THE WATER WHEEL

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RURAL WATER SUPPLY

Smart, scalable, and ready for the field: A digital operator for rural water plants

WEF NEXUS

Breaking the Silos: WRC's WEF nexus research transforms policy and practice

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WATER RESEARCH COMMISSION

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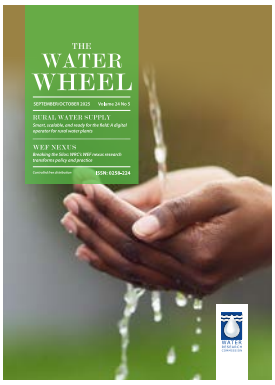
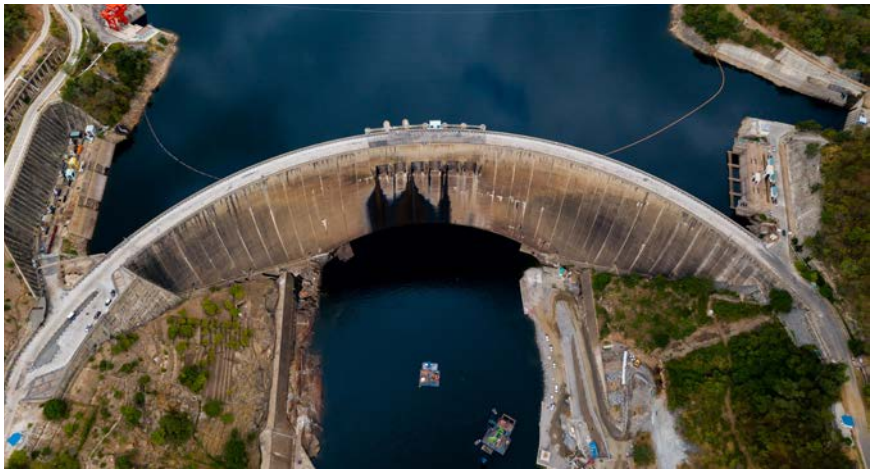
The Smart Water Operations Platform (SWOP) is a frontier-technology solution supporting rural and decentralised water treatment systems. Read more about it on page 10.



NEWS

African leaders commit to increase water and sanitation investment



African leaders have agreed to a roadmap that will pave the way to improved water and sanitation investment on the continent.

The Cape Town Declaration on African Water Investment was adopted at the inaugural Africa Water Investment Summit. The summit, held from 13 to 15 August in Cape Town, was held in the context of South Africa's chairmanship

Leaders at the summit committed to scaling up domestic public and private finance for water investments, including mobilising resources through national budgets and innovative financing mechanisms. "We commit to call for the reform of the multilateral financial institutions, taking into consideration the urgent need for accelerated investment in the water and sanitation sector, with priority given to Africa to bridge the water investment gap," the declaration states. Further, priority will be given to the deployment of de-risking tools where they add value – particularly in underserved rural and peri-urban areas, fragile and conflict-affected states, and for nature-based solutions."

African leaders also committed to raising the profile of water projects to drive sustainable economic growth and improve people's health, nutrition and prosperity across the continent, recognising that water investments can reduce the impact of climate change and build resilience. They further committed to call on their governments and development partners to work together and secure significant investments, including public and private finance, in increasing water security and access to safe water, sanitation and hygiene.

"[We] call upon the international and regional financial institutions in Africa to prioritise financing water and sanitation investment pipelines, including innovative financing mechanism," the declaration reads.

Aquatic science congress aims to close the gap between research and implementation

The Southern African Society for Aquatic Scientists (SASAqS) hosted its 2025 conference from 29 June to 3 July in Pietermaritzburg.

This year's theme, 'Aquatic science and practice', aimed to bridge the gap between research and implementation by bringing together researchers, industry professionals, and students to explore sustainable solutions for challenges facing aquatic ecosystems.

Hosted by the Institute of Natural Resources (INR) at the University of KwaZulu-Natal, the conference featured interdisciplinary presentations spanning hydrology, freshwater ecology, social science and policy. According to SASAqS President, Wynand Malherbe, the goal was "to combine the aquatic sciences we do as researchers and showcase how we can put it into practice [to] find effective and sustainable solutions for all the problems we have in the aquatic environment."

One of the defining features of this year's conference was its deliberate focus on transdisciplinary research and early career researchers. Matthew Burnett, principal scientist at the INR and part of the local organising committee, explained: "We tried to highlight early career researchers – from MSc to postdocs and those just entering the industry. We had at least 51 early-career researchers, nearly half of the total attendees."

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WRC wins international award

The Water Research Commission has won the Resource Recovery Cluster Best Practice Award 2025 from the International Water Association (IWA).

The award, presented earlier this year during the 6th IWA International Resource Recovery Conference held in Leeuwarden, the Netherlands, recognises outstanding achievements in implementing resource recovery solutions at full or demonstration scale within the water cycle.

Developed under the South African Sanitation Technology Enterprise Programme (SASTEP), WESS technologies transform human waste into valuable resources (recycled water, nutrients, and energy) while drastically reducing water use. The decentralised systems, based on technologies like Clearwater, NEWgenerator, and Dewdrop, serve over 49 000 users, demonstrating practical, scalable alternatives to traditional sewered sanitation.

The initiative's success lies in its collaborative model involving government, academia, the private sector, and communities. Supported by the Department of Basic Education and the Development Bank of Southern Africa, WESS has been implemented in 60 schools, with plans for broader municipal rollout.

Praised for its circular economy approach and positive community impact, the WRC's programme exemplifies innovation in resource recovery. "A great example of holistic, sustainable sanitation," said Prof Ana Soares, co-Chair of the IWA Cluster.

Water organisation, department sign landmark agreement to advance water security and sanitation

On the sidelines of the AU-AIP Water Investment Summit, Minister of Water and Sanitation, Pemmy Majodina, and the Association of Water and Sanitation Institutions in South Africa (AWSISA) Chairperson, Ramateu Monyokollo, signed a Memorandum of Cooperation (MoC), marking the beginning of a collaborative effort to expand access to clean water and improve sanitation for millions of South Africans.

The agreement cements a shared commitment to unlock investment, drive innovation and expand access to clean water and dignified sanitation for communities across South Africa. It establishes a framework for cooperation that will see the two parties work together to align strategies, programmes and plans across the sector; create platforms for joint engagement on policy development, legislative reviews, and sector reforms; and facilitate research, data sharing and innovation to address pressing water and sanitation challenges.

The partnership also promotes leadership development, governance improvements and targeted capacity-building initiatives to fast-track service delivery. In addition, the parties will collaborate on advocacy and public awareness campaigns, and co-host summits, workshops and initiatives focused on infrastructure delivery, climate resilience and transformation.

"This agreement is more than a symbolic gesture; it is a practical and urgent commitment to work side-by-side in solving South Africa's water and sanitation challenges, said Majodina. "Access to clean water and proper sanitation is a basic human right and a cornerstone of public health, dignity and economic development. By pooling our expertise, resources and influence, we can accelerate the pace of change, address infrastructure backlogs, built institutional capacity and introduce innovative solutions that respond to the realities of our communities. This is how we create a water-secure South Africa and contribute meaningfully to the African continent's development goals."

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GLOBAL

Plastic pollution treaty talks adjourn – countries want to 'remain at the table'

The international push for consensus on a legally binding deal to end plastic pollution proved beyond the grasp of United Nations (UN) member states meeting in Geneva in August, as they agreed to resume discussions at a future date.

"This has been a hard-fought ten days against the backdrop of geopolitical complexities, economic challenges, and multilateral strains," noted Inger Andersen, Executive Director of the UN Environment Programme (UNEP). "However, one thing remains clear: despite these complexities, all countries clearly want to remain at the table."

Responding to news of the failure to reach an agreement, UN Secretary-General António Guterres said: "I deeply regret that, despite earnest efforts, negotiations to reach an internationally binding instrument on plastic pollution, including in the marine environment, concluded without achieving a consensus."

The fifth session of talks – referred to as INC-5.2 – gathered over 2 600 participants. The goal of the negotiations was to agree on a text for the legally binding instrument to end plastic pollution, "and highlight unresolved issues requiring further preparatory work ahead of a diplomatic conference," UNEP said.

South Africa expressed its disappointment with the outcome and concerns about the procedural failings that stalled progress. "While the lack of agreement is frustrating, South Africa will not waver in our fight to end plastic pollution and create a fair, practical regulatory environment," said the Minister of Forestry, Fisheries and the Environment, Dr Dion George. "We will keep driving action at home and pressing for solutions abroad."

At home, South Africa is already moving to ban microbeads and phase out single-use plastics. These steps reflect a proactive strategy to reduce environmental and health risks.

Extreme heat is breaking records worldwide – UN weather agency

Extreme heat is breaking records around the world, with wildfires and poor air quality compounding the crisis. This is according to a report from the World Meteorological Organisation (WMO), released in August.

Extreme temperatures caused about 489 000 heat-related deaths a year between 2000 and 2019, with 36% occurring in Europe and 45% in Asia. The health impacts of heat are especially severe in cities due to the so-called 'urban heat island effect' – the overheating of dense city areas compared with their rural surroundings – which is magnifying problems as urbanisation continues. Amid rising twenty-first century temperatures, the WMO underscored that July 2025 was the third-warmest July ever recorded, behind those in 2023 and 2024.

In this record-breaking July, heatwaves especially impacted Sweden and Finland, which experienced unusually long spells of temperatures above 30°C. Southeast Europe also faced heatwaves and wildfire activity, with Türkiye recording an extreme new national high of 50,5°C. in Japan, a new national temperature record of 41.8°C was set on 5 August, breaking the previous record set a week prior.

"Extreme heat is sometimes called the silent killer, but with today's science, data and technologies, silence is no longer an excuse. Every single death from extreme heat is preventable," said WMO Deputy Secretary-General Ko Barrett. The WMO is working to strengthen heat early warning systems under the 'Early Warnings for All' initiative. In collaboration with global and local partners, it is helping countries develop heat-health action plans and ensure at-risk populations receive timely alerts.

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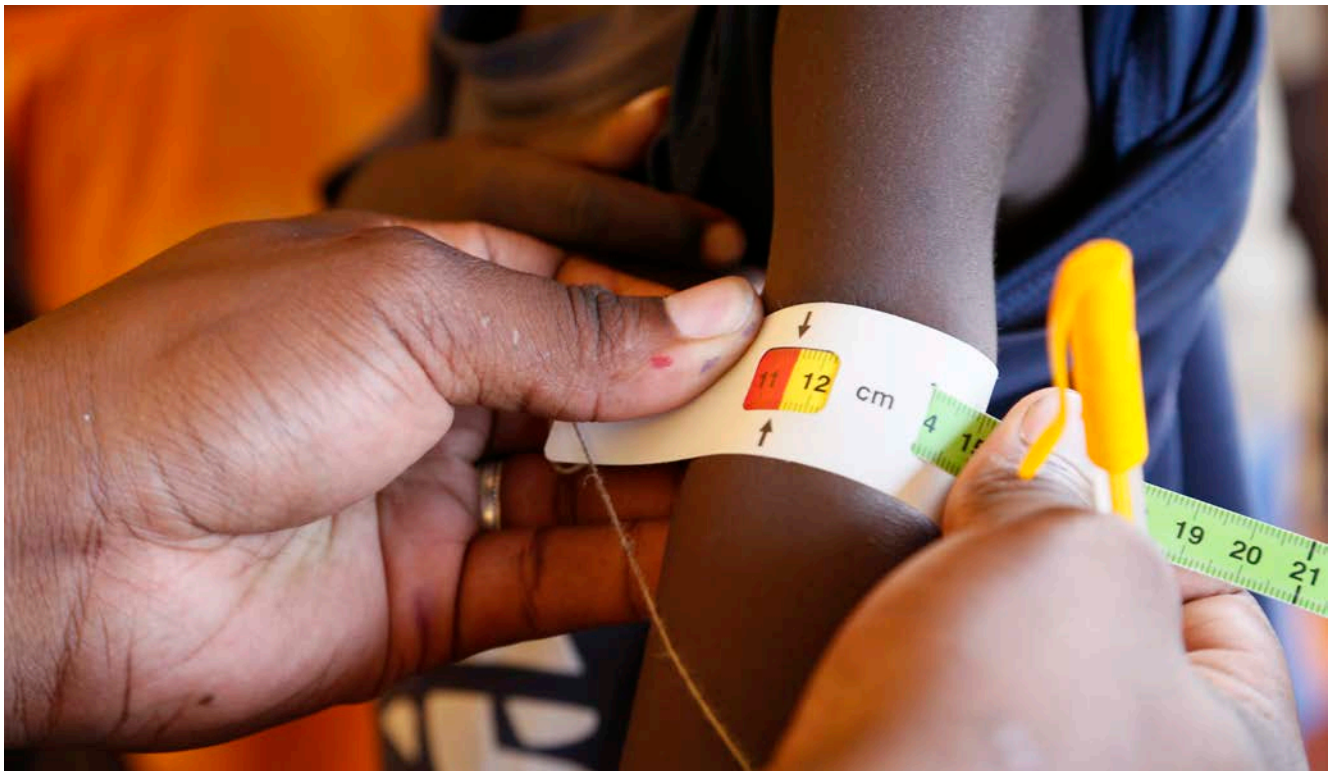
Africa's nutrition crisis: Rising stunting and overweight threaten child development



Africa continues to bear a significant burden of child malnutrition. This is according to the latest ***Joint Child Malnutrition Estimates 2025*** report by the United Nations Children's Fund (UNICEF), the World Health Organisation (WHO) and the World Bank.

In 2024, 64.8 million children under five in Africa were affected by stunting – an increase from 61.7 million in 2012 – making it the only region where stunting numbers have worsened. The highest stunting prevalence in Africa was recorded in Middle Africa (40.1%), followed by Eastern Africa (31.2%). Stunting refers to a child who is too short for his/her age. These children face long-term physical and cognitive challenges, undermining development goals.

Wasting, a sign of acute undernutrition, affected 11.7 million African children in 2024, down slightly from previous years. Still, Africa remains second to Asia in the global burden of wasting, accounting for 27% of all global cases. Severe wasting, which increases mortality risk, affected 1.3% of African children, with conflict, food insecurity, and poor health systems aggravating the situation.

Childhood overweight, often overlooked in African contexts, is also on the rise. In 2024, 9.7 million African children under five were overweight, making up 27% of global overweight cases. Notably, Southern Africa showed one of the highest overweight rates in the world at 12.1%.

Despite progress in some regions, many African countries are off track to meet the Sustainable Development Goals (SDGs) related to malnutrition. Data gaps remain a major challenge, limiting the ability to monitor and respond effectively. The report stresses the need for robust, regular data collection, and emphasises the importance of multisectoral strategies involving nutrition, health, water, sanitation, and social protection systems.

Addressing malnutrition in Africa requires urgent investment, strong political commitment, and community-level action to ensure all children have access to nutritious food, clean water, health services, and supportive care environments necessary for survival and development. Without accelerated progress, Africa risks reversing decades of hard-won gains.

The report noted that gaps in data in some regions make it challenging to accurately assess progress towards global targets. Regular data collection (every three to five years) is therefore critical to monitor and analyse country, regional and global progress on child malnutrition going forward.

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NEW WRC REPORTS

Policy brief: Institutionalising the safe implementation of direct potable reuse (DPR) in South Africa: Lessons from a laboratory to pilot demonstration project

A long-term collaborative project between the Water Research Commission (WRC) and Umngeni-uThukela Water (UUW) has provided critical insights for advancing water utility-led implementation of direct potable reuse (DPR) schemes in South Africa. Findings from the project have underscored the importance of foundational research, technology demonstration, and technical oversight as key components of the roadmap toward full-scale DPR implementation. The successful demonstration of a two-megalitre-per-day pilot plant at UUW has highlighted both the capabilities and requirements of a water utility to be able to effectively plan, design, operate, and maintain a DPR scheme.
Link: https://bit.ly/4lRm3Ga

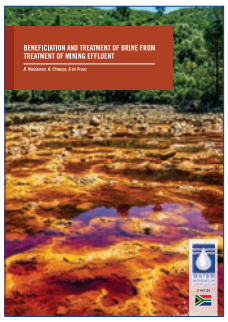
Position paper: The socio-economic, technical and institutional dimensions of non-payment for water: Solutions and lessons for South Africa

Non-revenue water is becoming a major challenge in South African municipalities, with almost half of the country's water (47%) lost to the water system. Non-revenue water has increased significantly since 2020 due to the impact of leaks, reduced payment levels, inaccurate billing, poor municipal governance, illegal connections, ageing infrastructure, with poor maintenance, and social, environmental and health disruptions (droughts, floods, COVID-19 pandemic). The Water Research Commission (WRC) initiated a study in 2021 to identify and analyse the reasons for non-payment for water services for domestic users in South Africa. The project aimed to understand the historical, geographical, socio-economic, technical and political factors which underpin payment for water services, drawing on knowledge from literature, legislation and policy, water sector specialists, municipal officials and residents.
Link: https://bit.ly/45Xx9DC

Position paper: Is it time for a water tariff innovation? The case for dynamic tariffs

The primary premise is that the current pricing system might be inflexible to balance short-term water demand with available supply appropriately and that it is inconducive to the changing global and national developments impacting long-term water resources. In economic theory, the price of a good or service shows the benefit consumers derive from said good and the cost of providing the good, i.e. the value of consuming and producing the good, respectively. Inefficient pricing systems can result in the poor allocation of resources, i.e., allocative inefficiency, where the pricing system fails to direct goods to where they are needed the most. It can also result in under-pricing and overconsumption if the price does not effectively reflect the economic value placed on a good or service.
Link: https://bit.ly/45T0xKW

Beneficiation and treatment of brine from treatment of mining effluent



South Africa's mining industry has played a significant role in the nation's economic development. However, the closure of coal mines in recent decades has led to the discharge of mine-influenced water (MIW) that requires management post-mine closure. Currently, the mines treat the MIW by neutralisation and discharge to rivers or through centralised reverse osmosis plants to produce potable water for local municipalities. The reverse osmosis membrane process generates substantial volumes of brine waste, which poses a significant challenge in terms of disposal or further treatment. Developing cost-effective and environmentally sound solutions for brine disposal or recovery of valuable components from the brines remains a critical area of research and development. Mineral carbonation offers a promising alternative by reacting CO with Mg- and Ca-containing liquid mine wastes to produce stable carbonates.
WRC report no. TT 947/24
Link: https://bit.ly/45M9nf3

Science brief: Assessing the performance of strategic partnership programme for smallholder irrigation schemes in Limpopo Province and opportunities for revitalisation of affected schemes

The Government of South Africa has supported smallholder irrigation as a means to create jobs, alleviate poverty, and promote pro-poor sustainable agricultural and economic growth, while also ensuring water and food security. Although some irrigation schemes have shown significant results, others have not achieved the intended outcome and have performed poorly, while others have collapsed. Strategic partnership has been cited as leading cause of the failure of some smallholder irrigation schemes. This has warranted further investigation, leading to a study commissioned by the WRC into the performance of the existing strategic partner programme.
Link: https://bit.ly/4n5DkfO

Evaluating the potential of hydroponic fodder production – Implications for smallholder and communal farmers in water-limited agro-ecological areas in the Northern Cape Province of South Africa

Livestock production in arid and semi-arid regions is increasingly challenged by unpredictable rainfall, recurrent droughts, and poor-quality rangeland forage. These environmental factors, exacerbated by climate change, contribute to reduced livestock productivity, increased disease prevalence, and poor reproductive performance. To mitigate these issues, alternative fodder production systems, such as hydroponic fodder, have been explored as sustainable solutions. This study evaluates the

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feasibility of hydroponic fodder as a supplementary feed source by examining its growth performance, nutritional value, cost-effectiveness, and impact on livestock condition and methane emissions.

WRC report no. 3218/1/25
Link: https://bit.ly/4lKWc2k

Water use estimation for pomegranate orchards using drone technology

Global warming-induced climatic changes, limited water resources and water restrictions for agriculture during drought force producers to invest in crops that are more suited to the potential future climate, such as drought-tolerant pomegranate (***Punica granatum***) trees. In South Africa, the pomegranate industry is small but expanding and in 2023, 79% of the plantings under this crop were in the Western Cape. A previous WRC-funded study measured water use for pomegranate orchards varying in canopy size and aimed to develop a method for practical estimation of crop coefficients for application in a water use model to enable calculation of individual orchard water requirements. The ground-based methods used to quantify the water use included a soil water balance, sap flow (transpiration) and micrometeorological methods (eddy covariance, surface renewal), whereas the canopy cover and tree dimensions of selected trees were monitored throughout the season. The abovementioned research paved the way to investigate the potential use of drones or unmanned aerial vehicles (UAVs) to improve pomegranate orchard irrigation management. The purpose of the current research was to relate drone image-derived tree geometric dimensions, spectral band reflectance, vegetation indices and thermal infrared temperature with seasonal canopy development and water use for pomegranate orchards in the Western Cape to determine if it could aid in on-farm irrigation and catchment-scale water resource management. It also aimed to provide supplementary information on the orchard properties, such as canopy cover and tree homogeneity, underlying water use values obtained via micrometeorological methods that will be made available for decision support and policy making in the water sector.

WRC report no. 3217/1/25
Link: https://bit.ly/45S4v6N

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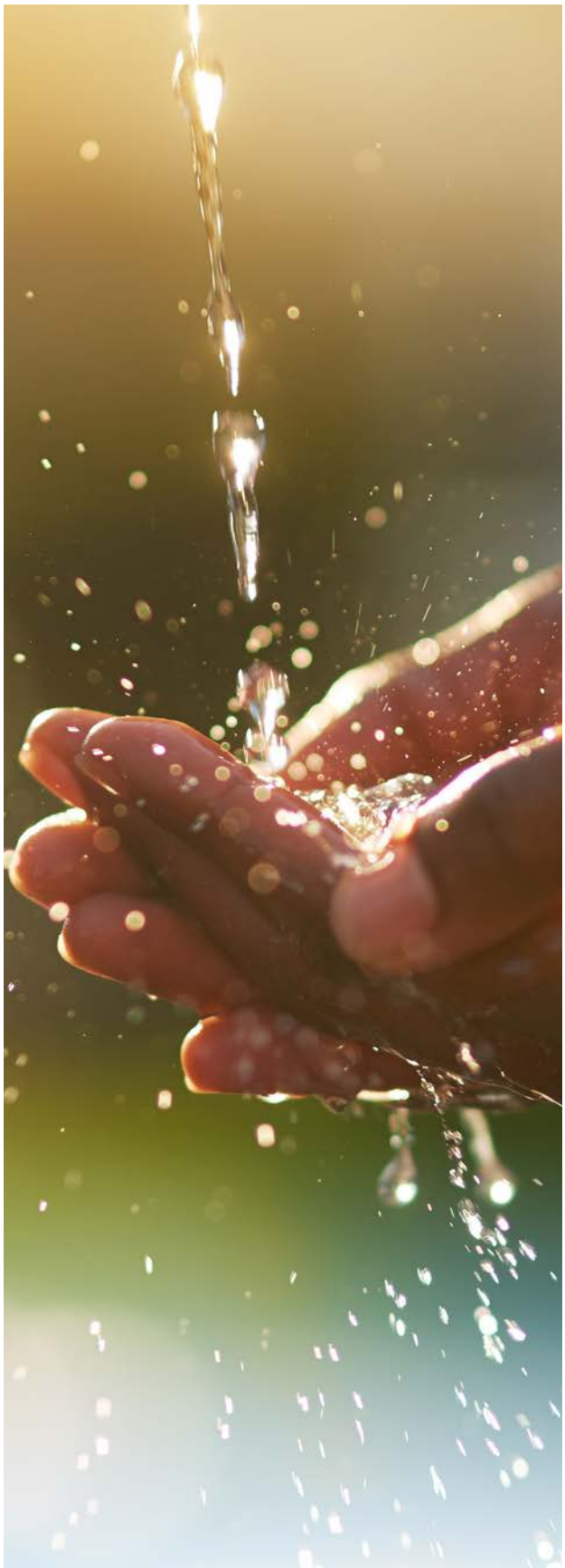

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RURAL WATER SUPPLY

Smart, scalable, and ready for the field: A digital operator for rural water plants

In many parts of South Africa, the challenge of delivering safe drinking water is not a matter of availability – it is a matter of operational control. Rural water treatment plants often face equipment failures, poor-quality monitoring, and limited oversight. These weaknesses are exacerbated by financial constraints, staff shortages, and an increasing compliance burden. A project funded by the Water Research Commission aims to change that. Article by Kim Trollip.

The Smart Water Operations Platform (SWOP) is a frontier-technology solution supporting rural and decentralised water treatment systems. Developed by a multidisciplinary team of engineers and researchers, it acts as a low-cost, autonomous digital 'operator', a plug-and-play supervisory system that can monitor key water quality parameters, automate basic responses, and enable remote oversight. SWOP is especially relevant to rural water treatment plants because it directly addresses the unique operational, financial, and human resource challenges these plants face, challenges that differ markedly from those in urban or well-resourced settings.

The platform can either be retrofitted to existing treatment facilities or supplied as part of new water treatment systems. Its primary function is to autonomously bridge the technical skills deficit and logistical challenges associated with deploying a human plant operator (process controller) to remote sites on a routine basis. As the authors note, "Technological advancements in microprocessors, low-cost sensors, wireless communication, cloud storage, machine learning and artificial intelligence (AI), which are driving the broader adoption of Internet of Things (IoT) is increasingly being explored to provide disruptive solutions for smart water quality monitoring."

Smarter responses to rural water challenges

South Africa's water crisis is deepening. As a water-scarce country, it faces growing pressure on limited resources due to climate change, erratic rainfall, and prolonged droughts. Rural

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and underserved areas feel the impact most, often forced to rely on unreliable or absent municipal supply. Many communities depend on groundwater from boreholes, which often produce low volumes and suffer from pollution. Government programmes have installed small-scale treatment plants, typically filtration and chlorination, but many fail within months.

One key reason is the assumption that short-term training equips community members to operate and maintain such infrastructure. Sustained support, technical oversight, and routine maintenance are essential but rarely available. Consequently, plants fall into disrepair or deliver untreated water due to inadequate disinfection; some are vandalised for parts.

Rural plants treating 10 to 100 m^3 daily are too small for full-time staff yet too complex to operate without skilled oversight. Staff shortages, budget constraints, and remoteness reduce servicing and compliance.

Smart, connected technologies offer a practical alternative. By integrating low-cost automation, real-time data capture, and remote oversight, these tools reduce municipalities' operational load while improving plant reliability. Frontier technologies such as IoT, analytics, and solar-powered automation enable a shift from reactive crisis management to proactive, data-driven resilience.

Digital control for decentralised systems

Traditional plant management relies on manual inspections and delayed interventions. SWOP, however, uses IoT, cloud analytics, and sensor-integrated microcontrollers to enable real-time decision-making. It continuously tracks pH, turbidity, electrical conductivity (EC), oxidation-reduction potential (ORP), flow rate, and pressure, providing early warnings when systems begin to fail.

The test platform integrates widely available hardware, ESP32 microcontrollers and Arduino boards, to keep costs low. Data is transmitted wirelessly via Wi-Fi to the Blynk IoT cloud, where users visualise system performance, detect anomalies, and initiate proactive maintenance.

Blynk was chosen for its real-time monitoring and control capabilities critical for maintaining optimal water treatment conditions. Its user-friendly interface allows operators to respond quickly to anomalies, enabling timely interventions.

Future developments will enhance alert functionality, optimise long-term data analytics, and expand real-time control capabilities for fully autonomous water treatment plant operations.

How SWOP works

The system is based on a low-cost microprocessor backbone, such as Arduino or Industruino, and integrates cost-effective physical sensors to enable real-time monitoring and operational control of rural water treatment plants.

The data collection subsystem comprises a range of sensors with either direct or indirect measurements of the parameters required, which are either wired to or wirelessly connected to the controller to transfer the information from the sensor. The data transmission subsystem receives information from the data collection system and transmits this data to the data storage cloud. Finally, the data management subsystem allows remote access by the end user to the data through an application on their mobile device or desktop computer.

The data management subsystem together with the application may or may not include data analytics, machine learning and artificial intelligence functionality.

The researchers carefully evaluated the choice of sensors, controllers, processors, hardware and software for each module to ensure that they make right choice for the platform and its intended application. The aim was to ensure that each module is stable and accurate and aligns with the operational requirements of rural water treatment systems, particularly in terms of real-time monitoring, data-driven decision-making, and system scalability.

A step toward safer, smarter water

To assess hardware and software performance, the team tested the system's ability to accurately measure, convert, and interpret analogue signals from various sensors. These tests were conducted using both synthetic and actual groundwater samples sourced from a diverse range of locations to ensure robustness and adaptability.

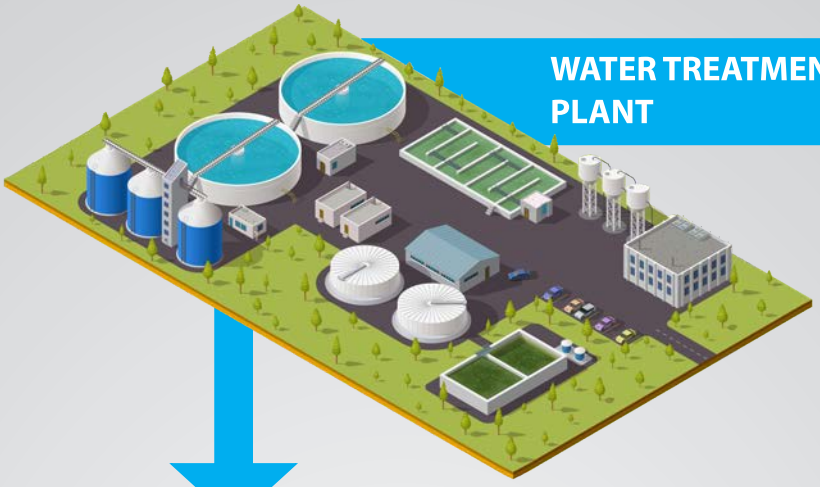
In controlled lab tests simulating diverse groundwater conditions, SWOP's sensor suite demonstrated strong correlation with commercial-grade reference meters. The pH sensor showed near-zero deviation; EC and ORP readings stayed within industry-accepted thresholds. While some calibration challenges remain—especially with flow and pressure under variable conditions—researchers are confident that these can be addressed through site-specific calibration during field deployment.

Critically, SWOP is designed with resilience and modularity in mind. It can be powered by off-grid sources such as solar panels, and its architecture allows it to be retrofitted into existing package plants without major modifications.

Proving the potential: Pilots and practical pathways

While the preceding sections outline the comprehensive range of potential features for the final SWOP system, the deliverables for this study were limited to the aspects of prototype development defined by the approved funding, focusing on specific prototype functionalities rather than full-scale system implementation.

These constraints shaped the development of the SWOP



Analog sensors monitor:
• pH • Turbidity • Electrical conductivity • ORP (Disinfection proxy)
• Pressure • Flow rate

Data collection subsystem

Data transmission subsystem

Data management subsystem
• Cloud dashboard • PCD screen onsite
• Alerts & diagnostics

Remote users
(Municipality, operators) view data, receive alerts, take action.

Optional:
Local SD card backup / AI module

A bloc BACK TO TOP *ystem.*

prototype, guiding decisions on component selection, system architecture, and functional capabilities.

Despite these limitations, the prototype still successfully demonstrated the core principles and objectives outlined in this chapter, laying the groundwork for future iterations and enhancements.

The development team now seeks extended field trials to validate performance in real-world conditions across diverse plant configurations. Future upgrades may include LED status indicators, enhanced enclosures, and additional sensors (e.g., for dissolved oxygen or total organic carbon). A more advanced version could incorporate AI-based analytics to support predictive maintenance and automatic calibration, further reducing the need for hands-on operator input.

SWOP's promise lies in reducing health risks linked to poor water treatment, especially in underserved communities. By automating routine monitoring and enabling early intervention, it tackles inconsistent water quality caused by a lack of timely, actionable data.

The platform is designed to be cost-effective enough to justify keeping a spare unit on-site, enabling quick replacement in the event of a system failure. Its plug-and-play functionality allows a relatively unskilled person to easily remove and replace a faulty unit without the need to dispatch a skilled technician to a remote location for troubleshooting or servicing.

Laying the foundation for digital water resilience

While technology cannot replace skilled operators or long-term infrastructure investment, SWOP offers a compelling support tool for rural water systems. It combines affordability, digital innovation, and practical application, aligning with national goals for water security and public health.

As the report concludes: "This study establishes a solid foundation for future research and development, providing a pathway towards smarter, more sustainable, and data-driven water treatment solutions. By addressing current limitations and incorporating advanced predictive analytics, the SWOP has the potential to revolutionise rural water management, ensuring safe drinking water access for underserved communities."

With further development, this digital operator could help municipalities move from reactive crisis management to data-driven operational resilience, one rural plant at a time.

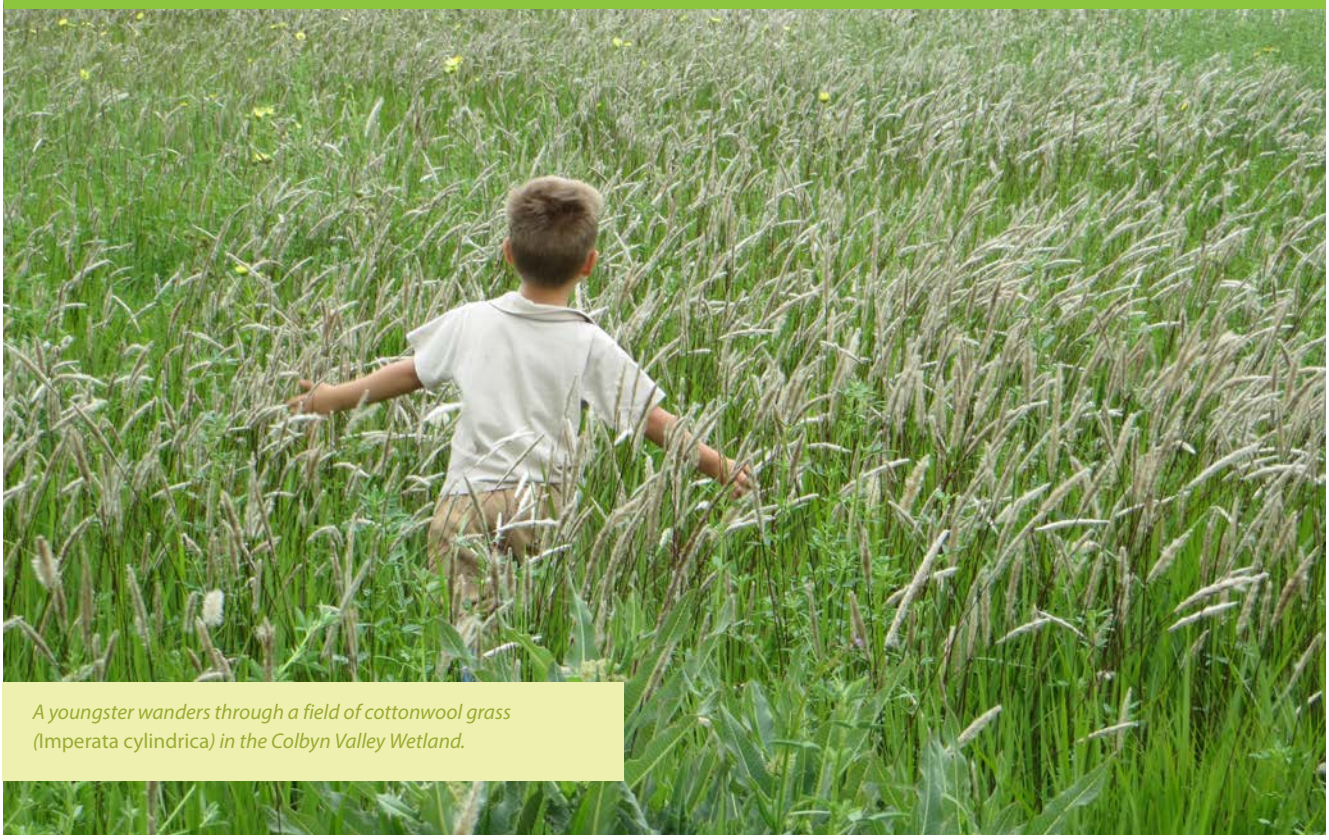
While technology cannot replace skilled operators or long-term infrastructure investment, SWOP offers a compelling support tool for rural water systems.

GREEN INFRASTRUCTURE

Why green spaces should be valued in Rands and cents rather than beauty alone

Towns and cities should place a financial value on their wetlands, rivers and other vital 'green infrastructure'. Tony Carnie reports on a recent case study to count the benefits of some of the muddier council assets in suburban Pretoria.

Tamsyn Sherwill



*A youngster wanders through a field of cottonwool grass (*Imperata cylindrica*) in the Colbyn Valley Wetland.*

Municipalities have large fleets of cars and trucks, along with all manner of pumps and machinery that grind to a halt unless they are oiled and serviced to keep them running smoothly. Other vital infrastructure, such as roads, bridges, power lines and stormwater drains, also need to be inspected and maintained to prevent potholes, cracks, rust or blockages. And, strange as it seems, rivers, wetlands and other 'green infrastructure' also require some regular TLC to make sure that they keep delivering free services to the communities that surround them.

One tangible example of free services from nature comes from the rivers and wetlands that feed the Roodeplaat Dam, a major source of clean drinking water for thousands of residents in the City of Tshwane. When river water is polluted with sewage or choked up with alien weeds and muddy sediments, it costs municipalities – and ratepayers – more money to purify the fouled waters that were previously filtered and purified at no cost by 'nature'.

This often overlooked value of natural spaces in towns and cities across the country is examined in recently completed project for the Water Research Commission that could pave the way for other municipalities to begin counting and valuing their 'green assets' in a more formal and methodical manner. Project leader

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Dineo Makate and a group of seven fellow researchers note that by valuing and managing natural assets alongside traditional concrete and steel infrastructure, municipalities can help to safeguard cities from floods and other climatic challenges, restore biodiversity and improve the overall quality of life for residents.

Unfortunately, the researchers say, money spent on protecting the environment is often viewed as an expense, rather than an investment. They argue, however, that green infrastructure, such as wetlands, rivers and water catchments, should be classified, managed and audited as 'assets' in formal municipal balance sheets.

To demonstrate the feasibility of incorporating green infrastructure into municipal asset management, they selected the City of Tshwane as a case study. The specific area covered parts of the Pienaars/Moretele rivers, including the Colbyn Valley Wetland, Roodeplaat Dam, Moreletaspruit and Hartbeesspruit.

The ecological state of most of these river systems were classified as category E, apart from Colbyn Valley, which was classified as category D – indicating that all the case study rivers were significantly degraded or modified in terms of a classification system that ranges from A (near natural) to F (critically modified). They calculated that it would cost nearly R12.2 million per year to maintain or rehabilitate these degraded rivers by clearing away alien vegetation; building and maintaining gabion walls and retention ponds, or replanting vegetation to improve the water quality.

That was one of the financial 'downsides' to river maintenance. However, these costs would be cancelled out by the financial benefits of ensuring a cleaner raw water supply at three key water treatment works: Roodeplaat, Wallmansthal and Klipdrift. Due to cleaner water from river restoration, it was estimated that water treatment costs at the three plants would be reduced by about R13.2 million per year due to savings in electricity and chemical treatment costs.

Rehabilitating the rivers would also result in further annual cost savings to the city of Tshwane of around R55 000 by extending the useful life of stormwater infrastructure and a further R24.2 million annual increase in property rates in adjoining green belts. Overall, the analysis showed that the financial benefits of river restoration and maintenance "significantly outweigh the cost of mitigation."

Elaborating on how these costs and benefits were determined, the researchers note that the Roodeplaat Dam (about 24 km northeast of Pretoria) is a critical water resource for parts of Gauteng and North West province, but its feeder rivers are becoming increasingly polluted by poorly treated domestic wastewater as well as farming and informal settlements. "Despite its importance, the Roodeplaat Dam suffers from high levels of eutrophication, algae, and water hyacinth, which degrade its biophysical integrity," they write in the final report.

Closer to the urban heart of Pretoria, the 60 ha Colbyn Valley Wetland Nature Reserve also helps to purify water, control flood damage and erosion of the river banks. Along with the Meintjieskop ridge, Pretoria National Botanical Gardens and the University of Pretoria experimental farm and sports grounds, Colbyn Valley plays an important role in forming a 'green' corridor in Pretoria's urban landscape, as well as providing a refuge and migration route for wildlife.

Further downstream, however, the Pienaars (Moretele) River flows through several informal settlements in Mamelodi with poor sanitation services and also suffers from illegal dumping. To alleviate these problems, the researchers say it is important to build or maintain gabion structures (rocks packed in metal cages) to reduce soil erosion of the river bed and channels, while water retention ponds help to slow down the speed of floodwaters. Further maintenance work includes refuse clearance and maintaining fire breaks to reduce damage to grassland and wetland vegetation from uncontrolled fires.

While these costs can be significant, the report states that the long-term benefits often outweigh the expenses. For example, healthy wetlands act as filters, removing excessive levels of nutrients, such as nitrogen and phosphates. They also help to settle suspended particles and sediments, thereby reducing turbidity in water.

Additionally, wetlands serve as buffers, slowing down and capturing runoff, allowing for the natural settling of pollutants. The combined actions of filtration, nutrient regulation, microbial activity, and pollutant retention underscore the vital role of wetlands in purifying water and sustaining healthy aquatic ecosystems. This ultimately reduces the cost of purifying tap water at municipal treatment plants.

Healthy rivers also play a vital role in managing stormwater by acting as sponges and preventing further wear and tear on concrete stormwater infrastructure. A further spin-off benefit from maintaining healthy rivers and green spaces in urban areas comes from higher property values.

The authors note that properties near wetlands often enjoy higher market rates due to their scenic and aesthetic value. Wetland areas also offer recreational opportunities for water-based activities, birding and hiking. The scenic appeal of wetlands also makes such properties attractive to buyers seeking

Peter Thompson

This African Finfoot was spotted in June 2024 swimming in the Hartbeesspruit in Derdepoort Recreation Resort, about 6 km downstream of the Colbyn Valley Wetland.

Tamsyn Sherwill

Frost-tipped grasses shiver on an icy winter morning in a wetland outside central Pretoria.

visually pleasing environments and environmental connection. "Hence, if wetlands are to be rehabilitated and conserved, the municipality will benefit from the increased rates from high-value property."

"The case study revealed that property values near green belts could increase by an average of 23% and enjoy higher market rates due to their scenic value, aesthetic appeal, and enhanced safety from flood mitigation provided by the wetlands. This, in turn, could result in increased property tax income for the City of Tshwane. The additional revenue from property rates is around R24.2 million per year."

As an example, a 2014 study focused on the Groenkloof Nature Reserve and Fountains Valley recreation resort suggested that more than R150 million in additional rates revenue in Tshwane was attributable to increased property values for homes within 500 metres of urban green infrastructure.

However, despite increasing global awareness about the importance and economic value of green infrastructure, the group of eight researchers says there are a few (if any) formal institutional arrangements in South African cities to formalise decision-making around these assets into day-to-day economic decision-making. "In this study, we investigate the potential of using municipal asset management systems as a mechanism for institutionalising such financial net benefits within municipal accounting systems, and thus creating incentives for investing in green infrastructure."

To do this, they examined asset management systems used in South Africa and other countries, along with the regulations governing the public sector. In South Africa, the regulatory framework for asset management is guided by the Constitution, the Municipal Systems Act (MSA), and the Municipal Finance Management Act (MFMA). They also mapped the geographical boundaries of each green infrastructure wetland area using desktop studies and ground truthing, and carried out valuations based on the financial benefits the municipality derives from these assets.

Tamsyn Sherwill

This large gabion structure helps to reduce stormwater erosion in the 60 ha Colbyn Wetland Reserve.

Tamsyn Sherwill

A view of the same gabion structure as shown left almost concealed by raging stormwater during a heavy downpour in 2019.

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Tamsyn Sherwill

A close up of the gabion structure in the Colbyn Valley Wetland.

Then came the somewhat more complex task of integrating these assets into the municipality's asset management system. "The assessment showed that municipalities do have available tools, frameworks and standards required for integration analysis."

While the Auditor-General did not provide explicit guidelines, the researchers conclude that rivers and wetland areas can be classified under "property, plant and equipment" in municipal asset registers, as green infrastructure was seen as the nature-based equivalent of built or hard infrastructure.

But there were also challenges ahead in ensuring that municipal personnel have the right skills to conduct economic valuations of natural assets. Another significant challenge is the substantial cost of conducting assessments, mapping, and monitoring green infrastructure. "Unfortunately, limited financial resources often result in a lack of skilled personnel, technical equipment, and resources necessary to conduct comprehensive assessments … Furthermore, insufficient financial support can undermine the capacity to address ongoing maintenance and monitoring needs, thus compromising the effectiveness and longevity of the incorporated green infrastructure.

"To address this challenge, innovative funding mechanisms, public-private partnerships, and sustainable financing models should be explored. Increased investment in green infrastructure should be considered not only for its environmental benefits but also for its potential to improve the general public's quality of life while generating economic returns in the form of ecotourism and ecosystem services. To conclude, many of the systems necessary for the successful integration of green infrastructure into the City of Tshwane's register (and other municipalities) are already in place."

However, potential challenges include the need for additional technical capacity (skills) and budget to manage the increased workload. "For further work, it is therefore recommended that these challenges be further explored, as they hold the key to the successful implementation of the framework. The framework must also be tested with several Metros to gain acceptance by the South African Local Government Association (SALGA)."

The following researchers were involved in the project: Dineo Makate, Christian Griffiths, Elsie Leshaba, Kyle Harris, James MacKenzie, Nompilo Mazibuko, Wendy Maiwashe and Jackie Crafford.

Tamsyn Sherwill

A party of visitors squelch through a muddy section of the Colbyn Valley Wetland.

Tamsyn Sherwill

Early morning mist hangs over the 60-hectare Colbyn Valley Wetland in suburban Pretoria.

SMALLHOLDER FARMERS

Bridging the water divide: Climate-resilient pathways for smallholder farmers in the Western Cape

In the quiet valleys and windswept plains of the Western Cape's historic towns, a slow crisis is unfolding. It doesn't announce itself with a single cataclysmic event, but with the relentless drip of drought years, the creeping decay of old pipes and furrows, and the quiet frustration of farmers watching crops wilt for lack of water. Yolandi Schoeman reports.

For South Africa's smallholder farmers, often the backbone of local food systems, water insecurity has always been a fact of life. But climate change is turning a challenge into an existential threat. The Western Cape's rainfall patterns have become erratic, droughts more prolonged, and competition for scarce resources fiercer than ever. When your farm relies on seasonal streams or a gravity-fed furrow system laid down decades ago, a single season of failed rains can mean the difference between a harvest and hunger.

A Water Research Commission-funded study, conducted by the Cape Peninsula University of Technology (**WRC Report No. 3194/1/24**), provides a comprehensive examination of this unfolding crisis. It examines not just the weather and the pipes, but the governance structures, economic inequities, and institutional gaps that determine who gets water, when, and how. And crucially, it offers a set of climate-resilient pathways that could transform vulnerability into resilience.

Beyond the weather: The three-headed challenge

The study's starting point is clear: water scarcity for smallholder farmers is not simply about "less rain." It's the result of three interconnected challenges:

- Climate change impacts

Increasingly frequent droughts, unpredictable rainfall, higher evaporation rates, and extreme weather events are placing unprecedented stress on water systems. For farmers, this means shifting planting calendars, crop losses, and increased costs for irrigation.

- Ageing and inadequate infrastructure

Across the Western Cape's smallholder farming communities, irrigation channels leak, storage tanks are too small, and pumps sit idle for want of repairs. The research found that while some

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new infrastructure exists, maintenance is inconsistent, and replacement cycles are slow. Even cost-effective gravity-fed systems are underused because farmers without secure land tenure are reluctant to invest in upgrades.

- Governance and institutional gaps

Policies and regulations exist, but their implementation often bypasses smallholders. The inability to enforce water-use rules or to include small-scale farmers in decision-making processes has left many marginalised. Structural inequities, rooted in South Africa's history, mean that commercial farmers are often better positioned to secure water rights, access subsidies, or influence local water allocation.

This combination creates what the researchers call a "governance-infrastructure-climate" nexus, a tangle of issues that can't be solved in isolation.

Farmers on the frontline

The study's fieldwork spanned 15 historic towns in the Overberg and West Coast Districts, places like Genadendal, Elim, Goedverwacht, and Barrydale. Here, smallholder farmers are innovating under pressure. Some are pooling resources through cooperatives, others are experimenting with conservation agriculture, crop diversification, and organic methods to make the most of every drop. Rainwater harvesting tanks and small farm dams have become lifelines. Yet these are often stop-gap measures – important, but insufficient for prolonged droughts.

The interviews reveal a stark reality: resilience exists, but it's often isolated. Many promising initiatives lack the support, finance, or coordination to scale up and benefit entire communities.

One farmer in Tesselaarsdal summed it up: "We know how to farm with less water, but we can't do it alone. Without support for infrastructure and fair access, our efforts stay small."

The infrastructure story: Pipes, pumps, and possibilities

The research team assessed the condition of agricultural water infrastructure using indicators such as adequacy, dependability, equity, and efficiency. With regards to storage, they found that many farmers rely on JoJo tanks or small on-farm dams, important but insufficient to bridge long dry periods. Challenges are also experienced with the conveyance of water – ageing gravity-fed channels and leaking pipes lose precious water before it reaches fields.

Where pumps exist, they are often old, inefficient, or broken. Few systems have functioning measuring devices, making it difficult to track and manage usage. Responsibilities for upkeep are often unclear, especially where infrastructure crosses multiple land parcels or falls under ambiguous governance.

Upgrading this infrastructure isn't just about replacing old parts, it requires clear management responsibilities, secure land tenure, and financing models that work for smallholders.

Water governance: The human infrastructure

Water governance in South Africa is underpinned by strong legislation – the National Water Act (1998), the Water Services Act (1997), and more recent strategies like the National Water Resource Strategy (2023). Yet in practice, smallholder farmers often find themselves on the periphery of decision-making.

The study applied selected OECD principles of good water governance, looking at transparency, inclusivity, capacity, and equity, and found consistent gaps:

- **Transparency and communication**: Many farmers are unaware of the processes for securing water rights or reporting infrastructure problems.
- **Participation**: Local water management bodies exist, but smallholder representation is weak, and women farmers in particular are underrepresented.
- **Capacity**: Catchment management agencies (CMAs) and water user associations (WUAs) often lack the staff and funding to engage meaningfully with all stakeholders.
- **Equity**: Historical inequalities continue to shape who has secure water access and who doesn't.

The result? Decisions that affect smallholder water security are often made without their full involvement, undermining both trust and effectiveness.

The research highlighted several important insights:

Water as the biggest bottleneck

Nearly every farmer interviewed noted that water availability determines what and how much they can produce.

Fragmented government support

Farmers receive assistance but programmes are often uncoordinated, short term or misaligned with local needs.

Weak farmer organisations

While some cooperatives exist, most are poorly resourced and lack strong leadership.

Gender and youth gaps

Women and young people are underrepresented in smallholder networks.

Potential in diversification

Farmers who grow multiple crops or combine crops with livestock fare better in terms of resilience and income.

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Farmers who grew multiple crops or combined crops with livestock were found to fare better in terms of resilience and income.

Seeds of change: Climate-resilient pathways
Using the Three Horizons Framework, the researchers worked with farmers, government officials, NGOs, and private sector stakeholders to envision practical pathways to a more secure water future.

Five priority shifts emerged, the first being the need to strengthen water governance and capacity. The final report recommends strengthening policies, digitising licensing systems, and building capacity in CMAs and WUAs. There is also a need to foster inclusive partnerships with NGOs and the private sector.

The second shift is to modernise agricultural water infrastructure. The researchers recommend investing in upgrading irrigation networks, storage facilities, and measuring devices. Dedicated maintenance funds should be established and technologies such as drip irrigation and rainwater harvesting incentivised.

There should also be a shift towards climate-resilient farming. "Expand access to drought-tolerant seeds, seed banks, and training in conservation agriculture. Support crop diversification to reduce dependency on water-intensive crops," the researchers say.

The fourth priority shift is enhancing farmer participation and equity by creating local water management councils with strong smallholder representation. Support should be provided for gender-sensitive approaches and finance models that work for marginalised farmers.

The last strategy is fostering collaboration and innovation. "Support farmer cooperatives, multi-stakeholder innovation hubs, and private sector investment in rural water solutions. Integrate traditional knowledge with modern technology," the report recommends.

From policy to practice: The next steps
The research doesn't shy away from the hard truth: solving smallholder water insecurity in the Western Cape will require both top-down and bottom-up change. From above, this means sustained policy attention, targeted funding, and institutional reform. From below, it means empowering communities to co-manage resources, innovate, and hold decision-makers accountable.

The authors also identify priorities for future research, including using remote sensing, geographic information systems (GIS), and smart irrigation to improve efficiency; integrating traditional practices into governance and adaptation strategies; testing innovative financial models (microfinance, blended finance, public-private partnerships) to sustain infrastructure and farmer support; and applying 'peace engineering' to design water systems that reduce conflict and foster cooperation.

Why this matters beyond the Western Cape
While the study focuses on the Overberg and West Coast Districts, its lessons are national, and even global. Across southern Africa, smallholder farmers face the same three-headed challenge of climate stress, ageing infrastructure, and governance gaps.

In a water-scarce country like South Africa, ignoring these challenges risks not just local food security but rural livelihoods, social stability, and economic resilience. The stakes go beyond agriculture – healthy smallholder systems are central to rural economies, cultural heritage, and biodiversity stewardship.

A call to action
The image that emerges from this research is not one of despair, but of untapped potential. Smallholder farmers are already adapting, innovating, and collaborating, but their efforts are too often fragmented and under-resourced. By aligning infrastructure investment, governance reform, and climate adaptation in a coherent, inclusive strategy, South Africa can turn its most vulnerable farmers into leaders of resilience.

As one cooperative leader in Barrydale put it during the study's workshops: "We don't just need water to survive. We need a system that sees us, hears us, and works with us."

The water is scarce. The time is short. But with the right pathways, the Western Cape's smallholder fields can still be places where resilience grows.

To access the report, ***Infrastructure Performance, Water Governance and Climate Change Impacts on Water Resource Management for Smallholder Farmers in the Western Cape, South Africa*** (WRC **Report No. 3194/1/24**), visit: https://www.wrc.org.za/wp-content/uploads/mdocs/3194%20final1.pdf

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WATER REUSE

Africa's water future: World Bank report calls for urgent action to scale water reuse

A new report from the World Bank Group has called for the scale-up of water reuse as part of a portfolio of options to stave off global water insecurity. According to the report, Scaling Water Reuse: A Tipping Point for Municipal and Industrial Use, accelerating investments into water reuse can develop the market, drive down costs, spur innovation and commercial finance, especially in water-scarce regions such as Africa. Lani van Vuuren reports.

The report outlines five strategic transitions and a suite of recommendations aimed at enabling governments, utilities, and industries to unlock the full potential of water reuse. With reuse representing only 3% of freshwater withdrawals in 2024 for municipal and industrial use, the world stands at a pivotal moment to turn 'wastewater' into valuable 'new water'.

Why water reuse matters for Africa

Africa is already facing acute water stress, with rising urbanisation, erratic rainfall, and infrastructure deficits putting millions at risk. South Africa, in particular, has made headlines for its periodic "Day Zero" threats in cities such as Cape Town. In such contexts, the report highlights that water reuse is not a luxury – it's a necessity. Cities and industries across the continent discharge enormous volumes of untreated water daily, missing an opportunity to transform this into a reliable, drought-resilient water supply. The report identifies reuse as a cost-effective and climate-resilient alternative to desalination or long-distance water transfers, both of which are often financially or technically unfeasible for African municipalities.

Africa, particularly South Africa, is home to several promising reuse initiatives. Notably, South Africa's eThekwini municipality is cited in the report as a successful model, with its Durban Water Recycling Project, for example, showing how reclaimed water can safely and reliably meet industrial and municipal demand. The country's first indirect water reuse scheme (via groundwater) was commissioned in the mid-1970s in Atlantis, Cape Town. The Atlantis aquifer is artificially recharged using a combination of stormwater runoff and treated domestic wastewater. Beaufort West was the first town to build a direct potable reuse plant in the country, where treated wastewater effluent is conveyed directly to a water treatment facility for further treatment to drinking water standard. Another successful example is the eMalahleni water reclamation plant in Mpumalanga, where mine-water is treated to drinking water standards.

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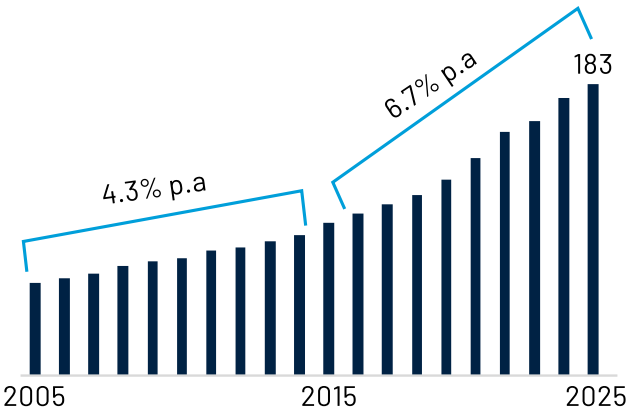
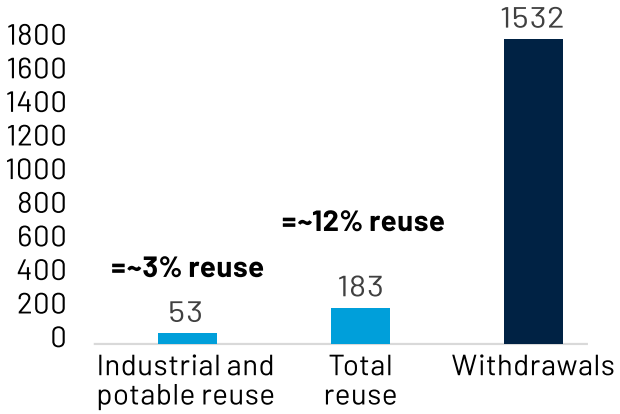


Total global installed reuse capacity (million m³/day).

Khemka, R. and Eberhard, R. 2025. Scaling Water Reuse: A Tipping Point for Municipal and Industrial Use. Washington, DC: World Bank.



Reuse as a percentage of freshwater withdrawals for the municipal sector (million m³/day).

Khemka, R. and Eberhard, R. 2025. Scaling Water Reuse: A Tipping Point for Municipal and Industrial Use. Washington, DC: World Bank.

As Kalebaila et al. point out in their working paper published in 2020, the potential role of water reuse as part of a portfolio of alternative water sources (above conventional surface water supplies) is well established in South Africa. The planning and commissioning of water reuse projects is guided by several policy documents and governed by legislation across different government departments. The country is planning to increase its dependence on water reuse to 18% (from the current 14%) by 2040. However, while several additional municipal water reuse projects are planned, progress is largely driven by crises during drought conditions when conventional water sources run dry. The water reclamation plants constructed in the towns of George and Mossel Bay during the drought in 2010 are examples of this.

Five key transitions for scaling water reuse

At the heart of the World Bank report are five "tipping point" transitions – clear, actionable shifts required to embed reuse in national and local water strategies:

1. **Value clean water appropriately**: Free or heavily subsidised freshwater makes reuse uncompetitive. The report calls on governments to adjust tariffs to reflect the full economic, environmental, and social cost of water.
2. **Prioritise high-value applications**: Purified water should be directed to uses where there is a willingness to pay, such as industrial processes or municipal drinking water, rather than low-value applications.
3. **Normalise 'new' water use**: Public perceptions must shift to accept treated used water as a safe, reliable source. Education and regulatory standards will be key to overcoming cultural resistance, particularly for potable reuse.
4. **Adopt programmatic, platform-based approaches**: Instead of isolated projects, the report urges countries to develop scalable, replicable programmes using consistent standards, public-private partnerships, and blended financing models.
5. **Mobilise private innovation and capital**: Just as renewable energy scaled through private investment and innovation, the same approach is needed for reuse. The report calls for creating bankable projects that crowd in commercial finance.

The African imperative: Specific recommendations

The report dedicates substantial attention to how these transitions can be implemented in African contexts.

Firstly, it emphasises the role of the public sector. The report recommends that African governments lead by establishing clear regulations on water abstraction and discharge, setting targets for reuse, and creating financial incentives for utilities and industries to invest in treatment infrastructure.

At the local government level, cities must include reuse in their water security strategies, especially as urban populations explode. By 2050, 70% of the global population will live in cities, many of them in Africa.

Water reuse offers various opportunities for the private sector. Industries, especially mining, textiles, and food processing, can adopt reuse to reduce risks and enhance supply reliability. The report identifies strong potential in industrial parks near urban centres where treated water can be looped back into production systems.

Lastly, there is a need for infrastructure investment. The World Bank estimates that US$170–340 billion is needed globally over 15 years to scale reuse to 25% of freshwater withdrawals. Africa will need a significant share of this investment, channelled into urban wastewater treatment, decentralised systems, and technology upgrades. Reuse must be integrated into broader water resource planning. In landlocked regions, it may affect downstream users. Systems thinking is essential to ensure equity and environmental sustainability.

Overcoming challenges: Cost, culture, and coordination

Despite its promise, the report acknowledges several barriers to widespread adoption. The first is the perception of cost. Compared to water reuse, freshwater remains cheap, and often free, in many parts of Africa. Until pricing reflects actual costs and risks, reuse will struggle to compete.

Then there is the 'yuck' factor associated with reused water – especially for drinking. As Kalebaila et al point out, in South Africa, a lack of public knowledge on treatment technology, a lack of trust in the implementation capacity of municipalities or a lack of technical skills within municipalities can jeopardise the success of any water reuse project. "In particular, the [general] poor performance of wastewater treatment works [in South

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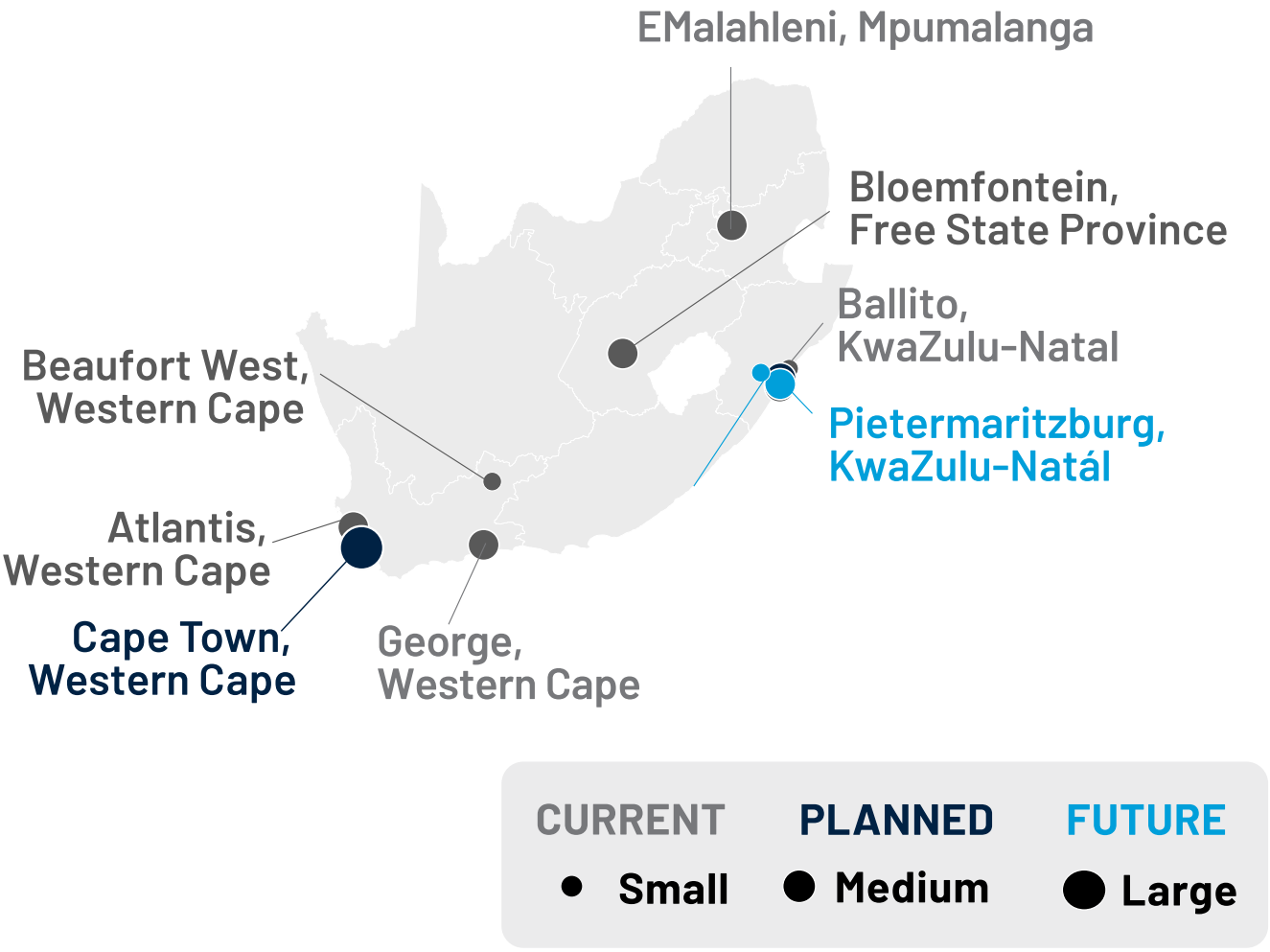
Khemka, R, and Eberhard, R. 2025. Scaling Water Reuse: A Tipping Point for Municipal and Industrial Use. Washington, DC: World Bank.

South Africa



Current and planned water reuse activities in South Africa.

Africa] paints a negative picture with regards to the ability of municipalities to manage wastewater treatment [and therefore water reuse]."

Further, the World Bank report points out that governance is often fragmented in African countries and coordination across water, sanitation, health, and environmental ministries is often weak. The report stresses the need for integrated water governance structures.

Looking ahead: Reuse as a cornerstone of Africa's water future

With rapid population growth, increasing climate variability, and rising economic aspirations, Africa cannot afford to ignore the potential of water reuse. The World Bank report offers a clear, evidence-based roadmap for how governments, industries, and citizens can work together to redefine water security on the continent.

From the dusty streets of Gaborone to the industrial corridors of Gauteng, reused water could be the solution that bridges the widening gap between demand and supply. It is not just a question of technology; it is a matter of political will, institutional reform, and visionary planning.

As the report concludes: "Water reuse is not a solution of the future, it is a solution for today." For Africa, embracing this solution could be the key to securing a liveable, prosperous future for generations to come."

To access the original report, visit; https://www.worldbank.org/en/topic/water/publication/scaling-water-reuse#:~:text=The%20World%20Bank%20Group's%20new,sustainable%20source%20of%20new%20water.

Additional reference: N. Kalebaila et al. 2020, Working paper: Strengthening the implementation of water reuse in South Africa, https://wrcwebsite.azurewebsites.net/wp-content/uploads/mdocs/WRC%20Working%20Paper_water%20reuse%20in%20SA.pdf

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WEF NEXUS

Breaking the silos: WRC's WEF nexus research transforms policy and practice

South Africa has quietly emerged as a global thought leader in one of the world's most urgent conversations: how to secure the future of water, energy, and food. At the centre of this effort is the Water Research Commission (WRC), which has spent more than a decade pioneering the water–energy–food (WEF) nexus approach, a transformative way of tackling interconnected challenges that threaten livelihoods, economies, and ecosystems. Article by Sylvester Mpandeli, Stanley Liphadzi, and Luxon Nhamo.

Research on the WEF nexus gained momentum in 2011 following the Bonn 2011 Conference, where it was introduced by the Stockholm Environmental Institute (SEI) (Hoff, 2011). This marked the realisation that the current exploitation and silo-based management of the three sectors was unsustainable, as resources were depleting and degrading at an alarming rate (UNGA, 2015). The SEI provided initial evidence on how the WEF nexus can improve water, energy, and food security by enhancing efficiency, reducing trade-offs, building synergies, and strengthening governance across sectors.

The SEI report (2011) also recommended policy harmonisation. Consequently, there was a consensus among world leaders and researchers to shift from the existing linear economic model to a systematic, transformative, and holistic approach that fosters sustainable development (UNGA, 2015). Alongside other research institutions, the WRC, with its partners, started engaging in WEF nexus research, contributing to the global transformation agenda and discourse. While the WRC had been promoting integrated approaches before this time, such as integrated water resources management (IWRM), the focus now shifted towards the more polycentric WEF nexus in line with global trends.

In 2012, the WRC established the WEF Nexus Lighthouse, a flagship research, development and innovation programme encompassing all WRC research themes to oversee work on the WEF nexus in South Africa. Several research projects across these themes are aligned with the WEF Nexus Lighthouse, following a structured research pathway to guide resource management, decision-making, and policy.

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This article details how the WEF nexus has evolved and highlights the WRC's role in holistically addressing diverse societal and environmental challenges through the WEF nexus. It also emphasises the progress made by WRC and its partners in transforming the WEF nexus from theory to practice, as exemplified by developing conceptual or discursive frameworks and transforming them into practical analytical decision-support tools. Policies influenced by the WEF nexus WRC-funded projects have enhanced livelihoods and advanced sustainable socio-economic development, contributing towards the realisation of the 2030 Global Agenda on sustainable development (Nhamo et al., 2025).

To date, the WRC has funded over 40 WEF nexus research projects, and its research managers are actively contributing to the research and publishing articles in internationally peer-reviewed journals. WEF research findings have provided local solutions with a global impact. Notably, the WRC-funded research has defined WEF nexus indicators, developed a WEF nexus analytical model, and applied the theory of change as a process to operationalise the WEF nexus (Nhamo et al., 2020). The results have benefited South Africa and have had substantial global influence, as evidenced by the high number of citations of its WEF nexus-related publications (Cho et al., 2023). South Africa and the southern African region are now recognised as global thought leaders in WEF nexus research, development, operationalisation, and implementation.

Through a bibliometric analysis, the article demonstrates the progress made in implementing and operationalising the approach. This was achieved through an impact research approach that assessed the contribution of the WRC in WEF nexus research. The data were obtained from the Scopus database (Figure 1). The focus was from 2012 to 2025, which witnessed a surge in WEF nexus research and innovations.

Milestones in WEF nexus research in South Africa

The WRC-led research on the WEF nexus reveals a clear evolution, where early work primarily involved literature reviews, framing the approach as a conceptual framework and discourse tool. However, recent research has transitioned towards developing the approach into an analytical and operational framework. Initial WEF nexus studies, funded by the WRC, successfully presented the approach as a conceptual model that simplifies human understanding of the complex connections among WEF sectors and promotes coherence in policymaking, thereby supporting sustainable development (Mpandeli et al., 2022). Several publications and reports from this period highlight the WRC's contribution to the WEF nexus and introduce innovative products that encourage transdisciplinary, transformative, and integrated research globally (Cho et al., 2023). Driven by the challenge of transforming the WEF nexus into a practical, evidence-based operational framework, the WRC has since developed WEF nexus analytical models and harmonised policy frameworks to facilitate coherent policy decisions for sustainable development.

Bibliometric analyses by author, country, and institution

The top five countries leading in the WEF nexus are China, the United States of America, South Africa, Germany, and Brazil, with South Africa occupying the third position. Only three of the BRICS countries, namely China, South Africa, and Brazil, are within the top ten countries. South Africa and Egypt are the only African nations in the top twenty. These findings align with a study conducted at the University of Pretoria in 2023, which identified South Africa, the WRC, and its research managers as among the top contributors to WEF research worldwide (Cho et al., 2023). The WRC has largely funded South Africa's WEF nexus research for the past twelve years. The WRC and its partners have produced numerous research articles and reports on the WEF nexus across various spatial scales, including households, catchments, local municipalities, provincial, national, and regional levels. In collaboration with the National Research Foundation (NRF), the WRC has invested significant financial and human resources to support research on the WEF nexus and other transformative initiatives.

While the South is doing well, the bibliometric analysis found that a lack of funding hinders research growth in the rest of Africa, along with inadequate institutional support, a lack of collaboration networks, poor research priorities, and low human capacity development. These challenges are compounded by low self-motivation, limited research capacities and self-efficacy, and a burdensome workload (Cho et al., 2023). However, South Africa seems to have overcome these challenges, leading in multiple collaboration publications (MCPs) (Figure 2), indicating a significant level of researcher collaboration within Africa and internationally. However, there is still a significant amount of single-country publications (SCP).

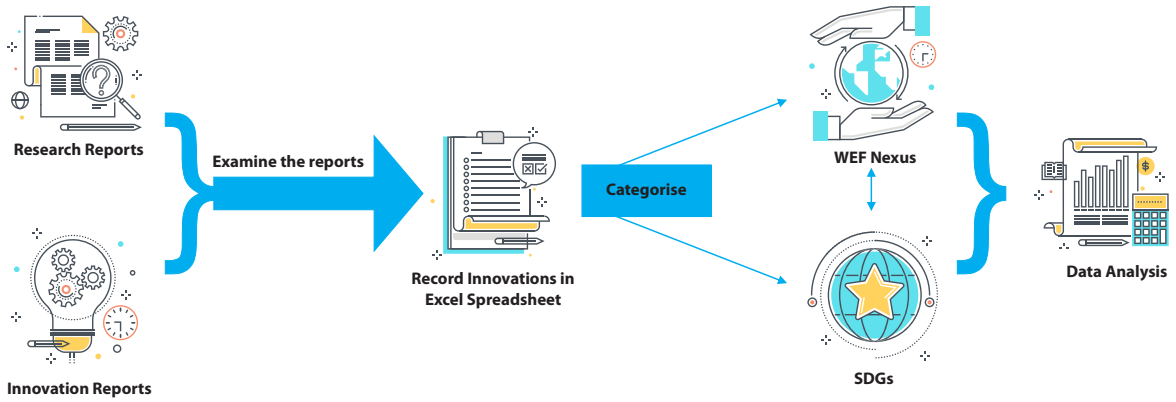


Figure 1. An analysis of the search process used to collect WEF nexus research outputs.

Cho et al., 2023)

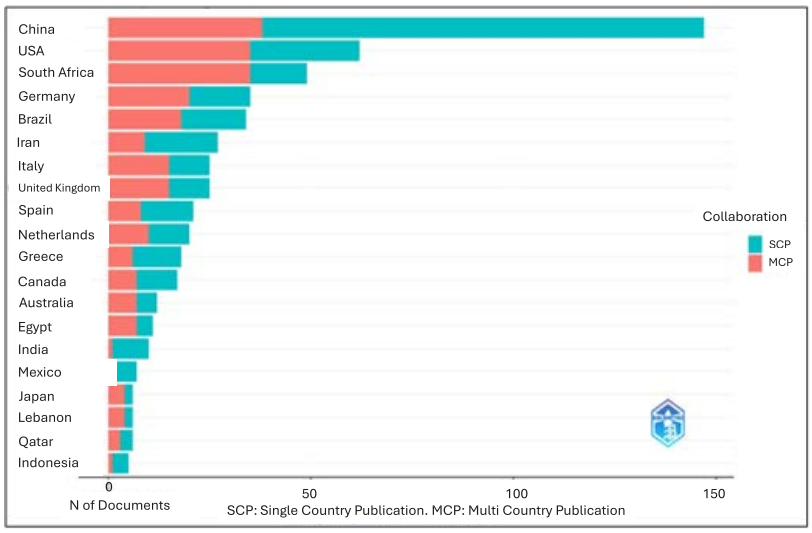


Figure 2. Country contribution to WEF nexus research.

Cho et al., 2023)

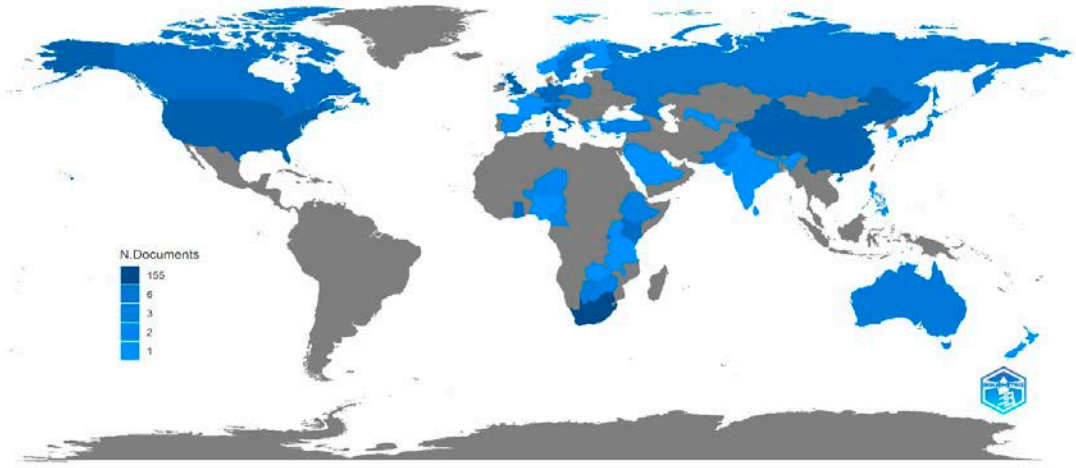


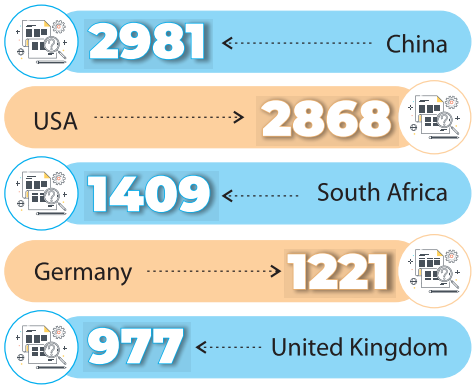
Figure 3. Country specific WEF Nexus publication productivity.

The heat map shown in Figure 3 supports Figure 2 regarding country-specific WEF nexus research publication productivity, where South Africa compares itself with the United States of America and China. The dark colour indicates countries with the highest publication productivity, while the lighter shades show decreasing levels. Countries coloured grey have no publication productivity at all or no publications discoverable/indexed in the academic databases.

As a water-scarce country, South Africa needed to invest in research that promotes water use efficiency, especially considering the recurrence of drought events, among other extreme weather events, in the country. Extreme weather events significantly affect climate-sensitive agriculture, water, and energy sectors, which are the key WEF nexus sectors. In addition, the country's National Development Plan (NDP) goals are linked to the global sustainable development goals. The country is obligated to achieve both the NDP goals and the SDGs by 2030. As a result of the financial resources invested in WEF nexus research, South Africa ranks third among the countries with the most WEF nexus publications worldwide (Figure 4).

The top five countries in terms of the number of WEF nexus publications:

Cho et al. 2023



China and the United States exceed South Africa in total citations because these countries are more developed and have more resources for research funding. South Africa remains the only African nation in the top ten for the most cited countries. Globally, researchers from South Africa are among the top five in publication volume, making a significant contribution to the WEF nexus body of knowledge (Figure 5). South African authors

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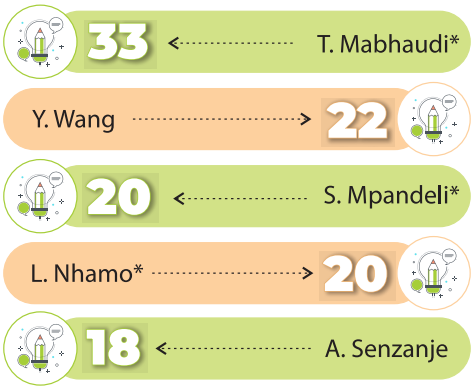
have taken on the role of promoting the African perspective and encouraging research collaboration among African scholars in WEF nexus research. The ten most published South African authors, listed in order of merit, include T. Mabhaudhi, S. Mpandeli, L. Nhamo, A. Modi, D. Naidoo D., and A. Senzanje, all supported and funded by the WRC.

Cho et al. 2023

Top five most relevant authors in WEF nexus research in the world in 2025.

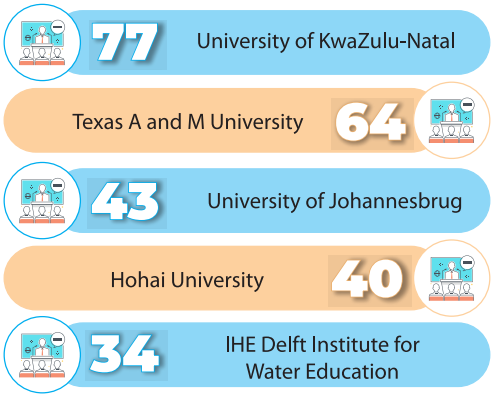


** South African authors*

In terms of the most WEF nexus research published by institutions in the world, the University of KwaZulu-Natal (UKZN) is topping the list, with 77 publications. South Africa has two other institutions in the top ten, namely the University of Johannesburg (UJ) and the University of Venda (UNIVEN). These South African institutions are mostly funded by the WRC. The results further confirm that the WRC made the right decision by investing in the WEF nexus. As the WRC, we believe that we need more universities, science Councils and NGOs to be actively involved in the WEF nexus, not only in South Africa, but across the African continent.

Cho et al. 2023

Top five WEF nexus research published institutions in the world.



Conclusions and recommendations

This article reviews how countries have performed in WEF nexus research over the past decade. WEF nexus research is vital for shaping the global transformation agenda and achieving the SDGs, especially as key resources continue to decline and deplete due to various drivers of global change, including climate change, rapid urbanisation, and growing population numbers.

The article emphasises the contributions of researchers from South Africa in WEF nexus research and global change. Currently, authors from South Africa are leaders in this field. A unified effort within and across WEF sectors is necessary to address the increasing challenges of resource insecurity. An expanding body of innovative solutions, created by the WRC, aims to tackle water, energy, and food shortages. Although the WRC has been pioneering WEF nexus research globally, its cross-sectoral and comprehensive adoption remains slow. Nevertheless, this approach is essential for tackling humanity's grand challenges and realising the SDGs. Developing a research agenda to guide WEF nexus research, development, and innovation is a fundamental part of the WRC's strategy to fund focused initiatives that broaden the evidence base, showcase the WEF nexus through pilot studies, and incorporate research outputs into national policy.

This article traces the development of WEF nexus research and innovation in South Africa and highlights the influence of the country's researchers on the field. The WRC primarily funds this research in South Africa, driven by the recognised importance of the WEF nexus in tackling national and regional priorities, such as resource insecurity, rising poverty and inequality, increasing unemployment, and urbanisation. WRC-funded WEF nexus research has produced innovations that support the transformational agenda. As a result, WRC research has transitioned from a purely theoretical approach to a practical, operational decision-support tool.

Notably, it includes creating an integrated and analytical WEF nexus model that simplifies understanding the complex linkages among WEF resources, demonstrating how resources are managed and identifying priority areas for intervention. These innovations have provided evidence and spurred policy changes to facilitate the shift from a linear to a circular economic model. However, further research is necessary to develop context-specific scenarios that reduce uncertainty caused by current sector-based and linear resource management approaches.

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WATER EFFICIENCY

Every drop counts: New labels to help South Africans save water (and money)

A Water Efficiency Labelling Scheme (WELS) for South Africa is on its way. Sue Matthews reports.

We've probably all had experiences with water-saving devices that test our patience. Perhaps it was some ineffectual waving of hands to get the sensor of a touchless tap to recognise our presence, or having to push repeatedly on a self-closing pillar tap for enough water to rinse off soap. Or maybe it was a low-flow showerhead that delivered an insipid spray, or the dual-flush toilet that couldn't remove toilet paper from the bowl unless the full-flush button was pressed.

But these types of plumbing fittings and fixtures do play an important part in reducing water use, which is especially important in South Africa, given that a substantial water deficit is expected by the end of the decade. A Water Efficiency Labelling Scheme (WELS) for taps, showerheads and toilets marketed in the country is therefore under development, intending to help consumers make informed purchasing decisions and encourage uptake of water-saving products.

In May 2025, a stakeholder consultation forum was held to share progress, solicit input and build partnerships as part of the national WELS development project. The project's Steering Committee is chaired by the Department of Water and Sanitation (DWS) and co-chaired by the Water Research Commission (WRC), with the South African National Energy Development Institute (SANEDI) fulfilling the secretariat function. SANEDI is also sharing its experience gained through the South

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African Appliance Standards and Labelling Programme in the development of the South African Energy Efficiency Label. That process was supported by CLASP, an international non-profit organisation that was originally called the Collaborative Labelling and Appliance Standards Programme. It now goes by the acronym only and is recognised as the leading global authority on efficient appliances and their role in combating climate change and improving people's lives. CLASP provided support to the WELS project, too, and appointed Jackstra Solutions to give technical assistance to the Steering Committee.

The May consultation forum marked the conclusion of the first phase of WELS development. According to Herman Strauss of Jackstra Solutions, a mature working document containing a draft standard has since been submitted to the South African Bureau of Standards (SABS), which will take it forward according to the legislated process for creating national standards. That includes review by a Technical Committee, which will revise it where necessary to ensure it's written in the correct format and aligned with international benchmarks, followed by gazetting for public comment, further redrafting and public consultation if appropriate, verification by the SABS Standards Approval Committee and, finally, publication as a South African National Standard (SANS).

The SABS is already well informed about the topic because it participated in the International Organisation for Standardisation (ISO) committee to develop ISO 31600, 'Water efficiency labelling programmes – Requirements with guidance for implementation', which came into effect with its publication on 21 June 2022. The standard includes best practices from existing schemes around the world. Australia has the most comprehensive mandatory one, with taps, showers, flow controllers, toilet and urinal systems as well as washing machines and dishwashers, retailed since 1 July 2006 required to display their water usage information and WELS star rating – six stars being the most efficient. Prominent voluntary schemes include WaterSense in the United States, sponsored by the US Environmental Protection Agency (EPA), and the Unified Water Label in Europe.

In South Africa, the goal of implementing a WELS was noted as early as March 2000, in the then Department of Water Affairs and Forestry's 'Draft Water Conservation and Water Demand Management Strategy for the Water Services Sector' This document was developed from the output of a workshop of key stakeholders in July 1999, but by the time the final version was published in August 2004, all mention of a WELS had been removed. Four years later, however, the WRC published a research report (**WRC Report No. TT 358/08**) by Dave Still and colleagues from Partners in Development, which explored the status and use of water-efficient devices in South Africa's domestic and commercial environments. The report recommendations highlighted the need for a WELS in South Africa and included proposed specifications for water-efficient fittings, fixtures and appliances. Still subsequently presented the project at the WRC's 40-year Celebration Conference in September 2011.

The matter appears to have been put on the back burner for a while, but in 2018, DWS released the National Water and Sanitation Master Plan, which included the establishment of a WELS in South Africa as a key action. Responsibility for this action was assigned to the SABS and DWS, with the target date for completion listed as 2025. The following year, the SABS Technical Committee on plumbing components began participating in the ISO committee to develop ISO 31600.

In 2020, as part of a global scoping study exploring how water efficiency standards can mitigate the impacts of climate change, CLASP commissioned Solid Green Consulting to conduct research in South Africa. Given the restrictions associated with the COVID-19 pandemic, this relied on desktop research and a limited number of semi-structured interviews, but the findings – detailed in the January 2021 report 'In-depth Assessment of Water Efficiency Opportunities in South Africa' – indicated that water-efficient taps and showerheads could reduce water use by more than one trillion litres per year. What's more, the reduction in electricity use to heat some of that water translated to energy savings of 18 terawatt-hours per year, avoiding 16 million tonnes of carbon dioxide emissions per year!

The report concluded with some "recommended next steps" including a gap analysis between the various South African product and installation standards, which were perceived to focus on maximum water flow rates rather than ensuring an appropriate and sustainable supply. Acting on this recommendation, CLASP commissioned SANEDI and Jackstra Solutions to conduct a study on taps in domestic and commercial settings. The resulting report by Herman Strauss, 'South African Tap and Flow Rate Gap Analysis', which was published by CLASP in January 2022, is a comprehensive evaluation of the various SANS and international standards relevant to taps. The gap analysis was performed by recording and collating all flow rate requirements, as well as test conditions for determining the flow rates, and then conducting a modelling exercise to establish whether taps tested internationally would comply with the equivalent requirements of the applicable SANS standard.

Several misalignments between SANS and international standards were found, so it was recommended that selected requirements of the SANS standards be amended. Strauss says that SABS subsequently began working on the amendments and they are now close to finality, which helps clear the way for a WELS to be introduced in South Africa.

"Many of the SANS tap standards were developed years ago, during a period when there were sanctions against South Africa, so a lot of products were manufactured locally and to our own requirements," he explains. "Over time, we became more and more reliant on international suppliers, so it's important to acknowledge that in our standards and prevent trade barriers, while also protecting our consumers by making sure we still get taps that are appropriate for the country."

Other recommendations in the report include maximum flow rates for each type of tap to align with similar international requirements, as well as target water-saving flow rates that could be used in implementing the WELS. For taps used in a hand washbasin, for example, the recommended maximum was 16 litres per minute and the water-saving target 10 litres per minute. In the case of bath taps, though, limiting the flow rate is unlikely to contribute to water saving, so a maximum flow rate was not

recommended and the water-saving target was set at 20 litres per minute.

Later in 2022, CLASP published the "South African Showerheads Testing Report", also written by Strauss. This covered testing of 19 showerheads representing all price categories – budget, low, medium and high – with water flow rates measured at pressures ranging from approximately 250 kPa up to about 550 kPa. Spray patterns at 300 kPa were also photographed, capturing the different settings for those showerheads that had such a feature. The results showed that the budget showerheads had an average flow rate of 26.8 litres per minute at 300 kPa, compared to 8.0 litres per minute for the high-priced showerheads. Showerheads with pressure-compensating flow rate regulators had an average flow rate of 6.6 litres per minute at 300 kPa, while those with a fixed orifice averaged 24 litres per minute, with one being as high as 37 litres per minute. A tap advertised as water-efficient had five settings, with only one of these having a flow rate under 10 litres per minute!

It was clear that a high flow rate is not necessarily equivalent to a better shower experience, because the showerhead's width or shape and the resulting spray pattern play a role too. At the same time, showerheads with low flow rates will not achieve their water-saving objective if users compensate for poor spray force or coverage by taking longer showers, removing the flow control components or switching to a high-flow setting.

Based on the report findings, a proposal was submitted to the SABS to create a South African standard for showerheads, aligned with international standards. It was recommended that the standard should require flow rates to be measured at both 300 kPa and 150 kPa, with the flow rate not exceeding 10 litres per minute at 300 kPa. For the purpose of future WELS implementation, showerheads with a flow rate of 4.5 to 6 litres per minute would be eligible for the highest rating.

At the stakeholder consultation forum in May, it was confirmed that the draft WELS standard deals with taps, showerheads and toilet systems. Dishwashers and washing machines, which have been subject to mandatory energy efficiency labelling since 2016, are not included because industry representatives requested a deferral while they consider how to incorporate a water efficiency indicator into the energy efficiency label.

Strauss says that a decision has not yet been made as to whether the WELS will be voluntary or mandatory. He explains that standards do not prescribe who must follow them, but once they are published, a regulation can be passed to make compliance mandatory. Engagements with industry representatives revealed that there was a preference for a mandatory WELS, but the final decision is up to DWS. There are also various options for including the standard in the Building Standards Act, National Building Regulations or SANS 10400 series used to demonstrate compliance with those regulations, possibly by integrating it into the voluntary SANS 3088: Water Efficiency in Buildings, which is due to be incorporated into SANS 10400.

Another important component of a WELS is the central register that must be maintained and made accessible to anyone wanting to confirm the validity of a label on a product. DWS is in the process of evaluating possible organisations that could host the register, and the best mechanism for appointing one.

"The model that most other countries use is to have a central body that keeps the register, but any supplier can go to an accredited test laboratory or certification body and have their products tested," notes Strauss. "The report can then be submitted to the register, where a verification is done and the products are listed."

He adds that consumers will soon ask questions if they walk into a shop and 80% of the taps have the WELS label, but the rest don't.

"It becomes a compelling mechanism to encourage compliance. In fact, the industry is regulated by consumers, because they decide what they pay for. And when they get a hefty water bill, they will have the information to realise that they can swap their showerhead or taps for more efficient ones. It's a strong motivator for consumers to adopt water-efficient devices, and I think the public is ready for it."

Communities that have experienced water restrictions associated with droughts or water-shedding are especially sensitised to the need to save water. But bearing in mind that homeowners and businesses effectively pay for water three times in our utility bills – buying our water, heating it and then disposing of wastewater – any water-saving measures we adopt put a lot less strain on our bank accounts.

Clearly, the development of South Africa's WELS in line with international best practices in sustainable water management represents a critical opportunity to address the country's water security challenges. Whether voluntary or mandatory, WELS is poised to become a catalyst for behavioural change. Ultimately, by reducing our water and carbon footprints and saving us money, it will contribute to a more resilient and sustainable future for all.

Water-efficient, dual-flush toilets are a common sight in many public restrooms.

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THE WATER WHEEL

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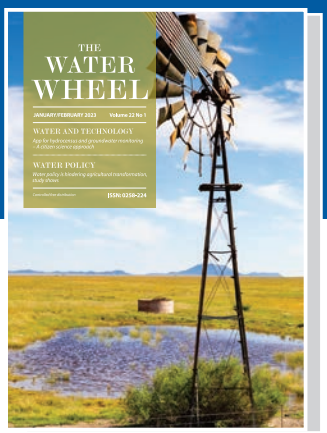

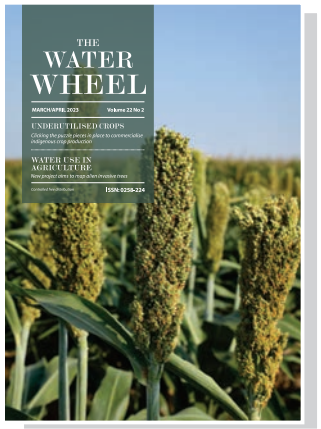

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The knowledge generated by the WRC generates new products and services for economic development, it informs policy and decision making, it provides sustainable development solutions, it contributes to transformation and redress, it empowers communities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

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