CITIZEN SCIENCE

Suite of tools help citizens take control of freshwater management

Citizen science tools developed under a Water Research Commission-funded project facilitate learning, increase knowledge and encourage co-management of water resources. Article by Sue Matthews.

Endangered Wildlife Trust Eco-ranger, Nduduzo Khoza, takes a reading with the water clarity tube during the Karkloof River Walk.

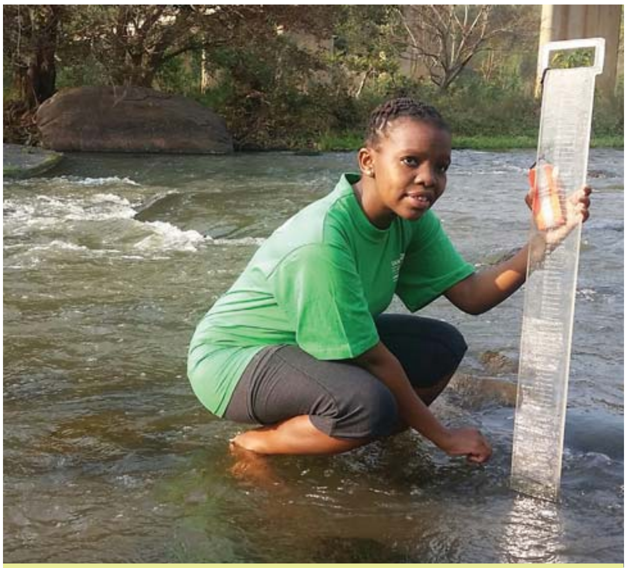
When members of the Karkloof Conservancy decided to host a river walk last year to assess the health of the Karkloof River, they were confident that they had simple but reliable tools at their disposal to accomplish the task. As part of a WRC-funded project conducted by GroundTruth and the Wildlife and Environment Society of South Africa (WESSA), a variety of water-resource monitoring tools had been developed for use by so-called 'citizen scientists'. These allow anyone with an interest in the management of water in their surroundings to improve their understanding of water-related issues and problems, which helps empower them to respond to such challenges.

The core team that set off on 26 March 2017 for the Karkloof Catchment to Confluence River Walk was made up of staff from the Karkloof Conservancy, WWF-SA, Endangered Wildlife Trust and GroundTruth, but during the six days it took to cover the 64 km from the river's upper reaches to its confluence with the uMngeni River, representatives of various landowners in the area – including SAPPI, tourist resorts and farming operations – joined them for part of the walk. More than 35 river sites were assessed along the way, using three of the citizen science tools developed or refined within the WRC project.

The miniSASS tool

The mini Stream Assessment Scoring System (miniSASS) is a citizen science version of the SASS5 biomonitoring method that is used by aquatic scientists and environmental practitioners to assess river health. While SASS5 requires the identification of

The 'river walkers used the citizen science tools to assess the health of the Karkloof River in the KwaZulu-Natal Midlands.



The velocity plank can be used to determine flow velocity of a stream, as well as depth and discharge.

over 90 families of macroinvertebrates, miniSASS involves only 13 broad groups, such as worms, crabs, snails, dragonflies, and bugs and beetles. Depending on which groups are found, a total score is calculated for the Present Ecological State of the river site, equating to a health category ranging from 'natural' to 'very poor'. Results can be uploaded to a Google Earth layer via the miniSASS website (www.minisass.org) or an Android app, with the health status of sampled sites depicted as different coloured crab icons.

The Riparian Health Audit tool

The RHA tool enables citizen scientists to assess the habitat integrity of a river by evaluating the condition of a section of the river margins, known as a riparian reach. It considers eight different types of impact – exotic plants, rubbish dumping, bank erosion, inundation, flow modifications, physico-chemical modifications, vegetation removal and channel modifications. These are rated according to six levels of impact, after which a mathematical model is used to calculate the ecological health of the riparian reach, ranging from 'natural' to 'critical' condition.

The water clarity tube

The clarity tube is a metre-long clear tube that gets filled with sample water to obtain a measure of suspended solids. Although suspended solids include soil particles, planktonic organisms and organic matter that occur naturally in the water column, pollution and other impacts of human activity – such as those mentioned in the previous bullet – can increase their concentration significantly. This not only degrades water quality, but also disrupts biological communities by reducing light penetration, smothering plants and bottom-dwelling animals, and clogging the gills of fish and invertebrates. While the clarity tube is not a South African invention, some design improvements were made to the locally made units during the WRC project, and calibration tests were conducted to determine the relationship between water clarity and alternative indicators of suspended solids, namely turbidity and total suspended solids, which require more sophisticated and expensive equipment.

The Karkloof river walkers had the added benefit of access to a water quality monitoring instrument, so they were able to measure pH, dissolved oxygen, electrical conductivity and temperature at each site. They also collected water samples for laboratory-based analyses of nitrates, phosphates and *E. coli* bacteria. This additional data helped interpret the findings from the citizen science tools, and all results were written up in a comprehensive report by GroundTruth. The results indicated that the river was in a fair to good condition, with minor impacts distributed over wide reaches and more intense impacts being very limited in extent. Invasive alien plants – particularly bramble, black wattle and bugweed – and diminished water quality due to nutrient enrichment and *E. coli* contamination were the main impacts.

In a separate project, GroundTruth was also involved in a year-long flow-monitoring study of the Karkloof River to inform irrigation management. Weekly field work was conducted using a traditional flow meter, but farmers were also shown how to use a velocity plank so that they could monitor river flow on their own. This was another of the citizen science tools tested during the WRC-funded research project.

The velocity plank

The velocity plank is a locally made version of the Transparent Velocity Head Rod (TVHR), which originated in the USA. It is a transparent plastic board with a measuring ruler that is used to determine flow velocity of a stream. By standing the board vertically on the streambed, the depth of the water can be measured, as well as the water level on the upstream and downstream side of the plank. The difference between these two water levels is used to predict flow velocity. Multiple measurements taken across the width of the stream can be used to calculate depth-averaged flow velocity (metres per second) of the stream, as well as its discharge (discharge = velocity x depth x width). During the WRC project, a calibration study was done to produce conversion tables that are included in the manual for this tool.

The citizen science 'toolbox' developed within the WRC project also includes a number of other tools.

The wetland assessment tool

This tool describes a method for assessing the ecological condition of a wetland based on land-cover type. It uses the same approach as the vegetation component of WET-Health Level 1 – a desktop assessment method used by wetland scientists – with impact scores assigned to various types of disturbance. The tool comprises a technical document outlining the scientific basis of the method, and a user guide that directs users to select either a simple tool to map the impacts on the wetland, or a more detailed tool that ranks impacts according to their severity and effect on wetland functioning. Based on the input from the ranking system, a present ecological status is automatically calculated using the provided Excel workbook.

The estuary tool

Estuaries are complex and dynamic systems that require some degree of understanding before appropriate monitoring parameters can be identified for a specific estuary. The WRC project therefore focused on developing an educational resource for a one-day visit to an estuary by school groups and other potential citizen scientists. The theoretical component of the resource is a written guide highlighting the key characteristics of estuaries, such as tides, salinity, river flow and estuary mouth dynamics, as well typical ecological features. The practical component includes activities such as measuring salinity and temperature, observing tidal patterns and mouth dynamics, and monitoring water flows. Data collection sheets are provided for these monitoring activities.

The spring tool

The spring tool begins with background information on springs, which are not only important for rural water supply in many areas, but may also have cultural, religious or tourism significance. A health index then leads the citizen scientists through a number of steps, from determining the location and type of spring to investigating the surrounding land use and geomorphology of the area. Next, the citizen scientists rate the intensity of 10 different kinds of impact on the spring, including livestock grazing, pollution, vegetation removal, soil erosion and groundwater withdrawal. Finally, a datasheet is completed that allows the citizen scientists to calculate the Ecological Condition of the spring as the percentage of change that has occurred compared to its natural (original) condition.

Weather monitoring tools

A variety of simple weather monitoring tools were tested during the WRC project, and calibrated against scientific instrumentation and a Davis home weather station. These include a rain gauge constructed from a two-litre Coca-Cola bottle, and a wind pressure plate made from plastic corrugated board and PVC electrical piping to measure wind speed and direction. Manuals for these tools have been developed, and information made available on why weather data is important to citizen scientists.

School lesson plans

School lesson plans and other resources in support of citizen science activities were developed or updated to comply with the Curriculum and Assessment Policy Statement (CAPS). These will enable teachers to plan, produce and conduct effective fieldwork experiences focused on rivers, wetlands and catchments. Specific lesson plans are provided for the Intermediate Phase (Grade 4-6), Senior Phase (Grade 7-9) and Further Education and Training (FET) Phase (Grade 10).

Uptake of the tools has been promising, thanks to a concerted effort made by the project team and others to publicise them through seminars, training days and events

Councillors and traditional leaders use miniSASS during the fieldwork component of the leadership seminars offered by WESSA in partnership with the Department of Cooperative Governance and Traditional Affairs.

Enviro Picture Building game
The WESSA Share-Net Enviro Picture Building game portrays environmental issues as pictures on cards, with supporting information on the reverse side. It encourages participants to visualise and interpret the impacts that various land-use types and human activities have on water resources. In this way it helps participants understand a more holistic and connected view of the environment in which they are studying.

The WRC project entailed not only developing, refining and testing these tools – all of which are available from GroundTruth or via the miniSASS website – but also researching their potential to effect meaningful change in water resource management. Dr Jim Taylor of WESSA headed this part of the project, but a number of postgraduate students and interns were involved in various aspects.

During this research, an adaptation of an open process framework was used to engage community groups in fieldwork activities and provide training on the citizen science tools. The 5T Model allows a matter of concern, or 'nexus', to be identified by the group as the main focus or issue to be addressed, after which the 5T's can be done in no particular order. These are 'Tuning in' (careful and collaborative planning), 'Talk' (dialogue), 'Touch' (real-life encounters such as fieldwork), 'Think' (reflection) and 'Take action'. The model will assist citizen scientists in working to resolve a water-related challenge they face or to learn more about an issue that interests them.

The project team also explored and identified the enabling factors that resulted in citizen science tools being readily understood, accepted or adopted, as well as the limiting or inhibiting factors that discouraged or prevented their use. These 'successes' and 'barriers' were grouped into social, technical, financial or geographic factors, but with appropriate training and support most of the barriers could be overcome, and even transformed into successes. The WRC project report provides examples of ways to achieve this.

Using a number of case studies, the project team demonstrated that the action-oriented learning that took place through use of the citizen science tools was more likely than passive awareness-raising to encourage local action by civil society, with positive outcomes for both social change and water resource management.

Uptake of the tools has been promising, thanks to a concerted effort made by the project team and others to publicise them through seminars, training days and events associated with National Water Week and Nelson Mandela Day. Presentations and workshops at national and international conferences have also helped spread the word, with the result that the tools are increasingly being used in neighbouring countries and further afield.

The miniSASS tool is especially popular, and has already been translated into isiZulu, Afrikaans, Swahili and French. It is being promoted by the Global Action Plan's Water Explorer programme – operating in 11 European countries and South Africa – that encourages students aged 8 to 14 to take action on water issues. Targeting an older group, Dr Taylor led a miniSASS workshop in June 2018 at the Empowerment for Climate Leadership programme held in Arusha, Tanzania, where 24 young climate activists from India, Tanzania and Germany came together to explore ways of implementing the Sustainable Development Goals and Agenda 2030. Subsequently, he hosted a telepresence video-conferencing session on citizen science while in Delhi in July, with participants from other parts of India, Singapore and Australia.

"Invertebrates were in existence before the dinosaurs, and long before Gondwanaland split up, so the same broad groups can be found on other continents," he points out. "The 13 taxa used in miniSASS therefore allow for easy identification and understanding of river health, irrespective of where you are in the world."

- The report, Development of citizen science water resource monitoring tools and Communities of Practise for South Africa, Africa and the world (**WRC Project No. K5/2350**) will be available later this year.
- A video on the Karkloof River Walk, as well as a daily blog and the results report by GroundTruth, can be accessed at https://karkloofconservation.org.za/karkloof-river-walk/
- Read more about miniSASS and other citizen science initiatives in the May/June 2014 issue of *The Water Wheel*.


Sue Matthews

Learners identify aquatic invertebrates using the miniSASS tool.