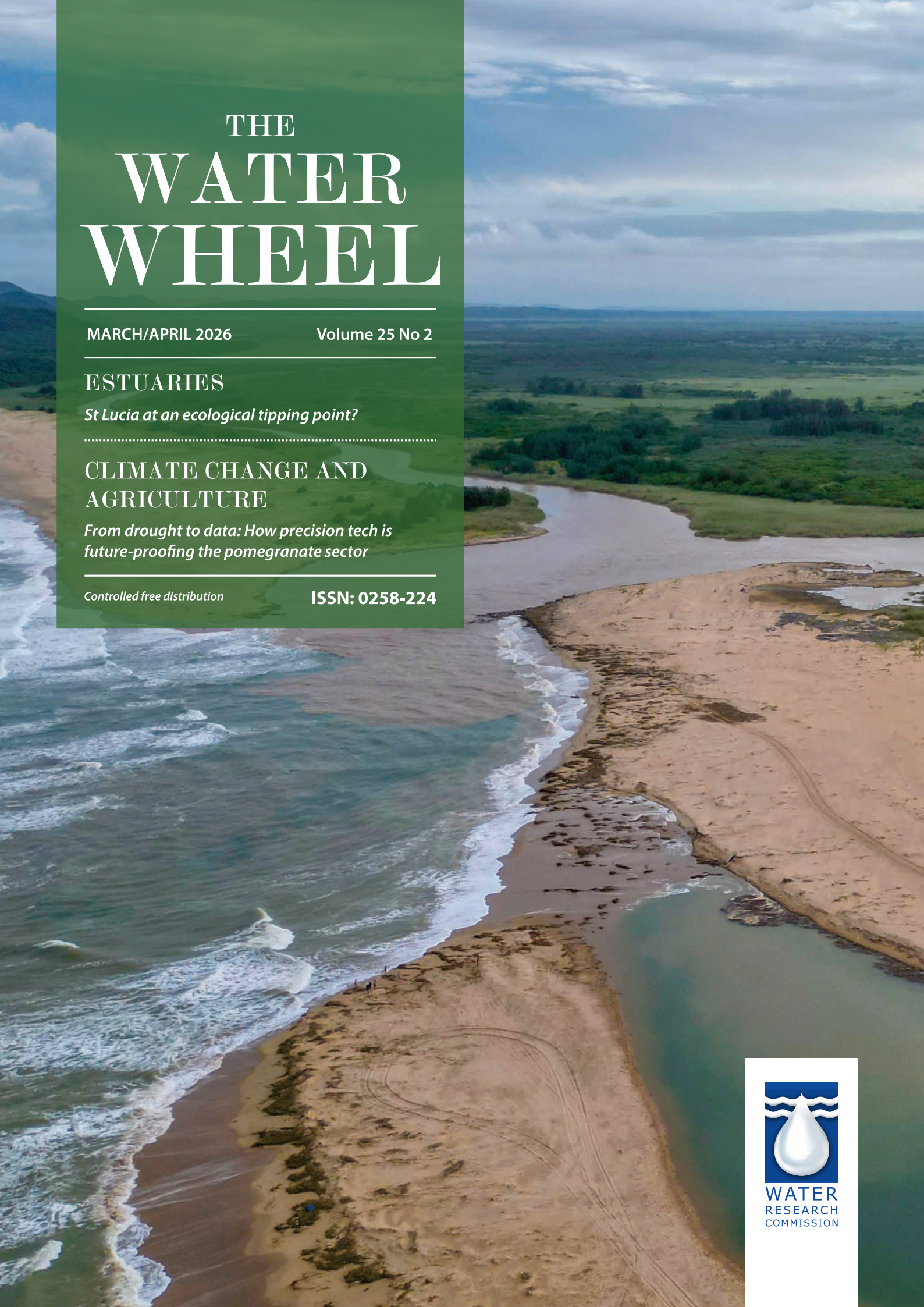

THE WATER WHEEL

MARCH/APRIL 2026 Volume 25 No 2

ESTUARIES

St Lucia at an ecological tipping point?

CLIMATE CHANGE AND AGRICULTURE

From drought to data: How precision tech is future-proofing the pomegranate sector

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WATER RESEARCH COMMISSION

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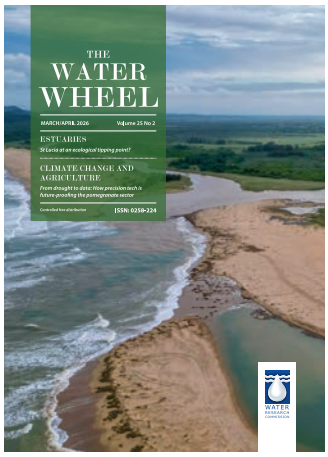

According to researchers, there are signs that St Lucia is close to a major ecological turning point. If this change happens, it will no longer function as an estuarine lake system. See article on page 12.

NEWS

WRC staff member honoured with international award

WRC senior research manager, Jay Bhagwan, was one of three water sector professionals honoured with an International Water Association Water and Development Award during a ceremony in Bangkok, Thailand, in December.

The awards recognise excellence, leadership and innovation in the water sector, with a particular focus on encouraging contributions to the sustainable management of water in low- and middle-income countries.

Bhagwan was recognised for his leadership in advancing non-sewered sanitation (NSS) innovation through the Water Research Commission's South African Sanitation Technology Enterprise Programme (SASTEP). Under his direction, SASTEP has transformed the national sanitation landscape by localising, commercialising, and scaling safe, sustainable, and climate-resilient off-grid systems.

The programme has provided dignified sanitation for over 46 000 users, influenced national regulations to include ISO 30500 standards, and built a thriving innovation ecosystem supporting local enterprises and jobs. Bhagwan's work has been instrumental in positioning South Africa as a global leader in NSS, shaping international standards, and inspiring replication across Africa and beyond.

UFS study detects hormone-disrupting chemicals in SA menstrual products

The National Consumer Commission has instituted an investigation into nine menstrual product manufacturers after a study by the University of the Free State (UFS) revealed the presence of hormone-disrupting chemicals in menstrual products sold in South Africa.

Published in the journal, ***Science of the Total Environment***, the study found that every sanitary pad and pantyliner tested contained at least two endocrine-disrupting chemicals (EDCs), raising concern about consumer safety, transparency, and long-term exposure.

The research was conducted by a UFS team that included Janine Blignaut (PhD candidate), Dr Gabre Kemp from the Department of Microbiology and Biochemistry, Prof Elizabeth Erasmus, Prof Deon Visser and Prof Marietjie Schutte-Smith from the Department of Chemistry.

The UFS research team analysed 16 brands of sanitary pads and eight types of pantyliners in South African retail stores. The study focused on three groups of EDCs, namely phthalates, bisphenols, and parabens. The findings showed widespread contamination across all products tested. Every single pad and liner contained at least two of the target chemicals. The researchers note that these substances are not always added intentionally, but may migrate into products from plastics, adhesives and manufacturing processes.

Although the levels detected in a single product may appear small, the researchers emphasise that the concern lies in repeated exposure over time. Menstrual products come into contact with mucosal tissue, which absorbs chemicals more quickly and directly than normal skin. Most women use these products for several days each month over decades. This repeated contact may contribute to cumulative exposure, which has been linked to hormonal imbalances, fertility problems, endometriosis and even certain types of cancer.

Prof Visser advises consumers to look for products certified under the OEKO-TEX Standard 100 or to consider reusable alternatives. The researchers say the findings underscore the need for clearer labelling, stronger chemical standards and continued monitoring of everyday menstrual products. "This study serves as a wake-up call that current regulations and 'clean' labels in South Africa may not be providing the protection consumers expect," noted Prof Visser. "

To view the original study, visit: https://www.sciencedirect.com/science/article/pii/S0048969726001701

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Eastern Cape launches irrigation schemes revival programme

Eastern Cape Agriculture MEC, Nonceba Kontsiwe, has launched a R19.5 million provincial irrigation schemes revival programme aimed at strengthening food security and driving agricultural economic growth.

The programme will support vegetable, grain and fodder production, as well as the provision of equipment and machinery, covering a total of 1 528 hectares of land across the province. In its efforts to curb food insecurity, the MEC said the department has prioritised the revitalisation of irrigation schemes during the seventh term of government to position agriculture as a key economic growth frontier.

She said the revival programme is set to improve agricultural productivity, enhance food security, provide reliable income for landowners participating in irrigation schemes, stimulate local economies and boost livelihoods in rural communities. "This revitalisation programme will ensure food security, strengthen farmer support and strengthen partnerships between government, private sector and communities," Kontsiwe said.

Of the total investment, the Amathole District will develop 613 hectares for R5 million, while the Chris Hani District will develop 700 hectares for R6 million. The OR Tambo District will develop 215 hectares, supported by R3.5 million. In addition, the department's implementing agency, the Eastern Cape Rural Development Agency (ECRDA), has been allocated R5 million to support the commercialisation of production. This includes organising markets, introducing new production technologies, providing technical support and facilitating access to production finance.

Kontsiwe said the revitalisation of irrigation schemes presents a significant opportunity to unlock this potential and expand productive land use across the province. "Agriculture is a major employer of semi-skilled workers, and investment in this sector can greatly contribute to reducing unemployment and food insecurity. Irrigation schemes are seen as a vehicle that can significantly contribute to an increase in agricultural productivity in the province," she said.

Freshwater on the brink: Two-thirds of South Africa's rivers now threatened

Rivers and inland wetlands remain among the most threatened and least protected ecosystems in South Africa.

This is according to the latest National Biodiversity Assessment (NBA), released late last year. The NBA is South Africa's most comprehensive report on the state of the country's biodiversity. A collaborative effort, the NBA is led by the South African National Biodiversity Institute (SANBI).

The assessment shows that 64% of river ecosystem types and 73% of wetland ecosystem types are threatened.

In the face of increasing pressures, South African freshwater ecosystems continue to degrade fast despite the investment in their conservation, management and rehabilitation. Key pressures include disruptions to the hydrological regime, deteriorating water, direct habitat loss and biological invasions, as well as the exacerbating effect of climate change.

As freshwater ecosystems are affected by land use within their receiving catchments, they are not easily protected within nature reserves and, therefore, implementation of other effective area-based conservation measures, ecological corridors and sustained hydrological and sediment connectivity is vital, noted SANBI in a statement. "South Africa must collaborate across all levels of society to conserve and wisely manage our remaining intact rivers and inland wetlands, and the freshwater species and downstream estuaries, marine ecosystems and people that they support. Urgent action is required to increase attention and funding on freshwater ecosystems and species, and to implement restorative actions in strategically identified areas."

For the first time, an assessment of fairy shrimp, or Anostraca, was included in the NBA. There are 40 described Anostraca species in South Africa, of which 36 were assessed. Of the assessed taxa, nine species (25%) were assessed as threatened with extinction, and of these, two species are considered Critically Endangered (Possibly Extinct). Endemism is high, with 44% (16) species only found in South Africa. Of these, 56% (9 species) are threatened with extinction, placing sole responsibility on South Africa to protect and conserve these species.

To access the NBA, visit https://nba.sanbi.org.za/

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GLOBAL

SDG 6 on the clock: UN report warns weak WASH systems threaten global health gains

Urgent action is needed to strengthen national water, sanitation and hygiene (WASH) systems so countries can accelerate progress towards Sustainable Development Goal (SDG) 6 and protect health, especially in the face of growing climate-related risks and recurring disease outbreaks.

This is the conclusion of the United Nations (UN) following the latest UN Water Global Analysis and Assessment of Sanitation and Drinking Water (GLAAS) report, ***State of systems for drinking water, sanitation and hygiene: Global update 2025***. The report, developed jointly by the World Health Organisation (WHO) and UNICEF, draws on data from 105 countries and territories (covering 62% of the global population) and 21 development partners.

"With less than five years until 2030, we are at a critical moment to review SDG 6 and take decisive action to accelerate implementation," said Dr Alvaro Lario, Chair of UN-Water and President of the International Fund for Agricultural Development (IFAD). "The choices we make now will determine whether we achieve our common goals and ensure WASH is a catalyst for better public health and its transformational benefits, particularly for vulnerable people."

Across countries, the pattern is clear: plans exist, but delivery capacity is thin. Many countries have policies and targets in place, but implementation is constrained by fragmentation, workforce gaps, and financing that does not reliably translate into results. For example, fewer than 13% of countries reported having sufficient financial and human resources to implement their WASH plans; 64% of countries reported overlapping roles and responsibilities across government institutions – often leading to inefficiencies and uncoordinated efforts; and while most countries have national targets for drinking-water and sanitation, only 49% reported a national hand hygiene target.

Despite steady global progress, unmet needs remain vast. Estimates show that 2.1 billion people still lack safely managed drinking-water, 3.4 billion lack safely managed sanitation, and 1.7 billion lack basic hygiene services.

The report identifies major opportunities to accelerate progress by improving how WASH resources are planned, executed and regulated. Data from 20 countries participating indicate a funding gap of 46% between identified needs and available funding to reach national targets. Efficiency losses further undermine services, with non-revenue water averaging 39% among reporting countries.

Sadly, at least 1.4 million people died in 2019 from preventable causes linked to unsafe water and poor sanitation, and in 2024 there were over 560 000 cholera cases and 6000 reported deaths across 60 countries.

For more information, visit: https://glaas.who.int/

Cigarette butts are an overlooked source of microplastic pollution

Cigarette filters are an underestimated source of microplastic pollution, researchers report.

It is well known that discarded cigarette butts release nicotine, heavy metals, and other toxins into the environment, including natural water systems. Less understood, however, is what happens to the plastic-based filters that shed these chemicals.

A new study examines this issue. The findings show that one cigarette filter can release up to two dozen microfibers almost immediately upon contacting water. More than 100 additional microfibers may break free of the filter within 10 days, depending on how the water is moving.

This quick release of cellulose acetate fibres, what most cigarette filters are made of, had not been precisely measured before, the study authors say. This and other findings from the study build upon the evidence that cigarette butts, the most littered item worldwide, are a direct and underestimated source of microplastic pollution.

"Microfibers in natural waters have been primarily associated with laundry and clothing. This work shows that microfibers from littered cigarette filters cannot be ignored," says the study's corresponding author John D Atkinson, a chair in engineering sustainability and associate professor in the University at Buffalo civil, structural, and environmental engineering department.

The findings appear in the ***Journal of Hazardous Materials: Plastics***. The study can be viewed here, https://www.sciencedirect.com/science/article/pii/S3051060025000368?via%3Dihub

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Material uses light to destroy 'forever chemicals' in water

Materials scientists have developed a material that uses light to break down a range of pollutants in water, including per- and polyfluoroalkyl substances, or PFAS, the 'forever chemicals' that have garnered attention for their pervasiveness.

The process involves the use of a class of materials known as covalent organic frameworks, or COFs, whose porous structure, and hence high surface area, make them useful in light-driven, or photocatalytic, reactions. When they interact with light, some of the electrons in COF molecules get displaced, forming holes, and this bifurcation of charges is what makes COFs good photocatalysts.

According to a study published in the journal, ***Materials Today***, the Rice team grew a COF material directly onto a two-dimensional film of hexagonal boron nitride (hBN), giving rise to a hybrid supercleansing surface that needs only light in order to cut through tough pollutants, including pharmaceutical waste, dyes, and PFAS. "By combining two safe, lightweight materials in a new way, we built a powerful pollution-fighting surface that works quickly, works on many different pollutants and does not rely on metals that could harm the environment," says Yifan Zhu, a postdoctoral researcher in Rice's material science and nanoengineering department and a first author on the study. "This matters because it offers a cleaner, cheaper, and more sustainable way to protect our water."

To examine performance under practical conditions, the team tested the material in vertical and horizontal flowing-water reactors, mirroring equivalent setups in water treatment facilities. The material performed consistently over repeated cleansing cycles, maintaining structure and stability. "These findings show that a single, metal-free material can tackle multiple hard-to-remove pollutants," says Jun Lou, a corresponding author on the study and a professor of materials science and nanoengineering. "This moves us closer to practical, low-cost solutions for cleaner water."

To view the original study, visit: https://doi.org/10.4060/cd7054en

Scientists uncover the climate shock that reshaped Easter Island

New research from the Lamont-Doherty Earth Observatory provides the strongest evidence so far that a prolonged drought reshaped life on Rapa Nui (Easter Island) starting around the year 1550.

To uncover this history, scientists extracted sediment cores from two of the island's limited freshwater sites: Rano Aroi, a wetland high in elevation, and Rano Kao, a crater lake. These sediments preserve natural chemical signals that record past environmental conditions. By studying the hydrogen isotope makeup of plant leaf waxes preserved in the sediments, the researchers reconstructed rainfall patterns stretching back 800 years. Their results show that annual rainfall dropped sharply in the mid-sixteenth century and stayed low for more than 100 years.

Rather than pointing to a sudden societal breakdown, the findings suggest that Rapanui communities adapted and persisted despite severe and lasting climate stress.

The analysis indicates that rainfall declined by about 600-800 mm per year compared with the previous three centuries. The team is now working with a much longer leaf wax isotope record from Rano Aroi that spans roughly 50 000 years. This extended timeline could reveal how atmospheric circulation in the southeast Pacific has responded to climate shifts over tens of thousands of years.

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NEW WRC REPORTS

Guidelines for faecal sludge collection, disposal and valorisation

Even though the legislation to collect, treat and reuse/dispose faecal sludges and/or excreta in South Africa exists, there are currently no guidelines that regulatory authorities, managers, entrepreneurs and practitioners responsible for faecal sludge management (FSM) can easily understand and incorporate as part of their service provision operations. These guidelines for faecal sludge collection and subsequent disposal or valorisation were developed through a wide spread review of the currently existing sanitation related literature documents together with the current existing regulations and policies that govern the water and sanitation sector in South Africa to ensure an effective, compelling and distinct regulatory provision incorporating all aspects of the sanitation service chain i.e. containment, collection, transport, treatment and end-use/safe disposal. These guidelines aim to provide guidance to local authorities, managers, practitioners, and legislators involved in FSM; technology innovators and entrepreneurs involved in the design and development of sanitation facilities; and local sanitation workers or "emptiers" and households to provide and / or accept a good practice concerning collection, transportation and disposal of the faecal sludge.

WRC report no. TT 959/25
Link: https://bit.ly/4cV7uQQ

Development of a frontier technology-based smart digital operator for rural water treatment plants – Mitigating against health issues arising from poor plant control and product water quality

The increasing complexity and scale of decentralised water treatment systems present significant operational challenges, particularly in rural and resource-constrained environments. Conventional management models rely on manual interventions, periodic inspections, and delayed responses to system anomalies, exacerbating risks associated with poor water quality and plant performance failures. The Smart Water Operations Platform (SWOP) was developed to address these challenges by integrating frontier digital technologies – including Internet of Things (IoT), real-time analytics, and remote system automation – into water treatment operations. The SWOP is designed to function as an autonomous, low-cost, plug-and-play supervisory platform capable of continuous water quality monitoring and process control. By leveraging cost-effective microcontrollers, advanced sensor networks, and cloud-based data management, the system aims to improve operational reliability, enhance decision-making, and mitigate health risks associated with suboptimal water treatment practices.

WRC report no. TT 958/25
Link: https://bit.ly/4b0w14q

Identification of the most suitable Brachiaria genotypes for improved livestock production in water-limited conditions in South Africa

Climate change can either directly or indirectly impact livestock production. One of the key indirect impacts of climate change on livestock production is the effects of elevated temperatures and reduced water availability on forage production and quality. This has motivated the world to look for forages that are adapted to extreme bioclimatic conditions and at the same time have the ability to potentially reduce greenhouse gas emissions from livestock production systems. ***Brachiaria*** grass, a genus of the subfamily ***Panicoideae***, and has been proposed as a suitable candidate for production under adverse bioclimatic conditions. This study was therefore aimed to identify the best performing, water-limitation tolerant ***Brachiaria*** genetic resources for improved livestock production in South Africa.

WRC report no. 3236/1/25
Link: https://bit.ly/3OEv2Q9

Examining the challenges and opportunities for enhancing the effectiveness of municipal water services by-laws in South Africa

By-laws are embedded in the laws and policies that regulate the powers and functions of municipalities in South Africa. The general objective of the study was to determine the effectiveness of water services by-laws and their use with regard to improving the water services environment. The study had three aims, namely to investigate the institutional context, application, and use of water services by-laws in South Africa; to determine the impact and effectiveness of water services by-laws and identify challenges and problems in their application; and to recommend solutions to address the challenges and problems identified in Aim 2.

WRC report no. 3234/1/25
Link: https://bit.ly/3OS94sQ

A novel solar-powered cold plasma ozonation system for point-of-use drinking water treatment

The potential for the destruction of microorganisms using plasma-based systems is well-established. However, most studies focus on simulated water and rarely carry out research on real water where there are several organic matters and inorganics that could reduce the efficacy of the system. This indeed is the strength of this research project, and the investigations in different real water bodies are elaborated in this report. To achieve this, continuous literature review, reactor/process design and construction, user perspectives evaluation and system process evaluation against SANS 241:2015 and WHO guidelines were carried out. The objectives of the project were to design, construct and operate a solar-powered plasma-ozonation system at laboratory scale for surface water treatment; evaluate user participation with respect to technology acceptability, design and usability of the point-of-use (POU) device, study the effect of reactor operating conditions on the performance (such as energy use, treatment time, and disinfection of contaminants) of the system, and evaluate the efficacy of point-of-use solar-

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powered cold plasma-ozonation technology on real water treatment considering the WHO's water quality standard and benchmark with well-established methods, with respect to cost per volume of treated water and energy consumption during the treatment.
WRC report no. 3221/1/25
Link: https://bit.ly/4r645SP

Piloting the implementation of the waste discharge charge system in the Crocodile (East) catchment

The waste discharge charge system (WDCS) is aimed at promoting waste reduction and water conservation in support of an integrated approach to managing the resource quality problems within specific catchments (reduction at source or in the resource). The key objective of this project was to pilot the implementation of the mitigation charge component of the WDCS in the Crocodile (East) catchment based on the waste related water uses (Section 21 (e), (f) (g) and (h)), captured on the water use authorisation and registration management system (WARMS) and determination of the waste discharge charge rates. The piloting exercise comprised two phases: Phase 1 focused on the determination of the mitigation charge rates that included a situational assessment of the Crocodile (East) catchment to identify key water users and water quality threats in the catchment, while phase 2 focused on the business case, addressing funding models and the implementation.
WRC report no. 3227/1/25
Link: https://bit.ly/3OKnWJM

Towards a health vulnerability index for extreme weather events

Extreme weather events (EWEs) are predicted to increase globally, necessitating an in-depth understanding of the extent to which these events may detrimentally affect human health. To manage risks to health appropriately, an understanding of the health-related risks associated with extreme weather events needs to be developed with the specific context in mind. This project provides three phases (desk-based review, group workshopping frameworks, and community engagement) to begin to unpack these risks and to develop some indicators to assess health vulnerability in the context of EWEs. The project made use of a systematic scoping review to develop an understanding of the evidence base associated with extreme weather events and human health outcomes. From there, the project drew on a health pathways approach to work backwards from these health outcomes to develop a framework to explore vulnerability to these specific outcomes. Thereafter, the project team took this draft framework to a number of neighbourhoods to engage with residents who had experienced EWEs to further workshop the frameworks and associated self-assessment materials to refine these materials.
WRC report no. 3231/1/25
Link: https://bit.ly/47lgjjl

Investigation of potentially toxic elements in selected water bodies in Limpopo Province: Transport, fate and risk assessment, and detection and remediation method development

The alarming deterioration rate of the water quality due to pollution causes a severe global health concern to both the ecosystem and humans. One such concern is contamination of water by potentially toxic elements (PTEs), which is the most pressing environmental problem in society resulting from industrialisation. In this project, PTEs and their species in water, sediment, soil, and vegetables were determined to assess the associated risks to humans via the food chain. The total concentrations of these selected PTEs in water and vegetable samples were quantified by inductively coupled plasma-mass spectrometry (ICP-MS). Whereas the concentrations of selected PTEs in sediment and soil samples were quantified by inductively coupled plasma-optical emission spectrometry (ICP-OES).
WRC report no. 3228/1/25
Link: https://bit.ly/4u2ihit

Ecological and human health risk assessment of microplastics in die Diep, and Plankenbrug rivers, Cape Town, Western Cape

Besides carrying additive chemicals and monomers, chemicals from the surrounding environment, like persistent organic pollutants, polyaromatic compounds, and metals, can sorb to the particle surface or partition into the bulk polymer. Plastics can also carry invasive species to new environments and act as a hard substrate for organisms. The assessments of the amount of plastic are scarce but important and the introduction of plastics into the environment can come from production plastics (called virgin pellets), after-use products and landfilled plastic waste. To fully assess the risks of microplastics in Cape Town, Western Cape freshwaters, it is important to consider the fate of microplastic particles which enters the environment in the Diep and Plankenburg Rivers including the ecological and human health risk assessment of the microplastics. Therefore this study aimed to quantify the amount of plastics present in the Diep and Plankenburg rivers as well as the contribution of wastewater treatment plant to plastic pollution in the Diep River.
WRC report no. 3156/1/24
Link: http://bit.ly/4bl3QP2

To download any of these reports
click on the web link provided, email:
hendrickm@wrc.org.za or visit: www.wrc.org.za

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FROM DEGRADED TO RE-WILDED: NEW HANDBOOKS SHOW HOW TO FIX OUR RIVERS

South Africa's rivers are under pressure, but they can be restored. So writes Liz Day, Hans King and Mandy Uys. The ***Let's Fix Our Rivers!*** handbook series turns complex river rehabilitation science into clear, practical guidance for action on the ground. Developed through a three-year Water Research Commission (WRC) project, these easy-to-read, illustrated handbooks put proven rehabilitation principles into the hands of government officials, farmers, community groups and citizen scientists, showing how damaged rivers and wetlands can be repaired, re-wilded and protected for the future.

The handbooks draw on rehabilitation principles and practices that have been developed by practitioners around the world, and which provide structured approaches to assist in practical planning and implementation of river rehabilitation projects in a South African context. It stems from the more detailed rehabilitation guidelines in the WRC's 2015 ***Comprehensive Manual for River Rehabilitation in South Africa*** (**WRC report no. TT 646/16**) and draws on many of the examples and principles outlined in that document.

The series comprises nine short, well-illustrated handbooks, compiled as easy-to-read guides. The target market for the series is non-academic and includes government agencies, farmers, citizen scientists and community groups. Each handbook provides an introduction to the topic of focus, a background to the impacts and degradation caused by humans, the consequences to the river or wetland system, and the best practices to apply in addressing the problem. Various river and valley-bottom wetland rehabilitation challenges and interventions are covered. The aim of the handbooks is to provide an easy, illustrated introduction to river rehabilitation principles and ideas.

The handbooks include an introduction to river rehabilitation as a code of practice; a guide to understanding the basic ecosystem function of South African rivers; the approach to, and steps to be followed in a rehabilitation project, with over-arching rehabilitation planning and design guidelines; principles of re-wilding a river; and best-practice guidelines for dealing with erosion, changes in floodplain and channel form, sedimentation, water quality and quantity problems, and issues with infrastructure design (e.g. fences, pipelines and culverts) over and near watercourses. The final handbook includes several case studies that highlight interesting rehabilitation interventions and learnings from South African rehabilitation projects.

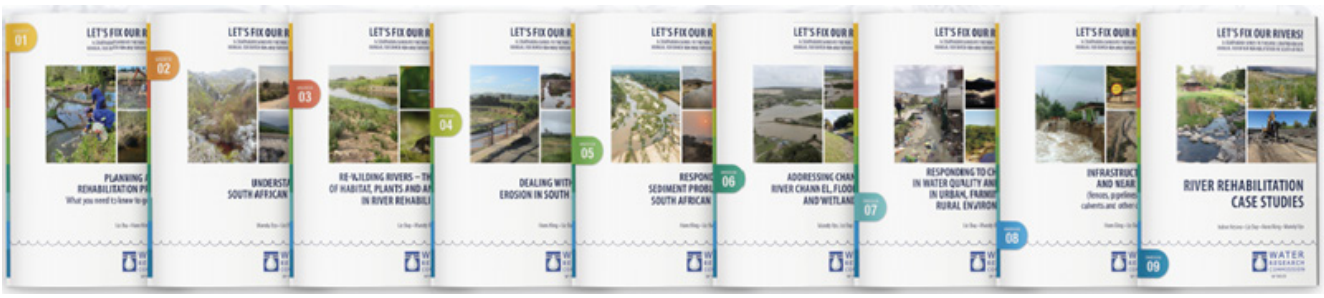
The handbooks make extensive use of annotated photographs and infographics to summarise and communicate technical information in a practical way. For example the infographics in Handbook 7 (Responding to changes in water quality and flow in urban, farming and rural environments) are designed to communicate the impacts to a catchment into a single picture, and – using the same graphic – summarises the change that is possible with best practise and rehabilitation.

Practical tips are provided throughout the series. These include tips for river bank shaping, planting and maintenance, and ideas for the creation of instream and riparian habitat in rivers that have been compromised by canalisation, channelisation or bed and bank stabilisation mechanisms.

The handbooks provide a well-balanced overview of how to: identify the source of river problems; understand the implication of doing nothing; evaluate optional remedial actions; and understand the do's and do-nots in addressing river problems. They briefly touch on current legislation and the importance of getting appropriate legal authorisations for some aspects of river rehabilitation, as failure to achieve this can derail well-intentioned rehabilitation efforts.

It is hoped that the series will draw the reader in to a holistic view of the scope of issues relating to river condition and river rehabilitation. Readers are referred to the Comprehensive Manual as well as other sources of information for more details on rehabilitation techniques and options, and it is emphasized throughout that most rehabilitation interventions require specialist input into both design and implementation.

The handbooks are downloadable from www.wrc.org.za, www.lizdayconsulting.co.za, hanskingsrs.com; and www.mandyuys.com.



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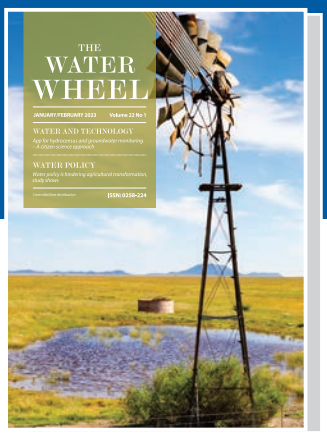

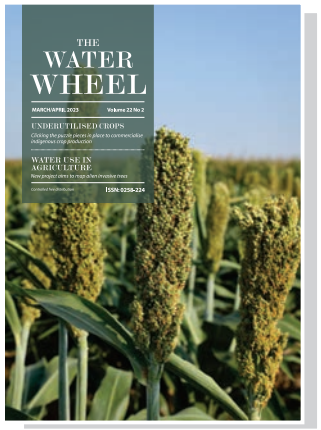

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ESTUARIES

St Lucia at an ecological tipping point?

St Lucia is progressing along a geological trajectory that has taken it from its ancestral form of a large deep estuary with major connections to the sea, to the shallow estuarine lake system it is at present, and onwards to a future state as a coastal floodplain containing freshwater pans and extensive swampland. Indications are that St Lucia is close to an ecological tipping point where it is about to change into the latter of these states, after which it will no longer function as an estuarine lake system. So writes Ricky Taylor and Alan Whitfield.

Turbid, sediment-rich uMfolozi River water in the Narrows, the indirect cause of the transformation of the St Lucia estuarine lake system into a freshwater lake system.

When this will occur, we do not know – it depends on estuarine channel connectivity, episodic river floods, sea-level rise, and the rate at which sediments accumulate in the existing St Lucia Estuary, Narrows, South Lake, North Lake and False Bay. But there are already strong indications that the system is on the cusp of switching from an estuarine lake system to a predominantly freshwater coastal lake and swamp system, with only a very small estuary component – comprising the existing Narrows, St Lucia Estuary and a small portion of the lower uMfolozi River that receives some saline inputs when the joint mouth is open to the sea.

This article describes how this once thriving estuary, which should act as a crucial nursery for marine fish stocks along a large proportion of the South African coastline, is rapidly losing its estuarine functionality. The details outlining this loss have been described in a variety of scientific papers over the past two decades, some of which are summarised in a recent review article in the ***African Journal of Aquatic Science*** by Taylor, Whitfield, Fox and Adams. Indeed, the St Lucia system has, until recently, provided approximately 50% of the estuarine surface area for all South African estuaries combined. Loss of the lake as an estuarine system, in particular, would have a major impact

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on fish and swimming prawn stocks of the subcontinent, upon which subsistence and small-scale artisanal fisheries depend, as well as the KwaZulu-Natal penaeid prawn commercial fishery that was once very active on the offshore Thukela Banks to the south of St Lucia.

North-eastward aerial view of Lake St Lucia, from Makakatana Bay looking across South Lake towards the coastal vegetated dune system in the far distance.

The St Lucia estuarine system is recognised for its beauty, its changeability and its biodiversity. It is a core feature of the iSimangaliso Wetland Park World Heritage Site and is a Ramsar Site of International Importance. It is well named iSimangaliso, meaning "place of wonder". It is Africa's largest estuarine lake that supports large populations of hippos, crocodiles and colonial-breeding birds such as pelicans, cormorants, terns, herons, gulls, pratincoles and other species. It is a magnet for regional and local tourism, being an important economic contributor to the local people, as well as attracting international tourists to South Africa.

The original St Lucia Game Reserve was established in 1896 to conserve one of the last major refuges for hippopotamus herds in South Africa at that time.

A feature of St Lucia is its continually changing salinity in response to natural wet-dry rainfall cycles. The estuarine lake has a surface area of approximately 35 000 ha, depending on water level, yet it has an average depth of less than one metre. The large surface area to volume ratio means that it is very sensitive to evaporation losses, which concentrate the salt in the water, or to the addition of rainfall or river runoff, which dilutes the saltiness. The result is that St Lucia is at times in a low-salinity state where it is dominated by both estuarine and freshwater plant and animal species. However, most of the time, it is in a range of salinities where it is dominated by estuary-associated marine and estuarine flora and fauna. At the other extreme, the estuary may reach salinity concentrations that are well above that of seawater, i.e., hypersaline. After a period of several successive dry years, much of the water may evaporate from this shallow system, exposing large areas of the lake bed. At each stage, as salinity changes, it supports those plants and animals that can cope with the ambient salinity of that stage.

To be a fully functional estuary, the ideal salinity should be in the 4 to 35 parts per thousand (ppt) range (seawater = 35 ppt), and there should also be a link with the sea through an open estuary mouth. It does not have to be open all the time, but for long enough periods to enable juvenile fish and invertebrates to enter from the sea, or leave the estuary as adults to breed in the marine environment. It is as a functioning estuary that St Lucia is of greatest benefit to the rich fauna and flora, as well as to people. It is to maintain this estuarine condition that all past management interventions have been directed. These actions have mostly focused on countering the effects of human-induced changes, including altered river flow regimes that increased salinity and promoted extended mouth closures, as well as increased quantities of sediment coming from the catchment areas that have promoted shallowing and constrictions developing within the system.

Extensive sedimentation in the St Lucia Estuary is clearly visible in this low tide aerial photo taken in 2023. These mainly compacted mud sediments effectively prevent the prevalence of a large tidal prism within the shallow estuary, and this therefore works against the retention and transport of saline water up the system.

To understand St Lucia, it is necessary to know about its geological evolution. At the peak of the most recent Glacial Period (~18000 years ago), the sea was about 120 m below the present-day level. As the earth warmed there was a rise in sea level, causing the basin that is now St Lucia to become an estuarine lake, and creating the conditions where the coastal dunes could form and be colonised by subtropical dune vegetation. The 'ancestral' St Lucia was much larger than the current system, and much deeper. It was fed mainly by the uMfolozi, uMkhuze and a few smaller rivers. These carried sediments into the St Lucia basin, and sand from the sea also entered the system. Slowly, the St Lucia basin filled, until it became the shallow estuarine lake that we know today. Some

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parts of the ancestral lake have filled in completely. These are now the uMkhuze and uMfolozi floodplains that are colonised by swampland vegetation.

The processes driving geological change have not stopped. St Lucia continues to accumulate sediment, and the trajectory is for St Lucia to fill up completely. In time, the system will resemble the current uMfolozi and uMkhuze floodplains. Both of these have considerable conservation value as freshwater wetlands with some shallow open water areas that assist in trapping sediments brought down by river flooding. Ultimately, St Lucia will no longer function as an estuary. The unfortunate thing is that the rate of the trajectory towards this state has been considerably accelerated by human activities, particularly accelerated soil erosion in the river catchments. Most of the St Lucia management interventions up until now have tried to slow down this artificially rapid change. In the 1950s the link between the uMfolozi River and St Lucia Estuary was closed to keep high sediment loads out of the estuary, in the 1960s dredging and hard structures were built in the estuary mouth to prevent sediments from blocking the estuary-sea link, and in the late 1970s a canal (the uMfolozi-St Lucia Link Canal) was constructed to bring in additional freshwater to St Lucia at times when the sediment load in the river was low. In January 1984, Cyclone Domoina washed away the hard structures at the mouth, destroyed the near-complete uMfolozi intake works, and severely damaged the link canal, never to be repaired.

A river bank breach into the Link Canal brings large amounts of sediment-rich uMfolozi River water into the Honeymoon Bend area of the St Lucia Estuary during river flooding. This breach needs to be blocked as a matter of extreme urgency if Lake St Lucia is to retain its connection with the sea.

The management dilemma has always been to either accept the sediment that comes with the uMfolozi water, or not have its water with the risk of the lake becoming extremely hypersaline and possibly even drying out altogether if the mouth remains closed during the time of a prolonged drought. Simplistically put, the management objective has been to keep St Lucia as a functional estuary – but without the uMfolozi water there have been ever increasing periods of hypersalinity and reduced lake aquatic habitat due to a major water shortage caused by extensive evaporation from the lake surface. The alternative has been to shorten the geological lifespan of Lake St Lucia by adding uMfolozi River water to St Lucia, which contains large amounts of sediment linked to increasing catchment degradation – a stark choice indeed!

Is there a compromise? The most recent management intervention of reconnecting the uMfolozi River with St Lucia had its origins in May 2010 when the Water Research Commission (WRC) funded a symposium held at St Lucia that gathered scientists with expertise on both the St Lucia and uMfolozi systems to discuss this issue. The proceedings from this meeting were published as a WRC Report, ***A review of studies on the uMfolozi Estuary and associated flood plain, with emphasis on information required by management for future reconnection of the river to the St Lucia system*** (**WRC report no. KV255/10,** https://tinyurl.com/3czv57a5).

The dual estuary mouth system that was artificially maintained between the 1950s and 2012, showing both an uMfolozi Estuary mouth in the top of the photo and a St Lucia Estuary mouth in the middle of the photo.

Following on this, in 2011 the iSimangaliso Wetland Park Authority (ISWPA) altered the policy that mandated that the uMfolozi River should be kept separate from St Lucia. The Authority obtained funding from the World Bank's Global Environment Facility (GEF) to undertake studies to investigate how this could be achieved. These studies indicated that reconnection, in its original configuration, could result in a system that would function naturally and bring uMfolozi River water into St Lucia. The system would have a single estuary mouth that would breach without human intervention, i.e., when water levels overtopped the beach berm or when there was a large river flood. The concept was that the rush of water during such a river flood would increase water levels in the estuary and trigger breaching that would flush accumulated sediment from the system into the sea. GEF funding was then used to reconnect the uMfolozi with St Lucia, an intervention which was achieved in July 2012.

Unimpeded uMfolozi water has been entering the St Lucia system since 2012, but the joint estuary mouth has remained predominantly closed for a continuous period between the beginning of 2015 and end of 2020. During this time, large quantities of sediment were deposited in the St Lucia Estuary and Narrows, encouraging littoral vegetation growth as well as reducing channel width and depth. This has severely reduced

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water flows within the estuary, Narrows and Potter's Channel. Part of the reason that the estuary mouth did not breach naturally during uMfolozi River flooding over this period was that Lake St Lucia had to fill up first before water levels at the Estuary could overtop the berm. Prolonged closure of the mouth meant that saline water was not entering Lake St Lucia, which was becoming increasingly 'fresh' and less 'estuarine' during this process.

Aerial view of St Lucia Estuary berm and muddy uMfolozi waters entering from the upper right of the photo. These conditions persisted for more than five years between 2015 and 2020.

Eventually, the lack of estuarine-marine connectivity, together with flooding of farmland on the uMfolozi floodplain, necessitated an 'assisted estuary mouth breach' following river flooding in January 2021. Unfortunately, much of the fine sediment that had accumulated in the estuary over the many years of mouth closure had compacted, forming an erosion resistant 'sill' within the estuary and mouth region in particular, and was not flushed out to sea. This compacted mud 'sill' also prevented the estuary mouth from migrating northwards in the normal manner once the estuary opened. The reduced tidal exchange of water meant that the suspension and scouring of sediments from the estuary and Narrows towards the sea did not take place as expected. This reduced the extent of the tidal prism, which then barely reached the St Lucia Bridge and meant that saline waters did not penetrate up the Narrows, let alone reach the lake. The result was that Lake St Lucia became increasingly more like a freshwater coastal lake system than an estuarine lake. Only the St Lucia Estuary seawards of the road bridge showed signs of being estuarine, and even here, the tidal exchange was muted due to the shallowness and restricted channel dimensions in the area. In June 2021, the St Lucia Estuary mouth closed naturally.

In April 2022 river-flooding caused the estuary mouth to breach – this time naturally. Again, the scouring of accumulated sediments from the estuary was limited and, once the floodwaters had dissipated, only a relatively small tidal prism was recorded. No seawater was documented reaching the St Lucia Bridge in the first two years that the mouth has remained open. The estuary mouth channel has remained relatively fixed due to compacted mud remaining in place, preventing the natural northward migration of this channel. This 'fixing' of the estuary mouth may well have prolonged the 2022-2025 open phase since 'wandering' estuary mouths are more prone to closure.

However, a major concern of aquatic ecologists is the lack of tidal prism and penetration of marine waters up the St Lucia system during the open mouth phase. This persistent feature during both recent open mouth states signals a transformation of St Lucia from an estuarine coastal lake system into a freshwater coastal lake system.

uMfolozi River floodwaters leaving the St Lucia Estuary via the Beach Channel (left) and Estuary Channel (right) after the natural mouth breach in April 2022.

Two other 'problems' have come into focus during the past decade. Firstly, the decommissioned Link Canal has been breached by floods in the uMfolozi River. The canal now carries large amounts of sediment directly into the estuary near Honeymoon Bend with each flood. This sediment deposit and the growth of reeds towards the middle of the channel from the banks have formed a constriction that inhibits the inward (upstream) movement of tidal water, and thus prevents saline water from moving any distance up the Narrows. The healthy state of freshwater shoreline reeds, which cannot survive saline water that is over 12 ppt, is a testament to the lack of saline intrusion up the Estuary and into the Narrows. An urgent action that needs to be initiated by the ISWPA is the physical blocking of the two points where the uMfolozi River has broken into the relic Link Canal. Following the creation of this blockage, accumulated sediments in the Honeymoon Bend area will need to be removed.

In a similar manner, management action is required at the junction between the Narrows and South Lake. Currently, the quantity of water pushed into the Narrows from the Lake by wind is limited considerably by extensive and dense vegetation growth in the Potter's Channel - Brodie's Shallows area (where the Narrows meets with the Lake). As the lake level rises due to river flow into False Bay and North Lake, the result is a head of water in the lake relative to the Narrows. Currently, this lake water can only 'seep' through the dense vegetation towards the Narrows when such conditions occur. Conversely, little or no movement of saline water can occur from the Narrows into the lake due to these extensive beds of submerged and emergent floodplain vegetation in the Brodie's Shallows area. The urgent restoration of Potter's Channel is therefore required if Lake St Lucia is to receive saline water up the Narrows and therefore remain estuarine.

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Google Earth satellite image of the Narrows (upper centre of photo), St Lucia Estuary (centre of photo) and uMfolozi River Beach Channel (lower right of photo). The introduction of turbid, sediment rich uMfolozi River water to both the estuary and Narrows by the Link Canal (bottom and centre right of photo) is clearly visible in the Honeymoon Bend area (centre of photo). A turbid water plume is visible in the sea in the bottom right of the photo. Note the clear dark water entering the joint estuary mouth from the Beach Channel, indicating that the turbid uMfolozi River water is not entering the sea via the Beach Channel but rather via the Link Canal.

Aerial view across the Makakatana Bay southern shore towards Potter's Channel and Brodie's Shallows in the upper central portion of the photo.

Aquatic biotic movements between the estuary and lake are also affected. Although marine larval and juvenile fish and invertebrates are currently able to find a path through these extensive plant beds and into the lake, the return migration to the sea to breed by adults of these species may be severely compromised if the Potter's Channel is not restored. Support for this view is the absence of the adult flathead mullet annual spawning migration from False Bay and North Lake, into South Lake and then down the Narrows during April/May. In the last century, these mullet shoals were preyed upon by large gatherings of crocodiles and flocks of pelicans in the Narrows, an event that appears to have been lost in recent decades.

There are 'symptoms' indicating that St Lucia is very close to its geological tipping point, after which it will no longer function as an estuary.

Also of importance is the low salinity prevailing in the lake – for the past three years South Lake, North Lake and False Bay have recorded salinities below 6 ppt. If this level falls below 3 ppt for any length of time, massive fish kills of marine fish species will likely occur and juvenile recruitment of marine fish species

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into the lake will cease. In the process, approximately 50% of the estuarine nursery area in South Africa for estuary-associated marine fish species will be lost.

Something that came out very clearly in our scientific review is that there are 'symptoms' indicating that St Lucia is very close to its geological tipping point, after which it will no longer function as an estuary. This is likely to be irreversible and, in the process, South Africa will have lost 35 000 ha of estuarine habitat. When this will happen depends on whether there are any mega-floods entering Lake St Lucia and/or coming down the uMfolozi River in the near future. As was the case with Cyclone Domoina, such ecological reset events are episodic and unpredictable. However, given the rapidity of climate change, it may be increasingly likely that northern KwaZulu-Natal may experience more cyclones as the cyclone belt moves southward. This increases the probability of St Lucia being 'hit' by such an event in the not-too-distant future.

What will St Lucia look like after it has passed the above-mentioned 'tipping point'? The lake will likely become an ephemeral shallow freshwater system during wet periods that dries up completely during extended dry periods. After the 'tipping point', there will no longer be a marine-estuary link with the lake, there will be no seawater exchange, and there will be further accumulation of sediments, which will reduce connectivity even further. It will therefore no longer be a functional estuarine lake system. During extended droughts, the now freshwater lake may dry completely to form a desiccated mud flat.

The St Lucia system is currently a "place of wonder". Some of that wonder will disappear if it is prematurely transformed into a freshwater coastal lake system.

So, how should St Lucia be managed going forward? In the near future, ISWPA management actions should be to initiate a few relatively small interventions that will help retain St Lucia its estuarine state for as long as possible. This is the state that is of greatest value to both the species richness of St Lucia and to humans. This is currently within our power to implement, but at some stage, there will be little more we can do. Then the decision will have to be made to 'let the system go', and allow it to pass through the tipping point to the next phase in its natural geological trajectory.

Three adaptive management actions are required in the short term to temporarily steer St Lucia back towards an estuarine trajectory. The most important action by far is the closure of the Mfolozi-St Lucia Link Canal, which was decommissioned after the huge 1984 Domoina cyclonic flooding. This canal is a conduit that carries uMfolozi flood sediments into the Honeymoon Bend area of St Lucia and causes a major constriction in the Estuary. To restore estuarine hydrological functioning, it may then be necessary, once the canal has been blocked off, to remove the accumulated sediment at the point where this canal enters the Honeymoon Bend area. This accumulated sediment currently prevents the inflow of marine tidal water into the upper estuary and Narrows.

Another important action is to open the Potter's Channel link between the southern part of the lake and the Narrows. The emergent and submerged vegetation there prevents free water movement between the Lake and Narrows, and vice versa. Unless this constriction to flow is opened up by recreating Potter's Channel, Lake St Lucia will become a freshwater lake. To promote the lifecycles of estuary dependent fish and invertebrate species between the estuary and sea, the combined St Lucia-Mfolozi Estuary mouth will need to be artificially breached if the mouth remains closed for prolonged periods that exceed three years.

When will it be necessary to allow St Lucia to progress to the state of a freshwater and floodplain wetland? This we do not know as the rate of geological change can be slowed by mega-floods and sea-level change, or speeded up by accelerated sediment yields from the catchment. Monitoring is needed to track the change and to guide the managers when to make the decision that further management actions are futile. From this point onwards there will be novel ecological conditions in St Lucia – that will still have significant conservation value for the system. We do need to embrace change and adapt to new opportunities, as well as guide conservation along these new scenarios.

A comprehensive hydro-ecological monitoring programme needs to be established in the St Lucia system, something that has been largely absent over the past decade. Although monitoring is key to guiding management, little of what will occur in the future can be backed by hard data at present. This must be done by science-based considered opinions, based on expertise, ecological and geological scientific theory and principles. In this regard, there is a considerable amount of existing scientific knowledge relating to St Lucia. The management authorities must involve experienced scientists who have worked at St Lucia for many decades to provide this advice. Conservation will be going into new territory as St Lucia changes – and this should lead us into new thinking to accompany these changes.

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WATER AND AGRICULTURE

Turning crisis into resilience: Water and Soil Accelerator scales up sustainable farming in Southern Africa

The Water and Soil Accelerator aims to speed up adoption of sustainable practices in rainfed agri-food systems. Article by Sue Matthews.

Dr Christian Thierfelder/CIMMYT

Just over two years ago, on 29 February 2024, the President of Zambia declared a national disaster and emergency as much of the country was experiencing the worst drought since records began. Attributing the drought to El Niño conditions, he noted that a million hectares of the 2.2 million hectares of planted maize had been severely affected, impacting more than one million farming households.

Likewise, the President of Malawi declared a state of disaster covering 23 of 28 districts in March 2024, and made another such declaration 18 months later, initially for 11 districts and then extended in November 2025 to the entire country. Projections had indicated that more than four million people faced acute food insecurity in the intervening months up to March 2026.

La Niña then made its comeback, and the 2025–2026 rainy season brought devastating floods to parts of both countries in December and January. Fields of maize and other crops, such as rice and beans, were washed away or inundated, and the loss of fertile topsoil meant that future plantings would be compromised.

Just imagine how crippling this is to rural communities, where most of the population is engaged in smallholder farming

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and dependent on it for their livelihood. Yet climate change is expected to increase the frequency and intensity of droughts and floods, and even without these extreme events, increasingly erratic rainfall will make harvests unpredictable. On top of that, altered temperature regimes and rainfall patterns will shift growing cycles and reduce the suitability of key crops in some areas.

Fortunately, there are measures that smallholder farmers can take to boost their climate resilience and agricultural productivity. At the same time, governance systems can be strengthened to improve watershed management, so that landscapes deliver a more reliable water supply and soil erosion is controlled.

With this in mind, the regional branch of the International Water Management Institute (IWMI) is leading a three-year, rapid-response initiative to scale up the adoption of sustainable practices from farm to landscape in the rainfed agri-food systems of Zambia and Malawi. Known as the Water and Soil Accelerator (WASA), the vision is to connect at least one million farmers and value chain actors to the tools and information they need to enhance water retention, soil regeneration and landscape management across one million hectares of land.

IWMI's Director for Water, Growth and Inclusion, Dr Inga Jacobs-Mata – who served in key leadership roles at the Water Research Commission and the CSIR before joining IWMI in April 2019, initially as Country Representative – is the overall Project Lead. But WASA is very much a collaboration between IWMI and two other organisations in the CGIAR stable, the International Maize and Wheat Improvement Center (CIMMYT) and Alliance Bioversity & CIAT (ABC), which represents the 2019 merger of Bioversity International and the International Center for Tropical Agriculture (CIAT).

All three organisations have been working in Zambia and Malawi for some time. For example, IWMI led the two-year programme Ukama Ustawi (roughly translating to 'partnership' and 'prosperity'), which by 2024 had engaged with more than 164 000 maize farmers on climate-smart agriculture practices, while CIMMYT was technical lead for the Accelerated Innovation Delivery Initiative (AID-I), designed to address the agricultural impacts of high fuel and fertilizer prices that had been exacerbated by the Ukraine conflict. And all have roles in CGIAR's current Scaling for Impact programme, dedicated to scaling innovations that tackle global poverty, food insecurity and climate risks.

While the three organisations are providing technical support, project oversight and a guiding hand, most of the on-the-ground activities are being carried out by consortia that were brought together through the co-design process of developing the WASA project. Following a series of meetings and consultations with government agencies, technical experts and development partners to assess needs and agree on management priorities, IWMI convened a multi-stakeholder Co-creation Workshop in Zambia in October 2024. Subsequently, a call for proposals was issued, with applicants encouraged to form consortia that integrated at least three of WASA's eight thematic focus areas (see box).

Thematic Focus Areas

1. **Sustainable Water Management:** Efficient and equitable water use and management from farm to landscape level.
2. **Green Infrastructure:** Nature-based solutions to enhance storage and infiltration, manage water flow, reduce erosion and improve ecosystem health, including the potential for mechanisation to support green infrastructure.
3. **Enhancing Agronomy, Crop Type and Coverage:** Methods and approaches to improve crop management by incorporating climate-resilient crops and agricultural approaches that enhance soil health and water retention, infiltration or storage alongside productivity gains.
4. **Capacity Building and Technical Support:** Innovative capacity strengthening, dissemination, knowledge sharing and extension mechanisms for farmers, public and private sector partners in water, soil and land management practices.
5. **Collective Action on Natural Resource Management:** Strengthening land, vegetation, and soil and water management through local institutions, private sector and cooperatives.
6. **Climate Information Services and Risk Management:** Providing farmers with access to climate information and early warning systems, as well as enhancing the access to and availability of mitigating choices in production to ensure early action to climate warnings.
7. **Enabling Environment, Financing, Investment and Stewardship**: Supporting agricultural water stewardship and inclusive innovative financing mechanisms, including climate finance and microfinance, de-risking mechanisms, carbon credits, etc.
8. **Gender Equality and Social Inclusion (GESI) and Land Tenure and Rights:** Ensuring equitable resource access, promoting gender equality and social inclusion, and securing customary or formal land tenure. This cross-cutting theme is integrated into all activities, ensuring that there are no unintended negative impacts on gender, inclusion and land tenure security for marginalised groups.

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Almost 30 applications in the form of concept notes were submitted, and once these had been assessed, shortlisted candidates interviewed, and full proposals evaluated by a review committee, five consortia were selected for funding. These are the:

- Catholic Relief Services (CRS)-led consortium operating in Malawi, with partners including Illovo Sugar Malawi, MwAPATA Institute and Churches Action in Relief and Development.
- Conservation Farming Unit (CFU)-led consortium operating in Zambia, with partners including Viamo, AgriPredict and Contractsure Services Limited.
- Total Land Care (TLC)-led consortium operating in both Malawi and Zambia, with partners including African Fertilizer and Agribusiness Partnership, Farmers' Outgrower Foundation, PELUM Malawi and Mediae.
- Solidaridad-led consortium operating in Zambia, with partners including Kvuno, Greencare Eco Solutions, AgriPredict and Mediae.
- One Acre Fund (OAF)-led consortium operating in Zambia, with partners including Golden Valley Agricultural Research Trust (GART), Green Cycle Ltd, Mediae and PASAP.

Dr Christian Thierfelder/CIMMYT

Smallholder farmers learn how mulching with maize residue can moderate soil temperature, retain soil moisture, reduce weed growth and provide habitat for beneficial organisms.

The advantage of using this consortia-based delivery model is that existing networks and partnerships – relying on established trust and community relationships – can be harnessed to promote the adoption of sustainable practices and ensure interventions are locally relevant. The experience gained by the consortia partners also bodes well for the longevity of interventions beyond the project's closure.

Indeed, from the outset WASA defined a sustainability and exit strategy, which is built on the four interconnected pillars of institutional embedding, financial viability, knowledge transfer and community ownership. This not only involves formal partnerships with government agencies, extension networks and district authorities, but also training and support for community-based natural resource management (CBNRM) groups and farmer cooperatives that could take ownership of landscape restoration and resource governance. Knowledge transfer and capacity development are prioritised at all levels – from grassroots to government – and financial viability will be secured through market-driven approaches, with a strong focus on enabling youth- and women-led enterprises.

Dr Christian Thierfelder/CIMMYT

Crop diversification by rotating maize with legumes like groundnuts, soybeans, cowpeas and pigeon peas may improve soil fertility, and provides substantial nutritional and economic benefits.

"An additional element to WASA is embedding a business incubator to support farmers and agriSMEs," says IWMI South Africa's Research Officer: Inclusive Agricultural Finance, Ms Mahlatse Nkosi. "Our main focus in doing this is to ensure long-term sustainability while covering last-mile delivery. Through the facilitation of market linkages and improving ease of access to finance, the hope is that co-benefits derived from the project are sustained beyond the project's conclusion."

Market linkages could take the form of supermarkets who purchase the farmers' produce, either directly from them or through an agri-dealer acting as middleman. And the focus isn't just on farmers' outputs but on their inputs too, ensuring that SMEs will be positioned by project end to supply them with affordable, high-quality inputs such as seed and compost. The farmers can expect to see higher yields and profits if they plant diversified, climate-smart crop varieties and improve soil health and water-holding capacity, using conservation agriculture and rainwater harvesting technologies such as minimal tillage, mulching, tied ridges and swales.

It's worth noting that WASA's resources will not be used to pilot new technologies or conduct basic research, but to accelerate the integration of validated interventions. Many of the smallholder farmers might even have been exposed to the technologies through farmer training days organised by other initiatives in the past, but it is moving beyond such knowledge transfer to adoption that is most important for WASA to achieve its goals.

"We're not reinventing the wheel – they are innovations that have already been tried and tested, and they have been proven to work," says Nkosi. "We now just want to push the envelope a bit and get their use more widespread."

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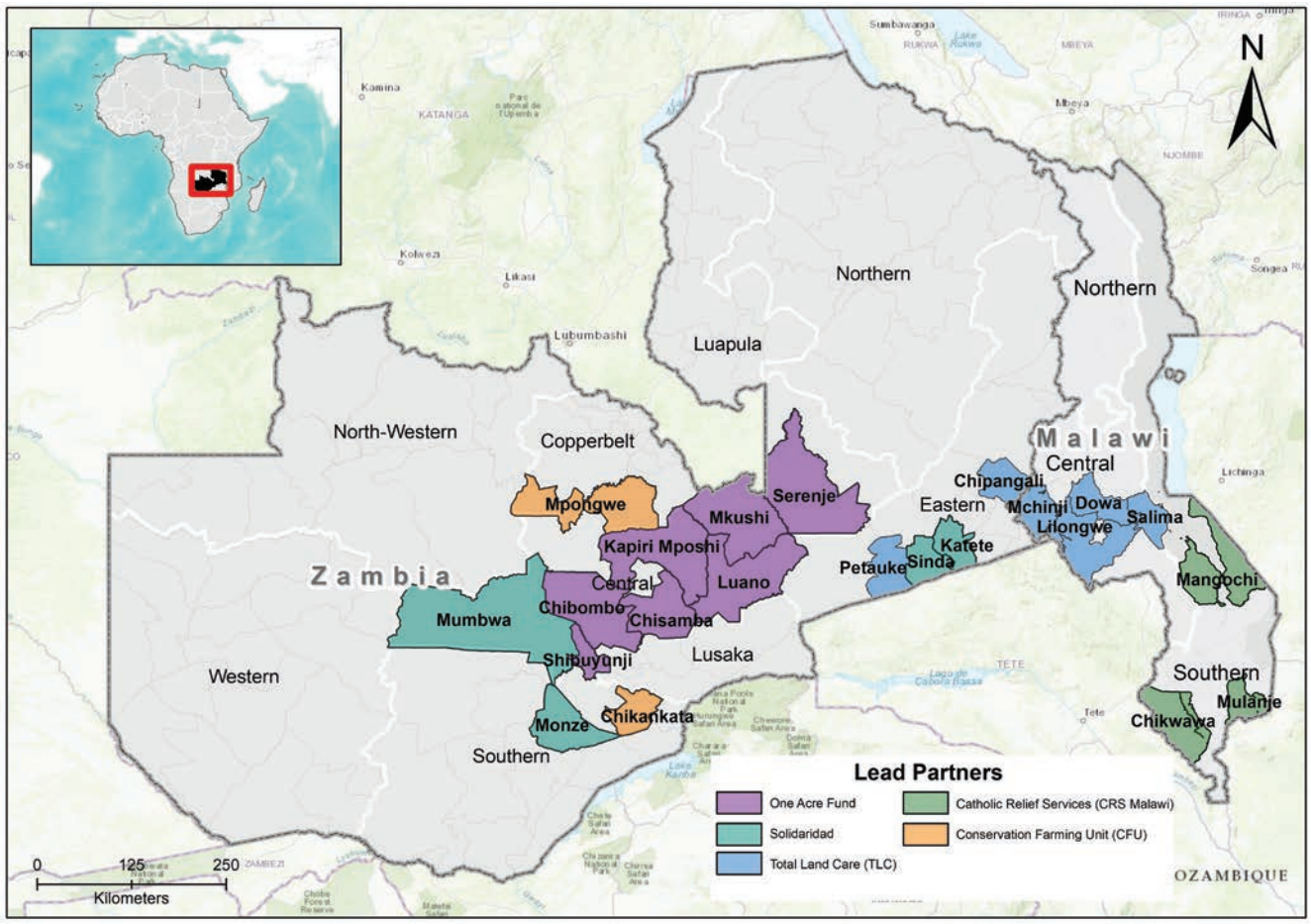
Women-led enterprises will be supported through a business accelerator to be launched this year.



The five consortia operating in Malawi and Zambia have been assigned various targets aligned with key results areas and indicators in WASA's Monitoring, Evaluation, Learning and Impact Assessment (MELIA) Framework. The targets are the minimum contributions each must make by June 2027 to reach the project's vision of one million smallholder farmers adopting improved soil and water management across one million hectares of land.

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CLIMATE CHANGE AND AGRICULTURE

From drought to data: How precision tech is future-proofing the pomegranate sector

As climate change tightens its grip on South Africa, agriculture sits on the frontline of rising temperatures, shrinking rainfall and increasing water pressure. Building resilience is no longer optional; it is essential. In the Western Cape, pomegranates are emerging as a climate-smart alternative, supported by new research that combines on-farm measurements with cutting-edge drone technology. Together, these innovations point to a future where farmers can produce more with less water, strengthening both livelihoods and water security. Article by Theresa Volschenk.

South Africa is recognised as being vulnerable to climate change impacts (World Bank Group, 2021). The country is warming by c. 0.2°C per decade, contributing to climate impacts including extreme heat, drought, sea level rise and flooding (Johnston et al., 2024). Climate change predictions for parts of the Western Cape foresee increased minimum and maximum temperatures, more hot days and heat waves, reduced average rainfall and more evaporation from soil and water surfaces by 2030 compared to the current climate (Midgley et al., 2021). This is disconcerting for a province which relies on rainfall and surface runoff as its main water source and where 75% of all the water used (government schemes, own surface supplies or groundwater) is for agriculture (World Bank, 2030 WRG, Pegasys, EDP, 2022). According to the Western Cape Climate Change Response Strategy (Birch et al., 2023) the agricultural sector will address the challenges posed by climate change by implementing the SmartAgri plan (WCDoA, WCDEA and DP, 2016). To become more resilient to climate change, one of the recommendations of this plan is to plant more drought-tolerant crops (DEA, 2016).

In addition to being a prime deciduous fruit-producing area, the Western Cape also harbours pomegranate (***Punica granatum*** L.) – a climate-smart crop. Pomegranate is world-renowned for its health benefits (Cheng et al., 2023). It is versatile as it can be marketed fresh or processed into ready-to-eat convenience foods, juices and other beverages, or used in pharmaceutical or cosmetic products. Their resistance to drought and adaptability

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to climates with hot summers and cold winters make them especially valuable in arid regions (Galindo et al., 2014). The South African pomegranate industry, having plantings of about 1 168 hectares (Viljoen and Hurter, 2024), is small compared to the 12 850 hectares of pears and more than 25 000 hectares of apples (Hortgro, 2024). About 79% of pomegranate plantings are in the Western Cape, 11% in the Northern Cape, 9% in Limpopo, with the remainder in KwaZulu-Natal and the Eastern Cape (Viljoen and Hurter, 2024).

In addition to planting drought-tolerant crops, resilience to climate change can also be achieved by adopting water-efficient production practices, such as optimal irrigation, using the right irrigation systems, applying mulch and implementing water-saving irrigation strategies. Proper irrigation scheduling can conserve water, allowing its use in other sectors during drought and benefiting the environment through efficient use of limited water resources and reducing fertilizer leaching into groundwater. Effective irrigation improves crop production and fruit quality, leading to higher production for local and export markets that support increased income, create sustainable job opportunities and strengthen food security. Advances in technology, such as precision agriculture using drones, digital farming solutions (e.g., mobile applications and cloud-based platforms), progressive data analysis and the use of smart irrigation systems, can further enhance water use efficiency, profitability and farming sustainability (Obaideena et al., 2022, Alazzai et al., 2024). Drones can support irrigation management by detecting potentially stressed areas in orchards to find, diagnose and correct underlying problems; to estimate orchard water use through evapotranspiration models or to derive crop coefficients to estimate water use for irrigation scheduling (Niu et al., 2020; Zhang et al., 2021, Ahansal et al, 2022).

To schedule irrigation accurately, information is required on the water use of the crop in question. The Alternative Crop Fund of the Western Cape Department of Agriculture, the Pomegranate Producers Association of South Africa (POMASA) and the Water Research Commission (WRC) initially funded a scoping study undertaken by the Agricultural Research Council (ARC) to provide a baseline understanding of pomegranate orchard water use in selected production areas (Volschenk and Mulidzi, 2020). The study confirmed that pomegranate trees, despite being drought-tolerant, require irrigation during the dry summer for optimal commercial production and that potential exists for some production areas to improve yield and fruit quality

Dr Christian Thierfelder/CIMMYT

A grove of pomegranate trees.

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through improved irrigation scheduling. However, no local information on the evapotranspiration of pomegranate orchards was available, and a practical means to derive crop coefficients for different orchards for irrigation scheduling purposes and catchment water management was required.

Accurate irrigation scheduling may improve yield and quality while reducing electricity consumption, thereby enhancing economic water productivity and export earnings for the country.

This research gap was addressed by two projects funded by the WRC, the National Research Foundation (NRF Grant no. 138129) and the ARC. The research was conducted in the Western Cape and focused on water use and water productivity of pomegranate orchards (WRC project no. C2020/2021-00404, unpublished) as well as water use estimation of pomegranate orchards using drone technology (**WRC Report No. 3217/1/25**, Volschenk et al., 2025). The multidisciplinary research team included researchers and students from the ARC, the University of the Free State and Stellenbosch University. POMASA supported research site selection, while the University of Pretoria: Department of Plant and Soil Sciences, which provided specialised equipment and expertise without monetary compensation, conducted a heat ratio sap flow method calibration in potted pomegranate trees.

The water use and water productivity research project aimed to measure water use, tree and fruit growth, yield and fruit quality in irrigated pomegranate orchards with varying canopy sizes and to determine several water use indicators. A practical method to estimate crop coefficients for calculation of individual orchard water requirements was also investigated. The second research project proposed to refine pomegranate orchard irrigation management by using the water use data generated by the first project, together with drone technology. It assessed whether drone-technology derived attributes for individual pomegranate trees can be related accurately to in-field measured tree dimensions and light interception. In addition drone-determined tree geometric traits and several vegetation indices were correlated with actual water use and crop coefficients at both tree and orchard scales. Orchard homogeneity for the two orchards was compared using the drone technology derived tree attributes.

The first project generated information on pomegranate orchard water use efficiency, biophysical and economic water productivity, seasonal water use, transpiration coefficients and crop coefficients. This local information can guide producers in on-farm irrigation management decisions and support catchment water management and policy making. A method to determine crop coefficients from fractional light interception in pomegranate orchards has been tested but requires refinement. Previously, no local water use information existed for pomegranate orchards of different ages and sizes. Such information was determined over two seasons for a young (four years old) and a full-bearing (thirteen years old) orchard

Drones played an important role in this project.

of an economically important cultivar 'Wonderful' – filling an important knowledge gap.

Accurate irrigation scheduling may improve yield and quality while reducing electricity consumption, thereby enhancing economic water productivity and export earnings for the country. Water use measured using micrometeorological (evapotranspiration) and sap flow (transpiration) techniques allowed partitioning of orchard water use into beneficial and non-beneficial components, helping growers to identify ways to reduce non-beneficial water losses, a critical consideration in a water-scarce country such as South Africa. Such a dataset is unique and a first-of-its-kind for pomegranate orchards.

The usefulness of drones to assist in the estimation of crop coefficients for orchards differing in canopy size and location was evaluated through drone surveys conducted earlier and later during the canopy development stage, at full canopy, during ripening, before harvest and after harvest, and by using selected tree and water use data from the water use and water productivity project. Linear regression relationships were obtained between drone image-derived spectral band reflectance, tree geometrical canopy characteristics, six vegetation indices (including Normalized Difference Vegetation Index) and thermal infrared temperature, and in-field measured tree canopy properties (dimensions, fractional interception, leaf area index); selected tree physiological parameters and tree water use (transpiration, evapotranspiration and crop

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A full bearing pomegranate orchard. Their resistance to drought and adaptability to climates with hot summers and cold winters make pomegranates especially valuable in arid regions.

coefficients). Regressions were conducted at two scales: (1) the individual tree scale – combining data of orchards/ surveys per site/ trees per survey per site, and (2) the orchard averaged scale – combining data of orchards/ surveys per site (Volschenk et al., 2025).

For the young orchard, orchard-averaged tree height could be estimated from the orchard-averaged blue spectral band reflectance with a low standard error of the estimate. Fractional light interception and orchard leaf area index could also be estimated from regression relationships with RedEdge spectral band reflectance, although with lower accuracy. Transpiration or crop coefficients for irrigation scheduling of a young orchard could be estimated from orchard-averaged drone image-derived RedEdge and near-infrared reflectance, respectively.

It must be emphasised that additional data collection is recommended to improve and to validate the above-mentioned regression relationships. Orchard water use homogeneity for the young pomegranate orchard was evaluated by estimating individual tree transpiration and crop coefficient values for different growth stages using the regression relationships obtained. Considerable between-tree water use variability was apparent for the c. 7 ha orchard and precision irrigation is therefore highly recommended to improve water use efficiency.

The knowledge generated by this research can support the formation of a water-wise agriculture sector that promotes sustainable and optimal agricultural production and thereby improves water security. Users and beneficiaries of the research include producers, the Pomegranate Producers Association of South Africa, the Water Research Commission, the Western Cape Department of Agriculture and National Department of Agriculture and science councils.

The references to this article are available on request.

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WATER AND HEALTH

Uniting water, sanitation, and health policy for lasting impact against neglected tropical diseases

For millions of South Africans, contact with rivers, dams, and informal water sources is part of everyday life. What often goes unnoticed is that these same waters can carry hidden health risks. Neglected tropical diseases thrive where unsafe water, poor sanitation, and inequality meet, quietly undermining health, learning, and livelihoods. Dr Eunice Ubomba-Jaswa from the Water Research Commission, Prof Paula Melariri and Prince Campbell of Nelson Mandela University highlight these often-overlooked infections.

Why do neglected tropical diseases (NTDs) still demand national attention? NTDs are caused by a range of parasites, bacteria, viruses, and toxins. Many depend on environmental conditions to spread, often involving insect vectors, animal hosts, or contaminated water. Their impacts are long-lasting, contributing to chronic illness, disability, missed school days, reduced economic productivity, and entrenched inequality. Despite being largely preventable and treatable, these diseases often persist quietly, overshadowed by more visible health priorities.

South Africa may not be geographically tropical, but structural inequality, water insecurity, sanitation challenges, and more frequent extreme weather events leave large parts of the country vulnerable to NTDs.

The Department of Health currently recognises four NTDs of public health concern: soil-transmitted helminths (worms), bilharzia (schistosomiasis), leprosy, and rabies. Emerging evidence also suggests that other diseases, such as echinococcosis (tapeworm larvae infection), may be more widespread than previously understood, underscoring the need for regular review of national disease priorities.

When everyday water use becomes a health risk

Bilharzia offers a clear example of how environmental conditions shape disease risk. The infection is caused by parasitic worms

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whose lifecycle depends on freshwater snails. People become infected through skin contact with contaminated water.

Globally, bilharzia affects around 240 million people, and more than 700 million live in areas where the disease is endemic. It is the second most common parasitic disease in Africa after malaria. In South Africa, prevalence among children in some endemic areas has been estimated to reach up to 95%. Endemic provinces include Limpopo, Mpumalanga, Gauteng, KwaZulu-Natal, and the Eastern Cape.

South Africa has made progress through preventive treatment, including school-based mass drug administration, which reduces infection severity. However, experience on the ground shows that reinfection remains common when treatment is not paired with a reliable water supply, adequate sanitation, snail control, and sustained health education. Evidence also suggests that extending deworming programmes beyond children to include adults would significantly improve long-term control outcomes (see Vere, 2024, https://tinyurl.com/apd2a8d9).

Building the next phase of South Africa's NTD response

Against this backdrop, South Africa's National Master Plan for the Elimination of Neglected Tropical Diseases (2019–2025) marked an important milestone. Developed jointly by the Departments of Health and Basic Education, it was the country's first coordinated effort to align disease surveillance, preventive treatment, and cross-sector collaboration under a single framework.

The plan reached the end of its intended cycle last year, presenting an opportunity for reflection, and critically, renewal. Since its launch, South Africa has faced increased pressure on water and sanitation systems, severe weather conditions, and rapid urban expansion – all factors that influence how NTDs spread and persist. While the WHO 2021–2030 NTD Roadmap offers interim global guidance, an updated and strengthened national master plan would allow South Africa to respond more directly to its own changing realities, building on progress while adapting to new risks.

Turning water and health research into early warning and prevention

Water quality is a critical determinant of NTD transmission. South Africa continues to face severe challenges related to dysfunctional wastewater treatment works, water pollution, and unequal access to basic services. Millions of people still lack access to clean, running water, and many more lack adequate sanitation. These conditions create environments where parasites and pathogens can persist and spread.

Research funded by the Water Research Commission (WRC) and led by Nelson Mandela University (NMU) is helping to strengthen South Africa's ability to respond to NTDs. This work focuses on understanding how water, sanitation, and environmental conditions shape disease risk, and on translating evidence into policy interventions and practical tools for prevention and early detection. With the active support of the Department of Basic Education and the Provincial Department of Health in the Nelson Mandela Bay Municipality as end-users, the research demonstrates the power of locally driven, evidence-based approaches to address provincial, national, and regional health challenges.

One completed project developed a decision-support and predictive tool that integrates environmental, biological, and community-level data. The tool enables authorities to predict hidden infections, identify high-risk areas even where reported prevalence is low, and strengthen early-warning systems for disease outbreaks. Importantly, it addresses a major gap in municipal disaster planning, where sanitation damage and disease risks are often overlooked due to infrastructure damage and environmental impact.

The research also developed improved ways to diagnose bilharzia, showing that standard tests often miss infections, particularly in areas where transmission is low but ongoing. By using more sensitive DNA and urine-based tests, health services can detect infection earlier and gain a more accurate picture of the prevalence of bilharzia.

Building on this work, an ongoing WRC-funded One Health project (2024–2027) is embedding environmental water quality and communicable diseases, including NTDs, into Municipal Disaster Management Plans, as required under the Disaster Management Act. By recognising the interconnectedness of human health, animal health, ecosystems, water infrastructure, and climate, the One Health approach strengthens preparedness for outbreaks linked to droughts, floods, and sanitation failures.

Skills, data, and locally-owned solutions: what lasting prevention requires

Beyond data and tools, these initiatives invest in people. Training and interdisciplinary collaboration are building local expertise in environmental health, diagnostics, epidemiology, and community-based research. This growing expertise is essential for ensuring that NTD elimination efforts go beyond short-term projects and are sustained, locally owned, and adaptable to future challenges.

Equally important, the work recognises that infrastructure and information alone do not change behaviour. Community-centred approaches, such as locally relevant storytelling and interactive learning, help close the gap between what people know about hygiene and what they do in daily life. Experience from school-based water, sanitation, and hygiene programmes shows that when children learn these practices early and consistently, the benefits last, making structured WASH education a practical and affordable way to prevent NTDs.

A shared responsibility to prevent and eliminate NTDs

Ultimately, no single sector can eliminate NTDs alone. Success depends on coordinated action: policymakers renewing strategies and prioritising NTDs; researchers generating relevant evidence; water and sanitation sectors addressing root causes; communities and civil society driving awareness and behaviour change; and funders, including the private sector, investing in long-term solutions.

The message is clear. NTDs must move from the margins to the mainstream of public health and development planning. Renewing the national NTD master plan, investing in water and sanitation, using science-based tools, and embracing One Health approaches are not optional – they are essential.

With evidence, innovation, and collaboration, South Africa can transform neglected diseases into prevented diseases and neglected communities into protected communities.

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OPINION

From crisis response to system care: Rethinking water security in South Africa

South Africa's water problems are often blamed on drought, but the real crisis runs deeper. Failing infrastructure, weak governance and short-term thinking are turning manageable risks into chronic water insecurity. To secure our water future, we need to move beyond firefighting and start caring for the system as a whole. So writes Dr Shafick Adams, Senior Research Manager of the Water Research Commission.

Many of South Africa's water crises are driven not by climatic shocks alone, but by a series of avoidable, simple mistakes. Over-reliance on single water sources, such as surface water, leaves systems highly vulnerable to drought. Historical neglect of alternatives like groundwater, desalination, or water reuse limits resilience. Insufficient investment in infrastructure expansion, driven by population growth and urbanisation, intensifies demand pressures. Slow adoption of technologies and innovations undermines efforts to improve water efficiency, monitoring, and maintenance. Poorly maintained infrastructure, much of it operating beyond its design life, leaks precious water at eye-watering rates across the country. Insufficient monitoring and weak data systems prevent timely interventions. Taken together, these oversights, along with high-consumption behaviour and the vandalism and theft of infrastructure, turn natural water scarcity into full-scale water insecurity, often long before environmental shocks strike.

Municipal water insecurity is also rarely the result of a single failure. It emerges from the convergence of infrastructure fragility, weak institutions, environmental pressures, vandalism, and growing demand. At the local level, it is experienced through intermittent supply, declining water quality, and rising conflict between communities and municipalities. These localised failures reflect broader challenges of national water availability, storage and distribution, climate variability, and uneven institutional capacity.

Recent hydrological droughts and technological or human-caused stressors have again exposed the vulnerability of municipal systems. Emergency measures, behavioural change, and the rapid development of alternative sources have sometimes averted total failure. Yet these responses have also highlighted municipal unpreparedness for prolonged or recurring stress. Infrastructure investment alone is not enough; governance, technical skills, routine maintenance, and public trust are equally critical. Where these are weak, interventions are short-lived and unsustainable. In several places, emergency boreholes that were drilled are neglected and fall into disuse, illustrating this pattern. A more resilient approach would be to maintain these assets for future crises, or better still, integrate them into the regular water supply system. Drought is often treated as an exceptional event rather than a recurring certainty, leaving systems exposed.

Groundwater has emerged as both a critical buffer and a

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frequently misunderstood resource. When planned and managed effectively, it can support essential services and community water supply during periods of stress. Where it is poorly understood, however, it often becomes the focus of myths, fear, and unrealistic expectations. Groundwater is neither a quick fix nor an unlimited reserve. Its sustainable use requires specialised expertise, ongoing monitoring, and clear governance. Failures are rarely due to the groundwater itself, but to weak institutional capacity, poor coordination and short-term decision making. Over-pumping will lead to aquifer depletion and "boreholes drying up" but this is because of the poor management of the system or absent operating rules and not the resource itself.

These experiences show that many of South Africa's water challenges are governance challenges rather than purely technical ones. Delayed decision-making, fragmented mandates across government, and a chronic lack of in-house technical capacity undermine effective action. Emergency powers enable rapid intervention, but long-term planning, licensing and operational responsibility often lag. Once immediate pressure eases, systems are neglected or abandoned because no institution assumes ongoing responsibility. This stop-start pattern reflects short political cycles, weak accountability and gradually erodes resilience.

A central challenge in municipal water management is a persistent failure of sense-making. Too often, municipalities misread the nature of the problem and then reach for solutions that do not fit, treating deep system weaknesses as if they were simple operational glitches. Having a rational way to separate routine issues from complex, fast-changing risks helps decision-makers respond with the right approach. One useful guide is the Cynefin framework, developed in the late 1990s by Dave Snowden. It groups problems into five domains: clear, complicated, complex, chaotic and disorder, reflecting how predictable cause and effect are in each case. Its practical value is simple: it helps prevent the costly mistake of applying the wrong type of response to the wrong kind of challenge.

Water governance spans all five domains of the Cynefin framework, shaping how water management decisions and practices operate within them, such that weaknesses in one domain often propagate across the system. Routine tasks, such as pump maintenance and meter reading, fall within the clear domain and can be managed through standard procedures. Although these are among the simplest functions, they are often poorly resourced and inconsistently implemented, undermining system reliability and weakening early-warning feedback. In contrast, infrastructure planning and hydrogeological assessments sit within the complicated domain, requiring specialist expertise and detailed analysis. Groundwater schemes are particularly vulnerable as only 2 of 257 municipalities have in-house groundwater expertise, limiting informed decision-making across the system.

Challenges such as climate variability, drought, and social inequality occupy the complex domain where cause-and-effect relationships are non-linear and outcomes emerge over time, demanding adaptive management and continuous learning. When accumulated stresses overwhelm the system, such as major failures or contamination events, push municipalities into the chaotic domain, requiring rapid action to restore basic order. Often, however, municipalities operate in a state of disorder, unable to accurately diagnose the nature of the problems they face, allowing risks to escalate across domains and resulting in fragmented and ineffective responses.

This misalignment drives local water insecurity. Infrastructure decay, groundwater mismanagement, and declining water quality are often treated as simple or clear operational issues, when they are in fact complicated or complex and require continuity, coordination, expertise, learning, and adaptation. Drought intensifies this complexity, yet responses remain short term and reactive. When systems fail, governance shifts abruptly into crisis mode, characterised by firefighting and delayed accountability rather than preparedness and adaptation. Water management is a deeply interconnected system in which climate variability amplifies existing weaknesses. Droughts, floods, and rising temperatures strain fragile infrastructure, funding models, and governance arrangements. These pressures interact with entrenched inequality, limited institutional capacity and poor system understanding, reinforcing local water insecurity. Climate change is not a standalone threat but a multiplier of risk. Improving water security requires adaptive, integrated governance that recognises complexity, rather than relying on isolated technical fixes or recurring emergency interventions.

Strengthening water security requires a shift from crisis response to system care. Routine maintenance, leak repair, metering, and basic monitoring must be funded and enforced as core services, not deferred until failure. Water supplies should be deliberately diversified, with groundwater, reuse and decentralised sources integrated into normal operations and emergency infrastructure maintained as permanent assets. Technical capacity needs rebuilding, particularly in asset management, groundwater, and data systems, through in-house skills or shared regional support. Financing must prioritise prevention, with ring-fenced funding for operations and maintenance and incentives that reward early intervention rather than late-stage emergencies. Governance must match the complexity of the challenge, with clear accountability, adaptive planning and institutions that assume climate variability and drought as recurring conditions rather than exceptional shocks.

Water security both underpins and depends on the effective functioning of interdependent systems, including energy, public health, municipal finance, spatial planning, housing, and food systems, all of which are embedded within and dependent on healthy ecological systems. Resilient water services enable electricity generation, sanitation, healthcare delivery, environmental protection, economic activity, and urban development, while water systems themselves rely on coherent governance, sustainable financing, institutional capacity, spatial planning, and reliable energy supply to function and adapt. Addressing water insecurity, therefore, requires integrated, systems-based planning that aligns decisions across these interconnected systems to manage climate variability alongside governance failures, infrastructure deterioration, spatial inequality, demographic pressures, and fiscal constraints, recognising feedback loops, trade-offs, and cascading risks that shape long-term resilience and livelihood outcomes. In practice, this means recognising that water insecurity is not a failure of rainfall or infrastructure alone, but of how we understand, govern, and manage complex systems over time.

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OPINION

Beneath the surface: Johannesburg's water crisis is bigger than we think

Johannesburg's water crisis has finally captured national attention. Suburbs have gone weeks without supplies. Residents queue at tankers. Civil society organisations are demanding disaster declarations and commissions of inquiry. In his recent State of the Nation Address, President Cyril Ramaphosa acknowledged the seriousness of water infrastructure failure and committed to renewed investment. This attention is necessary. But it is incomplete. So writes Dr Yazeed van Wyk.

The public conversation is currently framed around pressure management, pipe bursts, pump station failures, and under-expenditure. These are real problems. Ageing infrastructure, operational inefficiencies, and governance fragmentation have pushed parts of Johannesburg to the brink. Yet if we reduce this crisis to broken pipes alone, we miss the deeper structural issue. South Africa's water crisis is not only about infrastructure decay. It is also about regulatory modernisation. And beneath the surface lies a governance blind spot that receives far too little attention: groundwater and the growing complexity of contaminants entering our water systems.

Around 80% of South African municipalities use groundwater in some form. In many rural areas, it is the primary or sole source of drinking water. In urban centres, it supplements surface supply or serves as emergency backup during outages. Yet very few municipalities employ dedicated hydrogeologists. Monitoring networks are sparse. And routine water-quality testing remains focused largely on conventional parameters designed decades ago. At the same time, our contamination profile has changed dramatically.

Across Africa, including South Africa, groundwater systems are increasingly impacted by contaminants of emerging concern, such as pharmaceuticals, antibiotics, personal care products, endocrine-disrupting compounds, industrial chemicals such as PFAS (per- and polyfluoroalkyl substances), and microplastics. These compounds are persistent, mobile, and often resistant to conventional treatment processes. They are not hypothetical risks. They are being detected in shallow and fractured aquifers influenced by wastewater leakage, landfill leachate, and urban runoff.

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When wastewater treatment works fail, and many are failing, the problem is not limited to nutrients and pathogens entering rivers. It includes pharmaceuticals from human consumption, industrial compounds from manufacturing zones, and persistent chemicals that can migrate through soil profiles and vadose zones and ultimately into aquifers. When landfill containment is weak, leachate carries complex chemical mixtures into the subsurface. When irrigation reuse expands under water-stressed conditions, treated effluent may introduce trace contaminants into shallow groundwater systems. Yet our regulatory frameworks and monitoring regimes have not evolved at the same pace.

The Department of Water and Sanitation's Blue Drop, Green Drop, and later No Drop programmes have been important governance innovations, introducing benchmarking and performance transparency for drinking water quality, wastewater treatment performance, and water loss management. However, while these frameworks have improved accountability around conventional parameters and infrastructure efficiency, they were not designed to address the emerging contaminant profile now shaping groundwater and surface water risks.

The National Water and Sanitation Master Plan provides a strategic blueprint for infrastructure renewal and long-term supply security. These initiatives deserve recognition. But they were designed in an era when conventional contaminants dominated policy thinking. Microbiological safety, nutrients, turbidity, and traditional chemical parameters remain essential. However, they no longer represent the full risk landscape. We modernised how we measure water quality. We now need to modernise what we measure. Most municipalities do not routinely screen for pharmaceuticals in groundwater. Few, if not all, have the capacity for high-resolution mass spectrometry to detect complex contaminant mixtures. Groundwater-specific guideline values for many emerging contaminants remain absent. Analytical capacity is unevenly distributed, concentrated in a handful of research institutions and specialised laboratories. In effect, we are managing a 21st century contamination profile with 20th century regulatory tools. This is not a criticism of individuals working within the system. It is a structural gap.

Johannesburg's current crisis is framed as a quantity problem: reservoirs too low, pumps not functioning, supply interrupted. But quantity and quality governance are inseparable. When surface systems falter, communities turn to boreholes and private abstraction. When wastewater infrastructure collapses, shallow aquifers become more vulnerable. In highly urbanised and industrial settings such as Gauteng, where fractured and unconfined aquifers enhance hydraulic connectivity, contaminants can move more rapidly than we assume. We should not wait for a contamination scandal to discover this blind spot. Beyond stabilising supply, we must ask a more fundamental question: are we equipping our water governance systems to manage the contaminants of today and tomorrow?

Cape Town's experience during the 2018 Day Zero crisis offered important lessons. Behavioural change, transparent data-sharing, and diversified supply planning helped avert catastrophe. Long-term strategy, including groundwater abstraction, desalination, and reuse, became central to resilience planning. But resilience is not only about augmenting supply. It is also about understanding what moves through that supply.

If Johannesburg and other metropolitan areas increasingly integrate groundwater, reuse, and alternative sources into their portfolios, then contaminant governance must be modernised in parallel. This includes systematic monitoring of emerging contaminants in vulnerable aquifers, development of interim screening thresholds informed by international benchmarks, and integration of hydrogeological vulnerability mapping into infrastructure planning.

Recent regulatory developments in Europe, such as enforceable limit values for selected PFAS in drinking water, illustrate how governance frameworks can evolve in response to emerging risks. The principle of precautionary, risk-based monitoring is instructive. We do not need perfect data before acting. We need adaptive governance that recognises complexity. The Johannesburg crisis should therefore serve as a catalyst, not only for infrastructure repair, but for regulatory renewal.

This renewal requires investment in the right skills. Municipalities that depend on groundwater must, as a matter of urgency, employ registered and skilled hydrogeological expertise. Monitoring networks must extend beyond surface reservoirs to include aquifer systems. Laboratory capacity must be strengthened to detect complex contaminant mixtures. Data must be publicly accessible, fostering the same transparency that proved decisive in Cape Town.

Above all, groundwater must be brought into the epicentre of the water governance conversation. It cannot remain an invisible, emergency backstop. It is a strategic national asset. South Africa does not lack policy documents. It lacks integrated implementation that bridges infrastructure investment, regulatory modernisation, and scientific capacity. The National Water and Sanitation Master Plan acknowledges systemic weaknesses. Blue Drop and Green Drop provide accountability mechanisms. Civil society is demanding action. The President has signalled urgency. The newly established National Water Crisis Committee now provides a platform to embed groundwater governance and contaminant modernisation into the national response, not as an afterthought, but as a core pillar of reform. The opportunity now is to connect these strands.

Johannesburg's crisis is not only about fixing what is broken. It is about governing what is unseen. Beneath the surface lies both vulnerability and resilience. If we continue to treat groundwater as an afterthought and emerging contaminants as a research niche, we risk stabilising supply while overlooking evolving risks. If, however, we use this moment to modernise water governance, integrating infrastructure renewal with contaminant awareness, hydrogeological expertise, and transparent monitoring, then this crisis can become a turning point. Empty taps are visible and politically urgent. Invisible contaminants are, however, more subtle but equally consequential. True resilience requires confronting both.

The question is not whether South Africa can fix Johannesburg's pipes. It is whether we are prepared to update the system that governs the water flowing through them above and below ground, and whether the National Water Crisis Committee will seize this moment to modernise not only infrastructure, but the governance framework that protects it before the next crisis forces our hand.

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DEEPLY ROOTED IN SOUTH AFRICA WATER SOCIETY

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The Water Research Commission not only endeavours to ensure that its commissioned research remains real and relevant to the country's water scene, but that the knowledge generated from this research contributes positively to uplifting South African communities, reducing inequality and growing our economy while safeguarding our natural resources. The WRC supports sustainable development through research funding, knowledge creation and dissemination.

The knowledge generated by the WRC generates new products and services for economic development, it informs policy and decision making, it provides sustainable development solutions, it contributes to transformation and redress, it empowers communities and it leads various dialogues in the water and science sectors.

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