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Citizen scientists monitor water quantity and quality in Kenya

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Key messages

- Low-cost, reliable methods for monitoring water levels and water quality are needed to assist water-resource managers in their decision-making.
- 'Citizen scientists' willing to take part in simple monitoring activities can expand the data sets in understudied regions.
- We worked with citizens in a remote Kenyan catchment who contributed valuable water level and water-quality data. Long-term motivation of participants, active recruiting of new volunteers, and an effective reward system will be key to sustainable citizen-resourced water-monitoring programmes.
- Data provided by 'citizen scientists' can be scientifically robust and cost-effective in supporting the monitoring needed to inform the development of water management strategies.

Background

Developing effective water-management strategies requires regular monitoring of both the quantity and quality of freshwater resources. In low-income countries, and especially in remote regions, the cost of scientific monitoring networks can be prohibitive.

Involving the general public in monitoring has the potential to reduce these costs. This project evaluated data generated by citizens in a remote Kenyan basin and assessed whether such 'crowdsourcing' is a suitable method to overcome data scarcity. For monitoring water quantity, water level gauges were installed along with signboards explaining the monitoring process to passers-by. Citizens carried out simple measurements, texted their results to a central data-collection number, and received immediate automated feedback. For water quality, participants were trained in simple techniques (such as test strips) to monitor levels of sediments and nitrate, texting data in the same way.

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Both scientific robustness of the data collected and potential for continued engagement of citizens were evaluated. Results indicated that crowdsourced data are robust (Weeser et al., 2018) and can be used for modelling and upscaling, which will be useful for any data-scarce environment, not just in Kenya. Assessments of citizens' involvement indicated that the initial engagement phase needs to be carefully designed, and financial incentives should be considered.

Citizens can provide valid, low-cost data on water level and quality

Fifteen of the United Nations' 17 Sustainable Development Goals (SDGs) relate directly or indirectly to water. In particular, SDG 6 focuses on ensuring the availability and sustainable management of water, indicators 6.3.2 and 6.4.2 requiring monitoring of water quality and availability of freshwater resources, respectively. SDG 13, on combatting climate change and its impacts, requires understanding of the adverse effects of climate change, including changes in water availability.

Working with the Water Resources Authority and the Water Resources Users Associations (WRUAs) of Kenya, a low-cost monitoring system involving the general public was implemented at the Sondu-Miriu river basin, a major forested area in Kenya.

To monitor water levels, citizens follow instructions at the monitoring point to take a reading of the water level and then text the value and site ID to a central phone number. Software developed by the project team verifies data plausibility and marks outlying data for further checking. A comparison between the crowdsourced water level data and data from automatic gauging stations established to study the role of land use on water supply (Jacobs et al., 2018) indicated that citizens can provide water level data of sufficient quality and with high temporal resolution (Weeser et al., 2018).

For water quality, levels of nitrate and turbidity were examined. To measure nitrate, citizens dip a test strip into a water sample and compare the colour of the strip to a reference chart. To measure turbidity, citizens fill a tube with water until the marking at the bottom cannot be seen, then read the scale on the tube. Researchers visit the citizen scientists each month for quality control and to answer any questions.

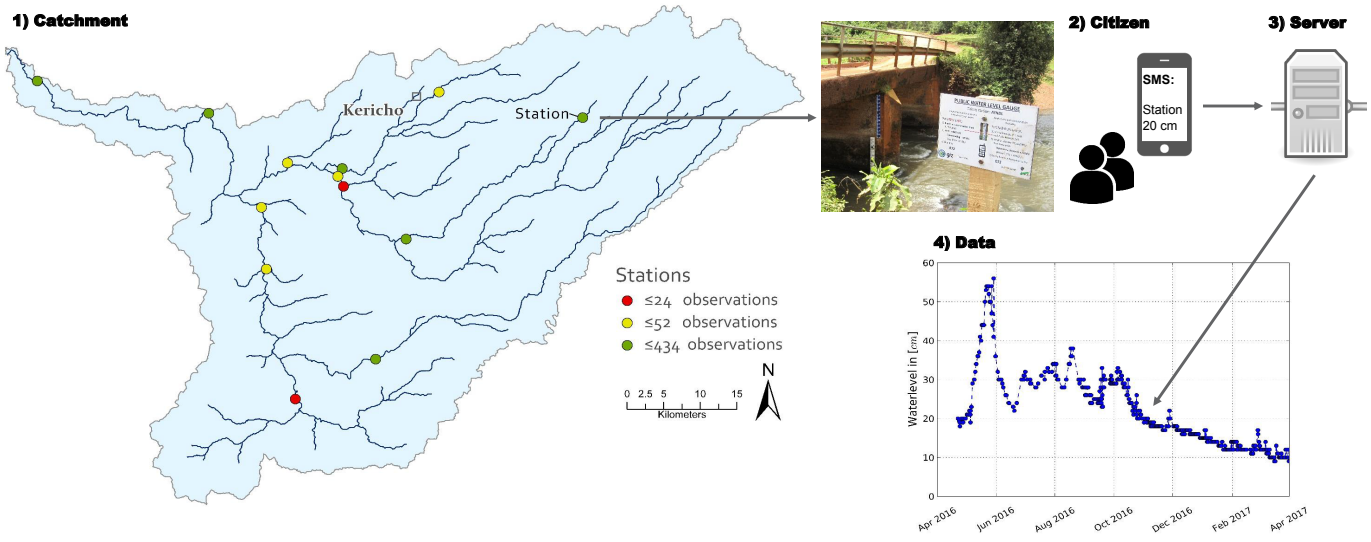
Results indicate that citizen-science data can contribute to hydrology modelling in remote catchments. Models are used to understand the impact of climate or land-use change on water provisioning, and to support the development of water management strategies. A model has been developed to represent the water flows in the basin, based on meteorological data, observed discharge and crowdsourced water level data. First results show that 10% of the crowdsourced data collected during high-flow conditions is sufficient to achieve high model efficiency – information that is valuable for upscaling. Close collaboration with local agencies to ensure use of the data, and modelling results will be crucial.

Citizen scientists were recruited and trained through the Water Resource User Associations, based on their interest and willingness to participate. Younger people (aged 20–31) were easier to mobilize initially, but hard to keep motivated. This group mentioned financial constraints and a strong demand for flexibility in relation to the unstable job market. The majority of highly committed volunteers were aged 31–50.

The major reason given for ceasing to participate was the lack of monetary support. A simple reimbursement system was trialled for participants at one station in the upper part of the basin: for every water level record transmitted, the transmission cost was paid back two-fold. The amount is automatically calculated by the server, and payments are transferred to the participant as phone credit at the end of each month. Other methods to motivate citizen scientists are being tested, together with the deployment of a communication strategy to increase awareness on the need to monitor water resources (CIFOR, 2018).

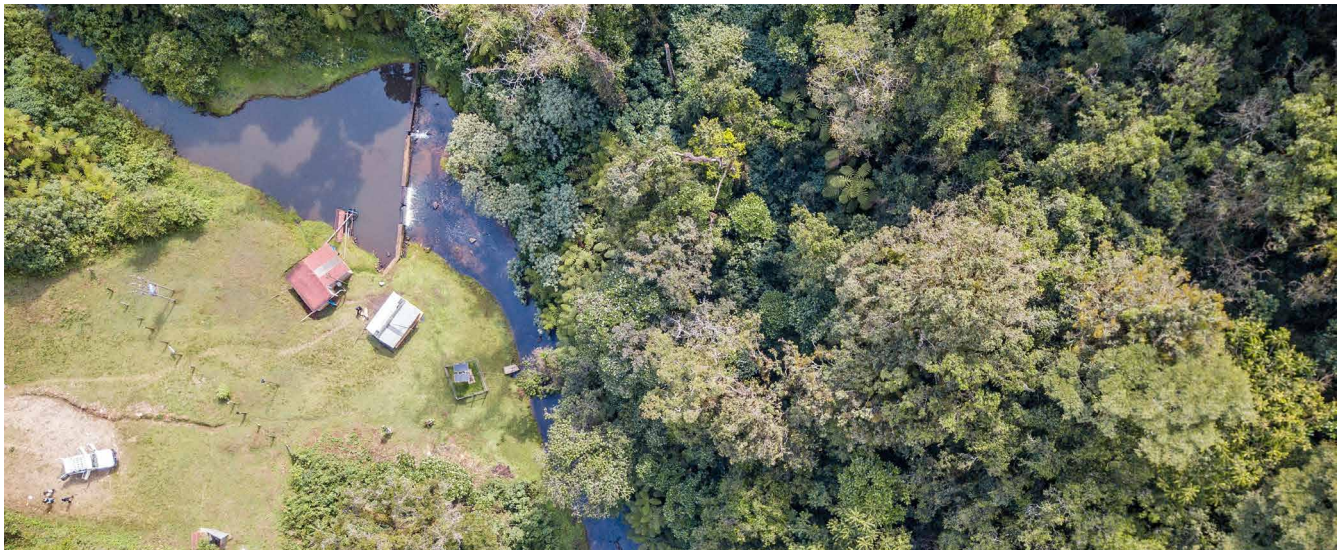
Participatory projects need to have a clear communication strategy to avoid misunderstandings about the goals. Many participants had a strong perception of the link between water and health and, in addition to involving water resource authorities, it would be helpful to collaborate with the Ministry of Public Health as an additional stakeholder.

Ongoing activities include citizens' collection of water quantity and quality data; modelling for upscaling; and testing of methods to sustain citizens' engagement. Long-term engagement of citizens remains a challenge, and more studies are needed on the role of citizen-science data in empowering communities to manage their precious water resources. This question is being investigated further under a larger Federal Ministry for Economic Cooperation and Development (BMZ) project: 'Water Towers of East Africa: Policies and practices for enhancing co-benefits from joint forest and water conservation'.

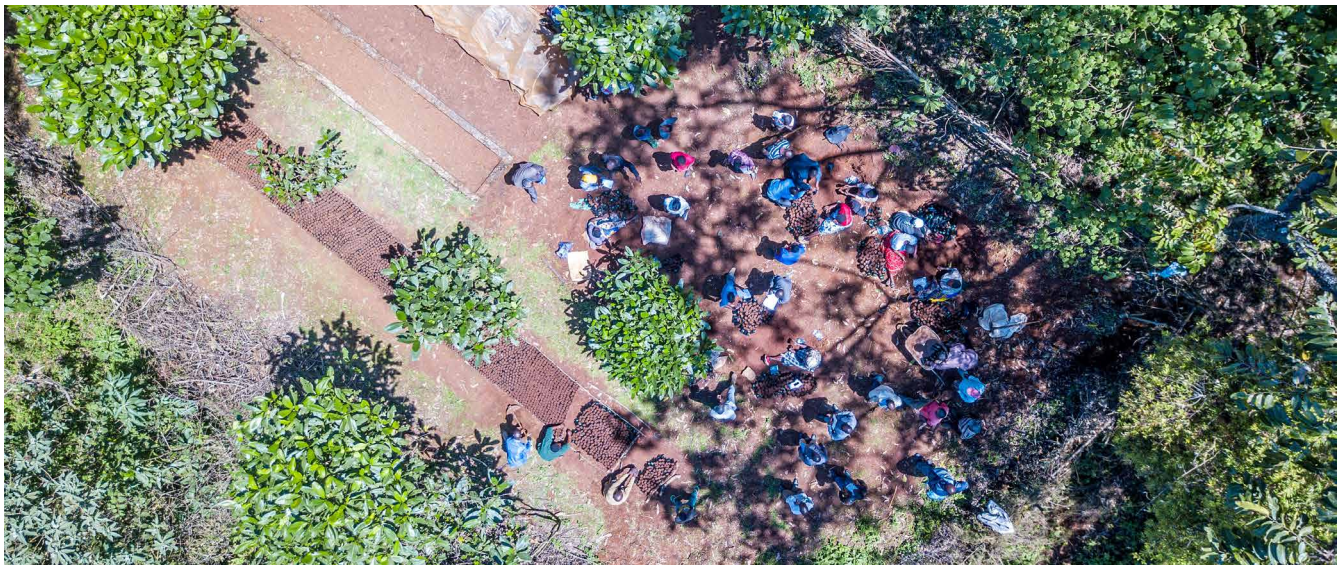


1) Map of the Sondu catchment showing the distribution of the water monitoring network, the amount of citizen-scientists observations; 2) Citizens send water-level observations using a text message; 3) A remote server processes the data; 4) A comparison of data collected by the citizen scientists, against water levels measured by an automated station.

Source: Weeser et al. 2018

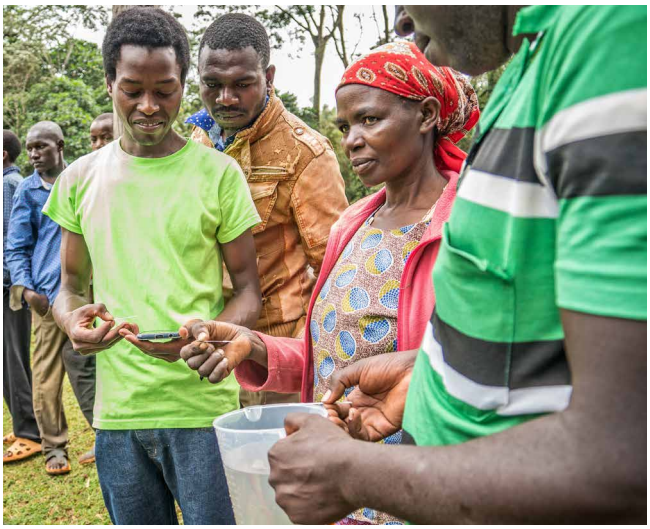


Aerial view of the Forest Water Monitoring Station, Southwest Mau Forest.



WRUA members working in their nursery.

Citizen Scientists gathering water samples, Sondu Basin.



Citizen Scientists gathering water monitoring data, Sondu Basin.

Photos by Patrick Shepherd/CIFOR

Recommendations

- Models for effective collaboration – that use crowdsourced data shared between Water Resource User Associations and the Water Resources Authority – are the next logical step for citizen-science applications for water monitoring in Kenya and elsewhere.
- Adequate training and getting the incentives right are two important success factors. Long-term motivation would be enhanced if citizens could use the information collected to design their own community-based water-management plans.
- The citizen-science approach developed to water monitoring is a substantial step towards understanding the impacts on land use on water resources. The data gathered through this project together with forest monitoring show the crucial role of forests on freshwater supply.
- This work continues under the 'Water Towers of East Africa' forest and water conservation co-benefits project, which will develop additional insights into involving citizens in environmental monitoring.

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References

CIFOR. 2018. The role of citizen science in monitoring water towers in Kenya: A technical overview. Elephant Song Media for the Center for International Forestry Research. https://youtu.be/jXIUI9dltig

Jacobs, S., B. Weeser, A. Guzha, M.C. Rufino, K. Butterbach-Bahl, D. Windhorst, L. Breuer. 2018. Using high-resolution data to assess land use impact on nitrate dynamics in East African tropical montane catchments. *Water Resources Research* 54(3): 1812–1830. https://doi.org/10.1002/2017WR021592

Weeser, B., J. Stenfert-Kroese, S. Jacobs, N. Njue, Z. Kemboi, A.M. Ran, M.C. Rufino, L. Breuer. 2018. Citizen science pioneers in Kenya – a crowdsourced approach for hydrological monitoring. *Science of The Total Environment* 631/632: 1590–1599. https://doi.org/10.1016/j.scitotenv.2018.03.130

WRMA, CIFOR, GIZ, Lancaster University, Justus Liebig University. 2017. Volunteer Water Monitoring Manual. Water Resources Management Authority, Kericho.

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