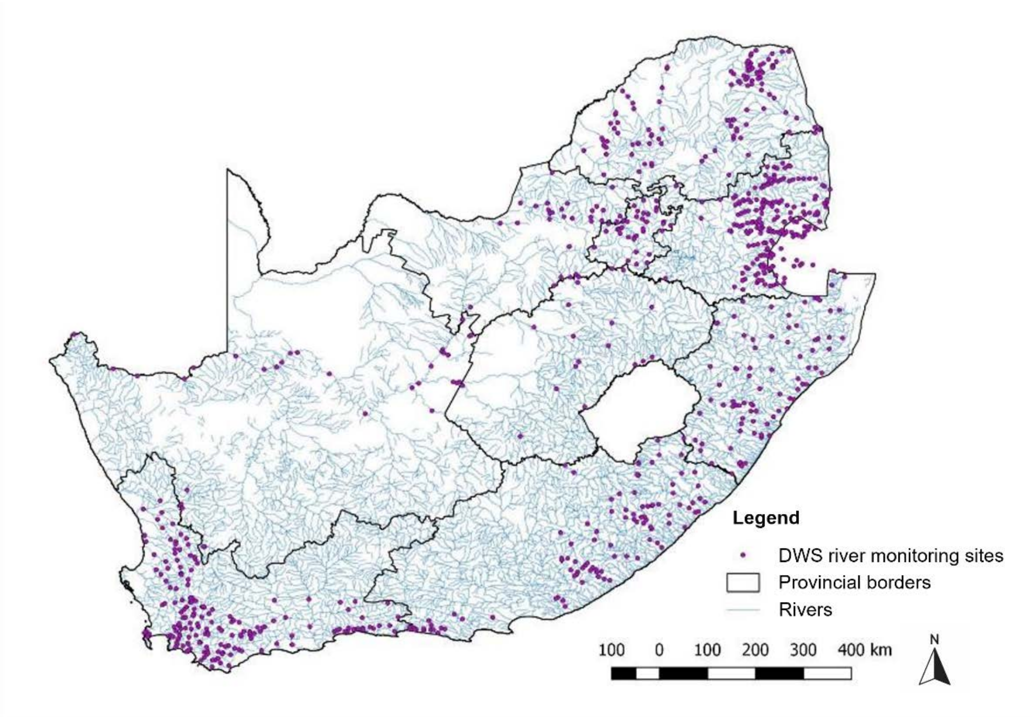

Figure 1. South African National River Ecological Status (Ecostatus) Monitoring Programme conventional river monitoring sites used to informs the National Government State of Rivers Report. The extent of rivers not monitored is clear - gaps which citizen science has the potential to fill.

Freshwater Watch Kit Training

On 16 July 2024, GroundTruth hosted a hybrid (online and in-person) training session on the use of the Freshwater Watch kits (Figure 2). A group of stakeholders who are involved in the citizen science State of Rivers research were selected for training. There were 42 training participants representing >25 organisations, teams, initiatives, or just individual citizen scientists.

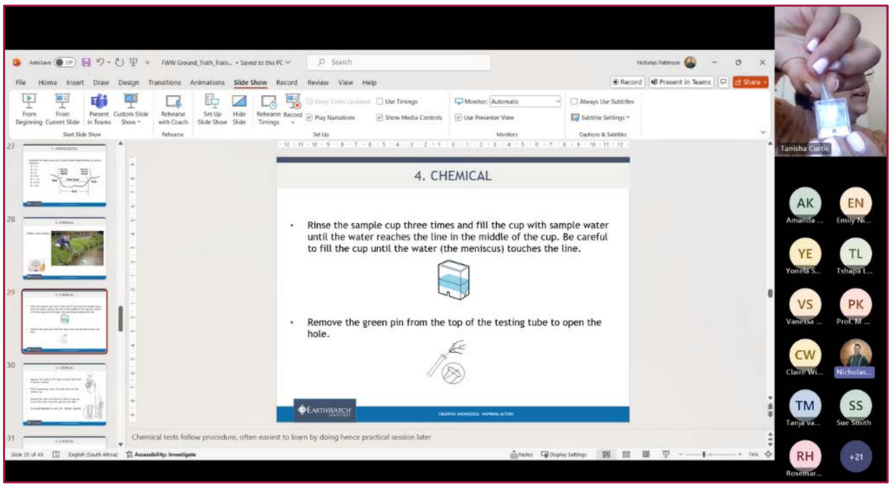

Figure 2. Screenshot from the online training platform, showing the Freshwater Watch training slide presentation, attendees, and Tanisha Curtis leading training in video.

Results & Discussion

Training Feedback:

- In-person and practical training is preferred over online training sessions. Participants expressed a preference to have in-field experience with the training.
- Participants expressed that seeing different results from the water tests would help understand how the test works. They suggested that water samples of differing quality (e.g. 3 samples with known differences in nitrate or phosphate concentrations) could be sampled during training to show the trainees the different results.
- Part of the training is a bit too technical and scientific for average citizens to fully grasp immediately, especially not having the training in-person for trainers to gauge the understanding of the concepts explained. Though the trainers encouraged participant follow up for any unclear concepts, going more slowly and allowing continuous engagement and questioning as anything was unclear would increase participant confidence.
- The majority of the feedback from participants indicated that these data would be helpful for national government as well as local communities.
- The educational training video[1] on how to engage with Freshwater Watch and carry out surveys was helpful. However, participants suggested that separate training and / or instructional videos on using the app would aid in downloading, installing, and using all the online resources.

Findings:

Between 16 July 2024 and 1 September 2024, 124 Freshwater Watch tests were conducted throughout South Africa and submitted on the portal[2] (Figure 3).

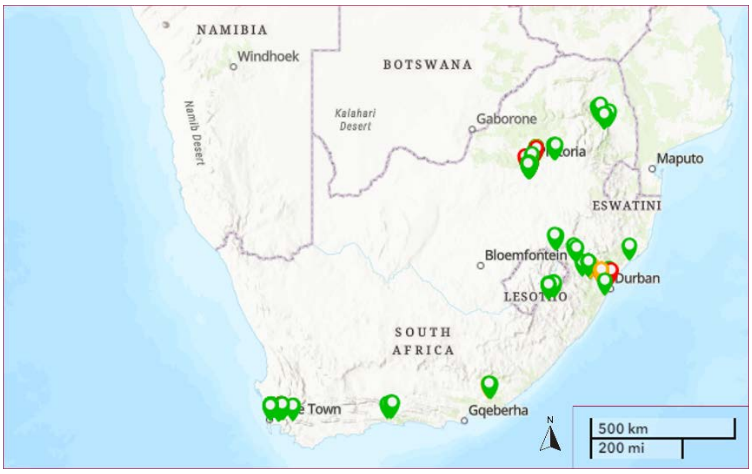

Figure 3. Map of South Africa on the Freshwater Watch online platform showing the Freshwater Watch kit survey data submissions (n = 124) across the country. Data were submitted via the ArcGIS Survey 123 application.

[1] https://earthwatch.org.uk/images/FWW/TrainingVideos/FreshWater-Watch-Training-Video-ENG.mp4
[2] https://www.freshwaterwatch.org/pages/0db6cdd7b4f347d1986fcbf35954810d

Data were collected across a range of land use types and varying types of streams, rivers, ponds, and impoundments. However, there did appear to be a preference for polluted / impacted areas, suggesting a potential bias in sample site selection. The nitrate and phosphate data indicated that a large portion of water bodies had low nutrient concentrations (<0.02 ml/L), though there were a significant portion (>50%) that showed detectable amounts, with >20% showing concentrations above 0.05mg/L indicating levels of concern (Figure 4).

Figure 4. Screenshots from the Freshwater Watch online platform showing pie charts for A) phosphate, and B) nitrate concentrations across all surveys in South Africa (n = 124).

Simultaneous monitoring: Opportunities for data integration

Over the same time period (i.e., July – September 2024) 69 mini stream assessment scoring system (miniSASS) observations (Figure 5) and >100 WaterCAN iLab testing kits water quality samples (Figure 6) were recorded. miniSASS is another citizen science tool, used for monitoring water quality and the health of streams and rivers through sampling and identifying aquatic macroinvertebrates[3], while WaterCAN iLab testing kits are citizen science kits for measuring

[3] https://hdl.handle.net/10568/134498

physical-chemical water quality[4], similar to the Freshwater Watch kits. Data from both these citizen science approaches were often collected by the same teams at the same time as the Freshwater Watch kit data. However, the data were captured using a different platform, either the miniSASS mobile application (app), miniSASS website[5], or WaterCAN digital tools[6]. Therefore, these data were not integrated into the Freshwater Watch database as part of this WWQA Data Integration project. This highlights that there remain challenges and considerable opportunities for enhanced data sharing across platforms to create a more comprehensive, integrated database of all credible citizen science data being collected.

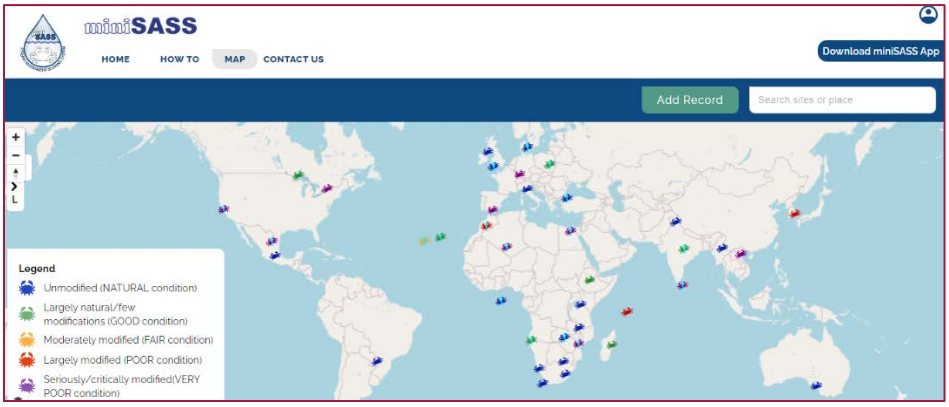

Figure 5. Screenshot of the mini stream assessment scoring system (miniSASS) website, showing the map of survey submission clusters. To date, there have been >2500 submissions, with 69 collected during the project period (i.e., 16 July – 1 September 2024).

Figure 6. Screenshot of the WaterCAN online platform, showing a map of South Africa with all the physical-chemical water test data submissions, along with other citizen science water monitoring data, indicated as different symbols.

[4] https://watercan.org.za/map/
[5] https://minisass.org/
[6] https://watercan.org.za/map-my-water-watercan-launches-new-digital-tool-for-water-champions/

Lessons Learnt:

- Based on training participant feedback, in-person and practical training is preferred over online training sessions. This is a limitation for scaling, given that in-person training of the number and geographic spread of people involved in the South African case study would not be possible. However, online training was successful enough that all the teams and individuals that attended were able to successfully capture good data. Follow up training sessions and support would increase data accuracy and confidence of participants.
- Citizen scientists in South Africa exhibit a wide range of digital literacy levels, as well as access to digital media and devices. Reaching rural communities and those who might benefit most from shared knowledge generation about their water resources can be excluded from online training or platforms that require digital devices for data capture. In the South African case study, several of the older participants experienced challenges with the complexity of the entire process, from attending online training, to downloading the app, registering across platforms, using the app to collect data, data submission, and eventually to viewing their data. This links to the participant feedback regarding video tutorials to take a new participant through everything step-by-step to help overcome and digital literacy barriers. However, trainers were available to provide support, which meant that all participants eventually engaged with data collection and successfully contributed to the research project.
- A major impact on the health of South African river systems is the discharge of wastewater effluent from wastewater treatment works which are not meeting operating standards, as well as wastewater not reaching wastewater treatment works because of failing sewage reticulation networks. Where there are extreme problems with sewage pollution, which is common in stream and river reaches located in and around most human settlements, the upper end of the measurable limit of the Freshwater Watch kits for nitrates and phosphates is below the real concentration. Participants wanting to see an estimate of actual nutrient concentrations are only able to see that the concentration is >1.0 mg/L. This indicates a severe nutrient loading issue, though participants learned that to get more accurate concentrations they would need to send water samples to laboratories for measurement. For citizen science groups not wanting to simply get concentration estimates of >1.0mg/L, sample design strategies should account for pollution sources and sample upstream or far enough downstream to get nutrient concentrations within the measurable scale.
- Participants were interested in using the ArcGIS Survey123 platform to view and analyse their results, especially those who have a professional background in water resources monitoring and are interested in learning more about the applications of citizen science in this space. Therefore, a note for citizen science monitoring and data integration is to ensure that data are not only findable, accessible, interoperable, and reusable (FAIR), but summarised and visualised in an intuitive way. This allows for the participants to visualise their data and see how it relates to other data being collected across the globe. Intuitive feedback and data accessibility are critical to participant engagement, especially return engagement, which is typically one of the most difficult challenges to citizen science initiatives.

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