

MARK GRAHAM

From algae to action: A career transforming water monitoring



History, someone once remarked, does not repeat itself, but it rhymes. GroundTruth founder Mark Graham's career has a certain circular quality too, with its recurring focus on nutrients in the water. He talks about water monitoring tools, citizen science and his consultancy's work with the Water Research Commission (WRC).

Matthew Hattingh reports.

On a bright autumn morning, we spot three AmanziChamps walking up Mandela Drive, Mpophomeni, not far from the wastewater works. Charlene Russell, wetland ecologist and educator with environmental and engineering consultancy GroundTruth, pulls over. We climb from her car, and Russell whistles. Seeing us, the men approach.

Nhlanhla Buthelezi wears a blue uMngeni-uThukela Water shirt and racy gold Aviator-style sunglasses. Colleagues Sphamandla Ncengwa, and Luthabo Xulu, also in the utility's livery, tramp about in gumboots. After greetings, the men tell us they've been collecting samples at Site 3, a wetland on the lower reaches of the Mthinzima stream. Running through Mpophomeni, a fast-growing township in KwaZulu-Natal's Midlands, it feeds Midmar Dam.

Ncengwa is carrying a velocity plank, a see-through yardstick. Put into a stream, broadside to the current, the difference in the water level at the stick, upstream versus downstream, shows water speed. Xulu has a water clarity tube. There's a disc inside the clear plastic tube: you draw it away from yourself. Moving the disc farther away, depending on how murky your sample is, you will cease to see it at some point. The tools are calibrated to give standardised measures of water at a given sampling point.

Xulu also has some tubes he's filled at Site 3; he says these must be kept warm in his pocket for 16 hours. Thanks to a chemical reagent, they change colour if they contain coliforms or *E. coli*. The quicker they change colour, the more *E. coli* there is. A chart tells the user at a glance the level of *E. coli* in the sample, revealing how much sewage was in the watercourse.

Test tubes, clarity tubes and velocity planks. These low-tech, accurate tools let the Champs monitor water quality in and around Mpophomeni. Data captured on a dedicated app is later mapped and analysed.

There's much at stake.



Founder of GroundTruth and co-developer of the internationally acclaimed miniSASS river monitoring tool, Dr Mark Graham is an aquatic ecologist with 30-plus years' experience in terrestrial and aquatic ecosystem functioning and management.

Mpophomeni, east of Howick, across the N3, is home to about 27 000 people. It's served by a R474-million wastewater treatment plant (opened in July 2025), but plenty of the township's sewage doesn't get to the plant, flowing instead out of manholes and elsewhere and finding its way into Midmar Dam, under a kilometre away. It's one of the dams on the uMngeni River supplying water to four million people in greater Durban and Pietermaritzburg.

Twelve Champs are employed by uMngeni-uThukela, part of an initiative established in 2011 by GroundTruth, civil society's Duzi-uMngeni Conservation Trust (DUCT) and the Wildlife and Environment Society of South Africa. Residents of Mpophomeni volunteered to do something about their township and its polluted waters and were initially known as EnviroChamps.

The Champs report blocked or broken sewers, helping reduce the number of overflowing manholes from 700 to about 40 over six years. They also report freshwater leaks and illegal dumping, and help with surveys and community awareness campaigns that educate residents about what not to throw down toilets and drains.

The Champs learned to use a citizen science version of the SA Scoring System (SASS) to assess rivers' environmental health using biomonitoring. Mark Graham, Chris Dickens, and Jim Taylor pioneered this simplified version, called miniSASS.

It averages sensitivity scores assigned to aquatic macroinvertebrates (think dragonflies, mayflies, beetles, crabs and snails), collected during a rapid five-minute sample of a river or stream's habitats. These organisms are identified using a simple field guide and grouped into 13 classes, each with a sensitivity score. Pollution-sensitive taxa such as stoneflies and caddisflies score highest, while true flies, leeches and worms score lowest. Averages above seven indicate near-natural conditions; those below five reflect poor water quality.

MiniSASS is a game-changer, says Graham, aquatic scientist and founding director of GroundTruth.

At GroundTruth's historic Hilton offices, Graham explains how miniSASS was developed in Mpophomeni and how it spurred a whole movement of water citizen scientists, in South Africa and abroad, giving the public a tool to produce credible results to hold local authorities and utilities to account.

Returning to KwaZulu-Natal around 1992 from abroad, he found work with uMngeni-uThukela Water (or uMngeni as it was then known), assisting with a WRC research project. Working on his MSc, he investigated algae proliferation in dams on the uMngeni system caused by eutrophication, or too many nutrients in the water resulting from sewage in the system.

This green water looks, tastes and smells bad. Worse, the algae can excrete "pretty nasty toxins", some linked to liver cancer. "So you have to filter and clean that stuff out before you can sell your water to your customers," he explains.

Algae was entering the pipeline between Nagle Dam and the Durban Heights Water Treatment Works. Turbulence and pressure changes caused the algae to rupture, making it "much more difficult to extract and clean". Graham was fascinated, trying to simulate what was happening with the Nagle water, and understand the algal rupturing process. The utility wanted to avoid similar problems between Inanda Dam (then being built), and the new Wiggins water treatment works.

Another WRC-funded project modelled the relationship between water quality and algal communities in very different dams in the uMngeni system. Researchers wanted to predict when algal levels in particular dams might become problematic, producing nasty compounds, to better plan treatment across the system.

Graham's next WRC project (the basis of his PhD), looked at algal dynamics and water quality and water treatment costs. At uMngeni Water until 2004, Graham did research, some under the WRC banner, and plenty of routine monitoring – water testing and analysis. He also developed biological monitoring and testing techniques based on algae counting and measuring, and very precise toxicity testing that measured the effects of pollutants that would be hard to analyse chemically.

Graham explains his interest in SASS biomonitoring: "The problem is...a biological organism [is] much more variable. How do you convert biological monitoring into a much more rigorous, robust technique that's repeatable?"

Along with some colleagues he found ways to apply the rigour essential to lab work to SASS methodology, producing the SASS version 5 technique and securing its International Standards Organisation accreditation. SASS5 offers several

advantages: Conventional lab analysis of chemical determinants in grab-sampled water provides a snapshot of water quality, at a particular place and point in time. But it tells you little about upstream or downstream water and might miss episodic pollution events. "So if you're an industry in town here," Graham explains, referring to nearby Pietermaritzburg, "You see the guys coming on Tuesday to sample. Then if you were a dodgy character, you would open the taps on Tuesday night, after they've gone and let all your nasty industrial pollution out."

By contrast, SASS testing is like a video, he says, producing "an historical picture of the quality in the preceding couple of weeks".

Macroinvertebrates can't leave the water when it's polluted. Their absence or presence makes SASS an effective indicator of typical water quality and reveals persistent and intermittent pollution, helping locate where water quality suddenly turns bad.

MiniSASS was spurred by a request from a colleague in uMngeni-uThukela's environmental education and outreach arm who wanted to make [SASS] more accessible and community focused. Graham and his co-developers distilled SASS. Drawing on a "huge data set", they optimised the weights attached to different data classes. This collaboration between uMngeni-uThukela's scientists and educators, and the Wildlife and Environment Society of South Africa produced an adapted, mini version, with results "pretty close" to a full SASS.

Graham says miniSASS prompted a water citizen science movement nationally, helping the public collect samples and investigate conditions in rivers, wetlands and other water bodies around them.

In 2004, Graham founded GroundTruth (above the garage at home, and financed from his home loan access bond). With his team – which eventually grew to about 50 water professionals and engineers – he continued developing miniSASS and other citizen tools. These have gained traction and interest in South Africa and abroad, with the United Nations recognising miniSASS as a valuable tool for monitoring its sustainable development goals.

In 2013, the WRC presented GroundTruth with a Community

Empowerment award for its miniSASS work. Subsequently, the WRC supported the consultancy to develop 10 citizen science tools and present the findings in book form. These included miniSASS and a website (<https://minisass.org/>) where the public can upload and share findings; water clarity tubes; velocity planks; and an adapted wetland health tool – miniWET-Health. These allow the public to produce data that suspected polluters, or officials, will struggle to fob off.

The clarity tube, for example, gives a calibrated, non-subjective measure of suspended solids, used to monitor outflows from sewage treatment works and monitor standards. It's much easier for the public to use than chemistry-based single-use tests.

In the early 2000s, DUCT and residents of Shiyabazali informal settlement above Howick Falls used citizen science to challenge declining quality from uMngeni-uThukela Water's Howick wastewater treatment plant. EnviroChamp and resident Zongile Ngubane took daily clarity-tube tests, but officials were sceptical. But when Graham, also a director of DUCT, confirmed the rigour of the tool, a dramatic recovery followed.

Graham says the 2026 Green Drop Report and a GroundTruth paper show wastewater treatment works and systems in catchments countrywide failing. "Water that goes into the rivers is poorly treated, if at all... and lands up in a dam and you've got eutrophication, you must clean this eutrophic algal-rich water," says Graham.

uMngeni-uThukela has a "significant problem with massive algal infestations" and is under pressure over water quality, while "treatment costs have rocketed", he says, costing millions of rands a month. Graham adds that neglected wastewater systems are malfunctioning, with municipal officials not directing sufficient resources at pressing priorities, including maintenance.

Graham feels his work gives the public greater agency to affect change. "You're knocking on the door at the right place to say, 'We see there's a problem. Here's our data, and we can see what it's doing to the system.'" It also addresses the lack of inspectors often given as an excuse for official inaction. "Now you've got the... population doing that, or every school kid in Grade 12 doing a project on this. Suddenly the leverage effect is enormous."



Graham demonstrating the velocity plank at the WaterNet conference in Lesotho 2024.



The AmanziChamps and GroundTruth team after a briefing on the new WRC project under way in Mpophomeni.

Citizen science has a democratising effect. GroundTruth has taught everyone from children to Pam Tshwete, the former Water and Sanitation deputy minister, how to use miniSASS. It helps people connect their actions to their consequences. “Whatever might be happening with that sewer, or that litter. Where is it going? What’s it doing? How is it impacting?”

After meeting the Champs, Russell and I visited sampling Site 3, where the Mthinzima enters a wetland immediately below the R617, the Underberg road, before trickling into Midmar. Years ago, someone, a farmer perhaps, cut a channel to drain the wetland, directing water straight into the dam. Around 2016, GroundTruth’s engineers designed berms and weirs to divert the water to seep slowly through the landscape. The rehabilitation was a success, but the wetland still receives a high nutrient load, notes Russell.

With this in mind, a fresh WRC-GroundTruth project aims to establish a framework for a water quality credit market at a municipal level, by incentivising practices to improve water quality at a household level. “Polluter pays” systems typically involve agriculture and industrial polluters buying credits (for pollutants like nitrogen and phosphates) from farmers already reducing their own nutrient runoff.

Russell explains that learning labs would get Mpophomeni residents to co-create water quality improvement practices – perhaps installing greywater filtering systems at their homes or collecting plastic for recycling. How it would all work, the nature of the credit system, and the size of incentives were still to be co-developed. A pilot of the system is scheduled for next year.

The Champs have been helping with a baseline study to understand residents’ circumstances and confirm locations of pollution hotspots where the project will be focused.

Ultimately, the aim is helping uMngeni-uThukela, and us, the greater public, to protect our investments – the new Mpophomeni wastewater plant, the restored wetland, and the dam below – a major tourism and water supply asset.

Russell notes that the dam is OK for now, but “It’s about preventing Midmar reaching that [tipping] point.”



To read more on Mark Graham’s research, visit: <https://orcid.org/0000-0001-9655-2296>



Zongile Ngubane filling up a clarity tube with discharge water from the Howick wastewater treatment site in Shiyabazali.