THE WATER WHEEL

JULY/AUGUST 2026 Volume 25 No 4

WATER-SMART AGRICULTURE

Blueberries that sip, not gulp: New research offers hope for water-smart farming of 'superfood'

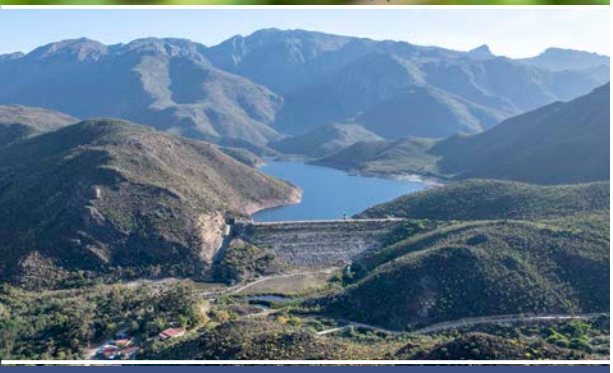
WATER RESOURCE MANAGEMENT

Holsloot River: The hidden waterway behind the Cape's fruit and wine heartland

Controlled free distribution

ISSN: 0258-224

WATER RESEARCH COMMISSION
55 YEARS
Supporting Sustainable Water Futures
1971-2026



THE WATER WHEEL is a two-monthly magazine on water and water research published by the South African Water Research Commission (WRC), a statutory organisation established in 1971 by Act of Parliament. Subscription is free. Material in this publication does not necessarily reflect the considered opinions of the members of the WRC, and may be copied with acknowledgement of source.

Editorial Committee:
Prof Sylvester Mpandeli (Chair), Ms Manjusha Sunil, Mr Bonani Madikizela, Dr Mamohloding Tlhagale and Dr Sudhir Pillay.

Editorial offices:
Water Research Commission, Private Bag X03, Gezina, 0031, Republic of South Africa.
Tel (012) 761 9300.
WRC Internet address:
http://www.wrc.org.za
Follow us on X:
@WaterWheelmag
Editor: Lani van Vuuren,
E-mail: laniv@wrc.org.za;
Layout: Anja van der Merwe,
E-mail: anjavdm@wrc.org.za

Contents

A recently-completed project funded by the Water Research Commission is assisting blueberry farmers to grow more with less water. See article on page 10.

NEWS

Research highlights urgent need to tackle plastic pollution from rivers to oceans

South Africa marked World Oceans Day 2026 by highlighting two major research studies that have shed new light on the growing threat of plastic pollution to the country's rivers, estuaries and oceans.

Both studies were funded by the Water Research Commission. The title of the first study is 'Assessing the impact of different pollution sources on the type of microplastics, associated microbial communities, antimicrobial resistance and transport of microplastics in selected urban rivers in South Africa' (WRC report no. 3230/1/25, https://bit.ly/4ewB13L). The title of the other study is 'Transforming the future of Durban Bay: Strengthening socio-ecological resilience' (WRC report no. TT 945/25, https://bit.ly/4exGCGY).

Speaking at the event, Deputy Minister of Forestry, Fisheries and the Environment, Narend Singh, said this year's theme, 'Reimagine: Beyond the world we know, a new relationship with our ocean', calls for a new approach to environmental management that recognises the deep connection between human activities and ocean health. The studies focus on the environmental challenges facing Durban Bay and the movement of microplastics and associated pollutants through the Msunduzi and Swartkops river catchments. The findings reveal how pollution originating far inland ultimately affects estuaries, coastal ecosystems and ocean health. "The research confirms that plastic pollution is more than a waste management issue. It affects biodiversity, human health, livelihoods, economic activity and community resilience," noted Singh.

The studies also identify practical measures to strengthen environmental resilience while supporting economic growth. The Deputy Minister emphasised that protecting oceans begins with managing rivers effectively and requires collaboration between government, research institutions, businesses and communities. He described the projects as a powerful example of science, innovation and cooperative governance working together to build a more sustainable future from source to sea.

Indigenous foods still shape diets in North West communities

Pumpkin leaves, sorghum porridge and bone marrow remain on the menu in parts of Mahikeng, even as younger generations drift toward processed foods. A new study by Modjadji Mandy Rasehlomi, a North-West University (NWU) Master's student, found that indigenous foods continue to support dietary diversity, household nutrition and the preservation of indigenous knowledge in communities in the Mahikeng Local Municipality.

The research found that indigenous foods are not only tied to culture and identity but also continue to play a role in household food security. The study identified 28 plant-based indigenous foods and eight animal-based foods still consumed across selected communities. These included thepe, lengana, morula, mabele, dinawa, dikgobe, tripe dishes and bone marrow.

"Indigenous foods remain part of people's daily lives and continue to contribute to healthy diets and cultural practices," Rasehlomi says. "The findings also show that these foods are accessible to many households because communities continue to grow, process and distribute them locally."

The study points to women as central figures in keeping indigenous food systems alive. Women were found to be responsible for ensuring that households included indigenous foods in their meals and most indigenous food outlets in the municipality were owned by women. "The passing down of indigenous knowledge still happens mainly through families, especially through parents and grandparents," Rasehlomi noites. "Without that transfer of knowledge, communities risk losing information about food preparation, harvesting and nutritional value."

Source: NWU

BACK TO TOP

Conservation is working – but the world is measuring it badly, says UP-led study

An international study co-authored by a University of Pretoria (UP) conservation scientists argues that global biodiversity conservation is delivering measurable gains – but only where progress is defined, tracked and communicated using clear quantitative targets rather than broad or alarm-driven global narratives.

Published in the journal ***Proceedings of the Royal Society B***, the paper assesses global evidence on species extinctions, population trends and habitat protection, concluding that conservation action has already slowed biodiversity loss, prevented extinctions and expanded protected areas across land and ocean systems. However, the authors caution that these successes are often obscured by inconsistent monitoring frameworks and overly simplified global indicators that can mask where conservation is working.

The study is led by Prof Stuart L Pimm, Extraordinary Professor at UP's Conservation Ecology Research Unit (CERU) and Doris Duke, Professor of Conservation at Duke University in the United States, working with an international team of conservation scientists.

The paper argues that biodiversity loss is real and serious, driven by habitat loss, overexploitation, invasive species, pollution and climate change. But it also finds that conservation action has already prevented a significant number of extinctions.

Across multiple assessments, the authors estimate that conservation has prevented dozens of bird and mammal extinctions since the 1990s. Without intervention, extinction rates would likely have been three to four times higher.

Prof Pimm pointed to examples that, in his view, are often overlooked in global conservation narratives. "There is a story that few people even inside South Africa know. South Africans reintroduced 22 species of large mammals – rhinos, zebra, giraffe and various antelope – to protected areas across the country. In doing so they saved some endangered species by expanding the geographic ranges of what had become very tiny populations."

Such success stories highlight the researchers' warnings about overly alarmist global biodiversity messaging. "One of the most common misconceptions about the current state of biodiversity conservation is that somehow it's too late," he said. "Yes, there are conservation problems, but we are solving some and could solve more if we had the resources."

He added that alarmist messaging can directly affect what action is taken on the ground. "It alters what we do. If the public feels there is no hope, it will distract from the challenges we face. How to reduce poaching? How do we ensure that all South Africans get to experience and celebrate nature?"

The paper finds that protected areas reduce habitat conversion – the rate at which natural habitats are being turned into human-used land – by around 50% on average compared with unprotected areas, with particularly strong effects in forests. The study also highlights substantial global expansion of protected areas across both land and ocean systems.

The findings feed into a wider international debate about how biodiversity change is measured and communicated. The authors conclude that, rather than signalling a uniform global collapse, the evidence points to a more complex picture in which conservation is already working in many contexts – but remains uneven, and often poorly captured by headline global indicators.

- To read the article, visit: https://bit.ly/4euPeye

BACK TO TOP

GLOBAL

Unsafe food causes 1,5 million deaths annually – WHO

Children aged less than five years face almost three times the risk of illness from unsafe food than older children and adults, according to new estimates released earlier this year by the World Health Organization (WHO).

Despite being just 9% of the global population, young children suffer from nearly one third of all cases of foodborne diseases, particularly diarrhoeal diseases which can be deadly for this vulnerable age group. In addition, exposure to chemical hazards such as methylmercury and lead in food can harm the developing brain and cause lifelong neurological and developmental problems in children.

WHO estimates that unsafe food causes around 866 million illnesses and 1.5 million deaths annually, many of which could be prevented with measures including improved water, sanitation and hygiene, food safety practices such as pasteurisation and access to healthcare for vulnerable populations.

Although the total foodborne disease burden has declined since 2000, major regional inequalities persist, with the greatest burden in Africa and South-East Asia.

Exposure to biological hazards, including foodborne bacteria and viruses as well as parasitic infections, caused the majority of foodborne illnesses (approximately 860 million in 2021), while chemical exposures drove a disproportionate share of deaths. In 2021, chemical hazards accounted for a striking 73% of deaths due to contaminated food. Most of these chemical-related deaths were linked to inorganic arsenic (42%) and lead (31%), largely because these exposures increase the risk of heart disease and cancers.

"Food safety is not an abstract issue – it touches every meal, every family, every day. Unsafe food has always been a major public health concern, but until now we lacked the bigger picture of its staggering human and economic toll. These new estimates change that," said Dr Tedros Adhanom Ghebreyesus, WHO Director-General. "For the first time, countries have their own data to see where the burden is highest. With that knowledge, governments can prioritise the actions needed to protect people's health."

For more information, visit: https://bit.ly/4axUS00

WMO urges nations to prepare for 'super' El Niño

Fuelled by unusually warm ocean waters in the tropical Pacific, El Niño conditions are developing. They are set to influence global temperature and rainfall patterns, increasing the risk of extreme weather over the coming months, according to the World Meteorological Organization (WMO).

A new WMO El Niño/La Niña Update indicates an 80% likelihood of an El Niño event during June to August. The probability that this will continue until at least November is near or above 90%. Although some uncertainty remains about El Niño peak strength and timing, most forecast models suggest it will be at least moderate – and possibly strong.

"The science is clear: El Niño is arriving on our doorstep in the coming months with 90% certainty. The world must treat it as the urgent climate warning it is. El Niño conditions will pour fuel on the fire of a warming world. Impacts will hit even harder, travel even farther, and cross borders with devastating speed. The only effective response is climate action equal to the crisis – ending the addiction to fossil fuels, accelerating the shift to renewables, protecting the most vulnerable, and delivering early warning systems for all," said UN Secretary-General António Guterres.

In late April to mid-May, the sea-surface temperature in the central-eastern Equatorial Pacific – the area used as a monitoring reference – was approaching El Niño thresholds, according to observations from different platforms used by WMO. These increasing surface anomalies are being fed by unusually warm subsurface conditions across the tropical Pacific, with temperatures exceeding 6 °C above average and providing a substantial reservoir of heat that is contributing to the observed surface warming.

Meanwhile, the Southern Oscillation Index, which is the atmospheric component of El Niño, is also consistent with developing El Niño conditions. "We need to prepare for a potentially strong El Niño event, which will exacerbate drought and heavy rainfall and increase the risk of heatwaves both on land and in the ocean. The most recent El Niño, in 2023/24, was one of the five strongest on record and it played a role in the record global temperatures we saw in 2024," said WMO Secretary-General Celeste Saulo.

"The WMO community will be carefully monitoring conditions in the coming months to inform decision-making by governments, humanitarian agencies and climate-sensitive sectors. Advance seasonal forecasts and early warnings are vital to save lives and cushion the impact on our economies and our communities," said Saulo.

BACK TO TOP

Scientists discover vast hidden structure beneath Antarctica's ice

Researchers have identified a massive hidden geological feature beneath the East Antarctic Ice Sheet, revealing a previously unrecognised connection between some of the continent's largest buried landscapes.

The newly recognised structure consists of a network of enormous basins concealed beneath ice that exceeds three kilometres in thickness in some locations. Together, these basins form a continent-scale fan-shaped pattern that researchers have named the East Antarctic Fan-shaped Basin Province.

The province encompasses several well-known subglacial features, including the Wilkes and Aurora basins, as well as the basin containing Lake Vostok, the largest known subglacial lake on Earth. Although scientists have studied many of these basins individually for years, this is the first time they have been recognised as parts of a single, interconnected geological structure.

According to the research team, the structure likely formed through a process known as distributed rotational extension. This occurs when continental crust gradually stretches outward from a central point. Researchers compare the pattern to a hand, where the base of the thumb remains fixed while the fingers spread apart. The spaces between the fingers resemble the triangular basins created as the crust extends. The East Antarctic Fan-shaped Basin Province may represent one of the largest examples of rotational extension ever identified within continental crust.

Scientists believe the structure developed through multiple tectonic episodes associated with the formation and evolution of the ancient Gondwana supercontinent. It may also be linked to the later separation of Antarctica and Australia and could even have played a role in that continental breakup.

The discovery raises several new questions, including when the structure formed and what geodynamic processes were responsible for creating it.

The study was led by Dr Egidio Armadillo of the University of Genoa and was supported by the Italian National Antarctic Research Programme.

To read more, visit: https://bit.ly/4uTaZ0n

Mozambique certifies its first drone workforce to fight floods and disasters

A new generation of certified drone operators is ready to protect lives and communities across one of Africa's most disaster-prone nations. Mozambique has trained a first cohort of 30 certified drone operators to respond to cyclones, floods, and humanitarian emergencies from the air.

Under the Drone-Based Disaster Management Solution project, supported by the African Development Bank and financed through the Korea-Africa Economic Cooperation Trust Fund, the milestone signals a shift in the country's approach to preparing for and mitigating against natural disasters. The project was officially launched in April last year and aims to enhance the country's preparedness and response to disasters by strategically deploying drone technology.

The training was delivered in the capital, Maputo, in partnership with the national Ministry of Communication and Digital Transformation and Busan Technopark of the Republic of Korea. PNU Drone, a faculty-founded enterprise in the Aerospace Engineering Department at Korea's Pusan National University, delivered the training.

"The Bank will continue to facilitate capacity building activities as part of its policy dialogue to deliver better services at reduced costs for the people of Mozambique. By moving from training into active operations, we are ensuring that national institutions have the tools and skills needed to respond more effectively and save lives," said Rômulo Corrêa, the Bank's Mozambique country manager.

The thirty certified professionals, including ten newly qualified drone instructors from various government entities and departments, received training in drone piloting, airspace regulations, data collection protocols, mission planning for disaster management scenarios, and drone maintenance.

With the training phase now complete, the project will deploy drones in five zones identified by the government as highly prone to disasters and flooding. Ten of the thirty certified operators will be selected for this phase. The drones will carry out search and rescue, aerial mapping and surveillance, water quality monitoring, and data gathering for warning systems.

BACK TO TOP

NEW WRC REPORTS

Assessing the impact of different pollution sources on the type of microplastics, associated microbial communities, antimicrobial resistance and transport of microplastics in selected urban rivers in South Africa

Plastic polymers, while revolutionising modern industries with their affordability, durability, and versatility, have created a global environmental crisis: the accumulation of non-biodegradable microplastics. These microplastics contaminate aquatic ecosystems, including rivers, lakes, and oceans, posing significant ecological and health risks. Sources of this pollution are diverse, encompassing improper waste disposal, wastewater discharge, and agricultural runoff. Notably, microplastics can act as substrates for microbial biofilm formation, fostering diverse microbial communities with potential ecological implications. This study aimed to evaluate the impact of various pollution sources on the type, associated microbial communities, and transport of MPs in selected urban rivers in South Africa.

WRC report no. 3230/1/25

Link: https://bit.ly/4fOXBpz

A water quality-based predictive tool for disaster management of waterborne infections during drought events

Adequate water supply and sanitation are critical for sustainable development in South Africa, yet significant challenges persist. Water quality degradation threatens human health, ecosystems, and agricultural productivity. Compounding these issues are climate extremes, population growth (31% over 20 years), and a R33 billion water infrastructure backlog, with 41% of the population in metropolitan areas nearing water deficits. Climate change exacerbates water scarcity and disease transmission. Addressing these challenges requires integrated strategies: upgrading water infrastructure, enhancing wastewater treatment, and scaling water, sanitation, and hygiene (WASH) initiatives. Through several work packages, this project aimed to achieve the following:

- Assess natural water bodies to determine vegetation type, and water physico-chemical properties in each sampling site, and the impact on schistosomiasis intermediate host (snail) distribution. (Work Package 1)
- Assess natural water bodies in the study area to determine the presence of snail intermediate host (potential transmission sites) and infected snails (transmission sites). (Work Package 1)
- Assess knowledge, attitude, and practices (KAPs) and risk factors associated with schistosomiasis prevalence and transmission among primary school-going children. (Work Package 2)
- Determine the prevalence and intensity of *S. haematobium* and *S. mansoni* infection through urine and faecal samples, respectively, in school-going children. (Work Package 2)
- Assess the bacteriological quality of water sources as well as the retrospective prevalence of diarrhoea in the study area. (Work Package 3)
- Assess an educational intervention on hygiene knowledge and practices among municipal waste and sanitation workers pre- and post-intervention in the study area. (Work Package 4)

WRC report no. 3229/1-5/25

Links: https://bit.ly/44d7zdc Volume 1 (Overview of work packages)
https://bit.ly/3ShNwHV Volume 2 (Work package 1)
https://bit.ly/4xyBaLw Volume 3 (Work package 2)
https://bit.ly/4oBa4Q1 Volume 4 (Work package 3)
https://bit.ly/4ab7tGy Volume 5 (Work package 4)

Application of research findings to support the empowerment of Agri-parks farmers to increase irrigated food production and market access

This project was undertaken to identify barriers hindering the success of government efforts to empower emerging farmers. The South African government developed the Agri-parks model to support emerging farmers in becoming commercial, but the initiative's success has been limited. This report presents the findings from implementing an alternative, bottom-up management approach at the Rooiwal Agricultural Hub. The Agricultural Innovation Platform (AIP) developed by van Rooyen et al., (2017) was implemented as part of the search for an alternative model for developing Agri-parks. The platform connected the farmers, government officials who work directly with them, market agents and other roleplayers. The AIP framework emphasises engaging all relevant stakeholders (government, private sector, researchers, markets, and farmers), building trust, identifying clear roles and forming a shared vision.

WRC report 3252/1/26

Link: https://bit.ly/4vkTmqE

Development of a climate and water availability indices app to support decision-making across South African water management areas

South African agriculture operates within a context of high climate variability, increasing weather and climate extremes, and water scarcity. Agricultural decision-making, from day-to-day operational choices to seasonal planning and longer-term risk management, is highly dependent on access to reliable, timely, and relevant weather and climate information. In recent decades, these challenges have intensified as climate variability and climate change have increased the frequency and severity of weather and climate extremes. For farmers, planners, and agricultural advisory services, the challenge is not only that weather- and climate-related risks are increasing, but that uncertainty around these risks complicates decision-making and limits the effectiveness of proactive adaptation strategies. The Weather Risk app was conceived as a response to a clearly identified scientific and practical gap. The project was motivated by the need to both improve access to actionable weather and water availability information for agriculture and to ensure that the indices underpinning such information are scientifically robust, contextually appropriate, and transparent in their limitations. Addressing this need required more than

BACK TO TOP

the development of a user-facing application; it necessitated a structured review of climate and water availability indices and climate service principles, applied evaluation of gridded datasets and indices through case studies, and an operational implementation informed by stakeholder engagement.
WRC report no. 3250/1/26
Link: https://bit.ly/3Sb9hct

Unmanned aerial vehicle (UAV) high-throughput phenotyping (HTP) of selected neglected and underutilised crop species (NUS) for improved water use and productivity on smallholder farms

Neglected and under-utilised crop species (NUS), including sorghum, cowpeas, amaranth, sweet potatoes and taro, offer an alternative crop to the current staple (maize) because of their inherent tolerance to droughts and flooding. However, these crops remain under-researched and are primarily cultivated by smallholder farmers who are familiar with their adaptive traits. Smallholder farming systems are highly heterogeneous, yet current production guidelines are overly generalised and are not adequately resilient to climate extremes. Improved, evidencebased insights derived from rapid and accurate field data are needed. Crop phenotyping is central to optimising crop management; however, the conventional methods are manual, laborious, subjective and lack spatial detail. While satellite remote sensing offers non-invasive phenotyping capabilities, its use in smallholder systems is constrained by their spatial and temporal heterogeneity and the high cost of fine-resolution imagery. Proximal remote sensing, using UAV-based high-throughput phenotyping platforms, has emerged as a cost-effective, rapid and efficient alternative for acquiring detailed crop data. Such platforms have proven themselves to be valuable for characterising NUS phenotypes.
WRC report no. 3251/1/26
Link: https://bit.ly/44fUv6K

Position paper: Solutions for billing and revenue challenges in growing serviced rural and peri-urban settlements on trust and private land

South African municipalities have a constitutional obligation to provide water services to all residents, including those living on customary land. Meeting this obligation in areas that fall outside the formal cadastre is a challenging exercise for municipalities that do not have de facto planning power in these areas. The recovery of costs when the service is provided is the focus of this study, which is funded by the Water Research Commission. The conventional billing model depends on formal property ownership, which links accounts to title deeds and enables municipalities to issue bills, monitor consumption, and enforce payment. In customary areas, this model does not apply because of the lack of formalised title. The challenge of charging for services above the free basic allowance has grown as these settlements expand and as more non-indigent households settle within them.
Link: https://bit.ly/4owWYmI

An integrated multi-omics approach to uncover drought tolerance biomarkers in two underutilised crops: sweet potato (*Ipomoea batatas* L.) and cassava (*Manihot esculenta* Crantz)

Drought stress poses a significant threat to global food security, particularly in arid and semi-arid regions where agriculture is increasingly vulnerable to climate variability. Root and tuber crops, specifically sweet potato (*Ipomoea batatas* L.) and cassava (*Manihot esculenta* Crantz), serve as essential staple crops due to their inherent resilience in marginal environments. However, their productivity is severely compromised by prolonged drought episodes, threatening the livelihoods of smallholder farmers. A meta-analysis conducted in this project revealed that drought stress reduces tuber yield by an average of 49.29% across major tuber crops, with sweet potato experiencing the highest reduction (61.08%) and cassava the lowest (32.45%). Despite cassava's relative resilience, all tuber crops face significant yield losses under water-limited conditions, emphasising the urgent need to enhance drought tolerance through dissecting the complex molecular mechanisms underpinning stress adaptation in locally adapted African germplasm.
WRC report no. 3253/1/26
Link: https://bit.ly/4aUcqUg

An assessment of agro-industrial wastewaters as a resource for biohydrogen recovery potential using dark fermentation biorefineries

South Africa's agro-industrial sector generates substantial volumes of wastewater, presenting both environmental challenges and opportunities for renewable energy production, particularly through the development of biohydrogen. Valorising these waste streams aligns with national strategies promoting the circular economy, the Hydrogen Society Roadmap and the Bioeconomy Strategy. This study assessed the agro-industrial sector's potential for biohydrogen production via dark fermentation, focusing on waste-stream quantification, spatial mapping, identification of high-potential streams, and technical feasibility. In this regard, a mixed-methods approach was applied, including literature review, industry surveys, geospatial analysis, and laboratory-scale experimental work. Data from various sources were used to estimate wastewater volumes, organic loads, and nutrient composition. Substrate suitability for hydrogen production was assessed based on wastewater characteristics obtained from literature data, while geospatial mapping identified provincial and district-level hotspots for implementing resource recovery interventions, including biohydrogen production.
WRC report no. TT 970/26
Link: https://bit.ly/4a9ulRg

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

BACK TO TOP

WATER-SMART AGRICULTURE

Blueberries that sip, not gulp: New research offers hope for water-smart farming of 'superfood'

In a country where every drop of water counts, growing the market of a thirsty crop, such as blueberries, can be challenging. New research has illustrated that these nutrient-rich berries can be grown more efficiently using less water – without sacrificing yield or fruit quality.
Article by Lani van Vuuren.

The study, titled 'Effect of different growth media on water use, yield and soil properties of blueberry cultivated under shade net' and published in May, was led by the Cape Peninsula University of Technology (CPUT) together with the Agricultural Research Council (ARC), and funded by the Water Research Commission (WRC). Researchers explored how different growing media influence water use, plant growth, fruit quality, and soil health in blueberry production. The results could help reshape how blueberries are cultivated in water-scarce regions of South Africa.

The findings come at a crucial time. South Africa's agricultural sector continues to feel the effects of climate change, rising temperatures, recurring droughts, and increasing competition for limited water resources. "Water demand is expected to increase in South Africa in the future, driven by an increase in temperature and evaporation due to climate change effects. This will likely increase irrigation demand by crops," explained Francis Lewu, a Professor in the Department of Agriculture at CPUT and leader of the project.

Yet amid these challenges, blueberries are booming.

A berry industry on the rise

Blueberries have become one of South Africa's fastest-growing fruit industries. Demand has surged globally thanks to the fruit's reputation as a "superfood" packed with antioxidants, vitamins,

BACK TO TOP

Lani van Vuuren

Blueberries account for more than 70% of the total area planted under berries in South Africa.

and health benefits linked to heart health, brain function, and blood sugar regulation. According to the South African Berry Producers' Association, blueberries account for more than 70% of the total area planted under berries in South Africa, about 2 800 ha.

This is great news, especially for the rural economy, as cultivating blueberries is a labour-intensive industry. Each hectare of blueberries planted results in the direct employment of 2.64 full-time equivalent workers, on average. This is the highest employment intensity among the major fruits grown in South Africa.

South Africa has positioned itself as a major player in the international blueberry market. Around two-thirds of the country's blueberries are exported, contributing significantly to the economy and creating jobs throughout the agricultural value chain. The Western Cape remains the country's blueberry powerhouse, producing about 60% of South Africa's crop, followed by Limpopo, North West, Gauteng, the Eastern Cape, Free State, and Mpumalanga.

But there is a catch: blueberries are thirsty plants. Their shallow root systems make them highly sensitive to water stress, and growers often rely on precision irrigation to maintain fruit quality and yields, a process known as fertigation. In a water-scarce country, this raises important questions about long-term sustainability. That is where this new research becomes especially important, especially as blueberries remain notably under-researched in South Africa. As Prof Lewu points out, most knowledge regarding the water-efficient growth of blueberries stems from studies undertaken in the Northern Hemisphere.

Rethinking how blueberries are grown

The researchers set out to answer a practical question: can blueberries be grown using alternative growing media that reduce water demand while still supporting healthy plants and good yields? Instead of planting directly in soil, the study used potted blueberry plants cultivated under shade-net conditions at the Wellington campus of the CPUT in the Western Cape.

The plants were grown in different combinations of materials including coconut coir, peat moss, mushroom compost, and zeolite – a mineral known for its exceptional water-holding ability. Peat moss and mushroom compost were selected based on their organic matter content, reduced soil pH, and the ability to promote uniform root growth and distribution.

"A literature review revealed that growth media composition positively influences the growth and yield attributes of fruit crops such as strawberries. With previously conducted research, we understood that zeolite had the potential to conserve water. This triggered our interest to look at the different media in combination with zeolite as a possible solution to grow blueberries more efficiently," explains Prof Lewu.

The materials were also selected on their affordability and availability to farmers. "Coir, for instance, is a standard growth medium in the blueberry industry, and is the growth medium used mostly by blueberry farmers in the Western Cape."

The research team monitored the plants closely over several growing seasons, collecting detailed information on water use, plant growth, yield, nutrient uptake, enzyme activity, and fruit quality. Moisture probes linked to real-time software allowed the team to track exactly how much water each treatment required. The project also investigated how different nitrogen fertilisers influenced plant performance and water-use efficiency.

The breakthrough: less water, strong performance

One of the project's most important findings was that a type of growth medium dramatically affected how much water the blueberry plants needed. Plants grown in a mix containing

BACK TO TOP

Lani van Vuuren

The blueberry's shallow root system makes it highly sensitive to water stress, and growers often rely on precision irrigation to maintain fruit quality and yields.

80% coir and 20% zeolite used the least water. This treatment required about 4 litres of water daily, compared to 4.25 litres for plants grown in pure coir.

While the difference may seem small at first glance, across commercial blueberry operations with thousands of plants, the water savings could become substantial. Zeolite proved especially valuable because of its ability to retain water and nutrients within the root zone. This improved moisture stability, reduced irrigation needs, and supported more efficient water use.

Another promising treatment combined 60% coir with 40% peat moss. This mixture also showed strong potential for conserving water while maintaining productive plants.

In essence, the study indicates that blending different growth media allows farmers to tailor water-holding capacity and drainage to the shallow, sensitive root systems of blueberries, says WRC research manager, Dr Luxon Nhamo. "This ultimately reduces the need for frequent irrigation, improving blueberry crop-water productivity."

Water-smart farming for a drying future

The implications stretch far beyond blueberries alone. According to Dr Nhamo, the project forms an important part of the Commission's agricultural water use research portfolio. "Enhancing water use efficiency is a foundational strategy for the agricultural sector's adaptation to climate change as it enables sector resilience against shifting precipitation patterns, rising temperatures, and frequent droughts. It is important to supply irrigation water when and where it is needed through irrigation scheduling informed by technological information. A technology-driven agricultural system and irrigation scheduling increase productivity while reducing water losses."

The blueberry project is the latest in a series of studies funded by the WRC to improve the water use of crops. Other studies have focused on commodity groups such as pears, pecan nuts, avocados, pomegranate, and apples, among others. As most of these studies are undertaken in collaboration with industry partners, the results are implemented immediately – a huge plus for the agricultural sector. Plans are afoot to disseminate the results of the latest study to blueberry farmers.

The blueberry project demonstrated how careful irrigation scheduling, combined with improved growing media, can help producers adapt to these realities, says Prof Lewu. He highlights the importance for farmers to determine field capacity accurately and use available tools, such as moisture probes, to optimise irrigation.

The study also showed that cultivation practices matter just as much as the crop itself. Sustainable agriculture is no longer only about what farmers grow, but how they grow it.

Quality berries still matter

Saving water is important, but farmers also need profitable crops. Fortunately, the research showed that water-efficient growing media did not necessarily come at the expense of fruit quality. In fact, the study found differences in mineral content and nutritional composition across the different treatments, suggesting that growth media can influence both the nutritional value and storage characteristics of blueberries.

The researchers also measured compounds such as phenolics, which are linked to antioxidant activity and consumer health benefits. Interestingly, berries grown in pure coir recorded the highest phenolic content, likely due to mild physiological stress associated with higher irrigation demands.

This highlights the delicate balance growers must manage between water conservation, plant stress, and fruit quality, says Prof Lewu. As consumer demand for healthy foods continues to rise, these findings could help producers target both sustainability and premium-quality fruit.

Finding the right fertiliser

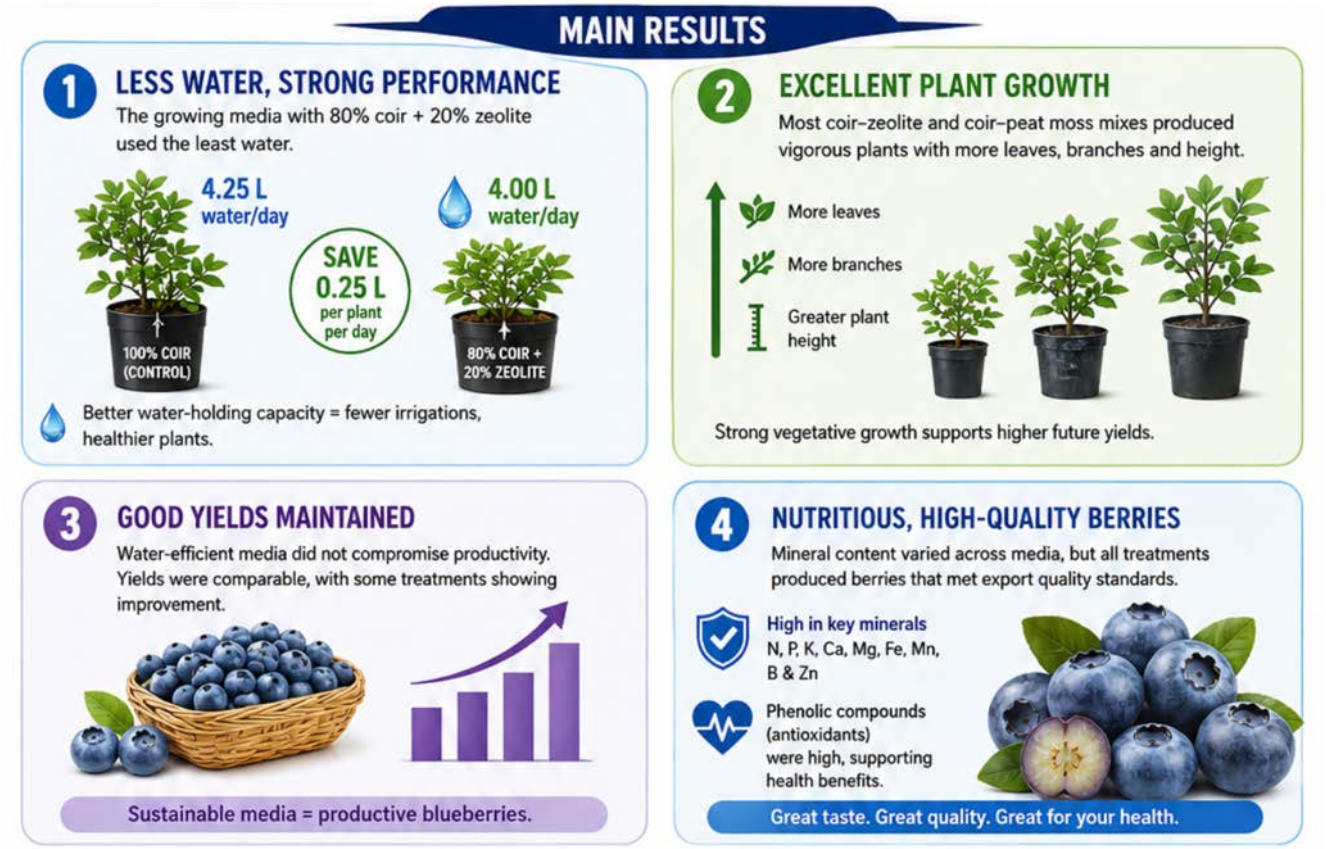
The project also examined how different nitrogen sources affect blueberry growth. Blueberries prefer ammonium-based nitrogen, and the study found that ammonium sulphate consistently improved vegetative growth, nutrient uptake, and reproductive performance.

This is important because nitrogen management is closely linked to water use efficiency. Healthier root systems and improved nutrient uptake help plants cope better under water-limited conditions. The researchers noted that ammonium nutrition may improve drought tolerance by supporting root growth and helping plants regulate water loss more effectively. For farmers, this means that selecting the right fertiliser strategy can play a major role in building climate resilience.

Another fascinating aspect of the research was its focus on biological activity within the growth media. The team measured enzyme activity and nematode populations to better understand how the different substrates influenced microbial processes and soil health. Certain treatments promoted higher enzyme activity, especially β-glucosidase, which plays an important role in nutrient cycling.

Healthy microbial systems are increasingly recognised as essential components of sustainable agriculture. They help recycle nutrients, improve soil function, and support plant

BACK TO TOP



The study shows that the use of growth media can help save water while protecting the quality of the crop.

growth naturally. In other words, sustainable farming is not only about conserving water above ground, but it is also about nurturing healthy biological systems below ground.

Why blueberries make sense for South Africa

At first glance, some may question whether expanding blueberry production in a water-scarce country makes sense. But the study suggests that with the right technologies and management practices, blueberries could become part of a more water-smart agricultural future.

Blueberries offer several advantages. They are high-value export crops that generate income, employment, and foreign exchange earnings. They also fit well into controlled-environment agriculture systems where water use can be monitored and managed precisely.

Importantly, the research demonstrates that innovation can significantly improve water productivity. Rather than abandoning water-intensive crops altogether, South Africa may need to rethink production systems to make them more efficient and climate-resilient.

A small berry with a big message

Ultimately, this blueberry project tells a much bigger story than fruit production alone. It shows that agriculture in a water-scarce country does not have to be trapped in a choice between productivity and sustainability. Through better science, smarter irrigation, improved growth media, and careful nutrient management, it is possible to grow high-value crops while using water more responsibly.

The humble blueberry may be small, but the lessons from this research are enormous.

As climate pressures intensify and water becomes increasingly precious, South Africa's future farmers will need crops and cultivation systems that can thrive with less. This research offers a glimpse of how that future might look: innovative, efficient, resilient – and still productive enough to compete on the global stage.

To access the report, ***Effect of different growth media on water use, yield and soil properties of blueberry cultivated under shade net*** (**WRC report no. 3245/1/26**), https://bit.ly/4wS0zjf

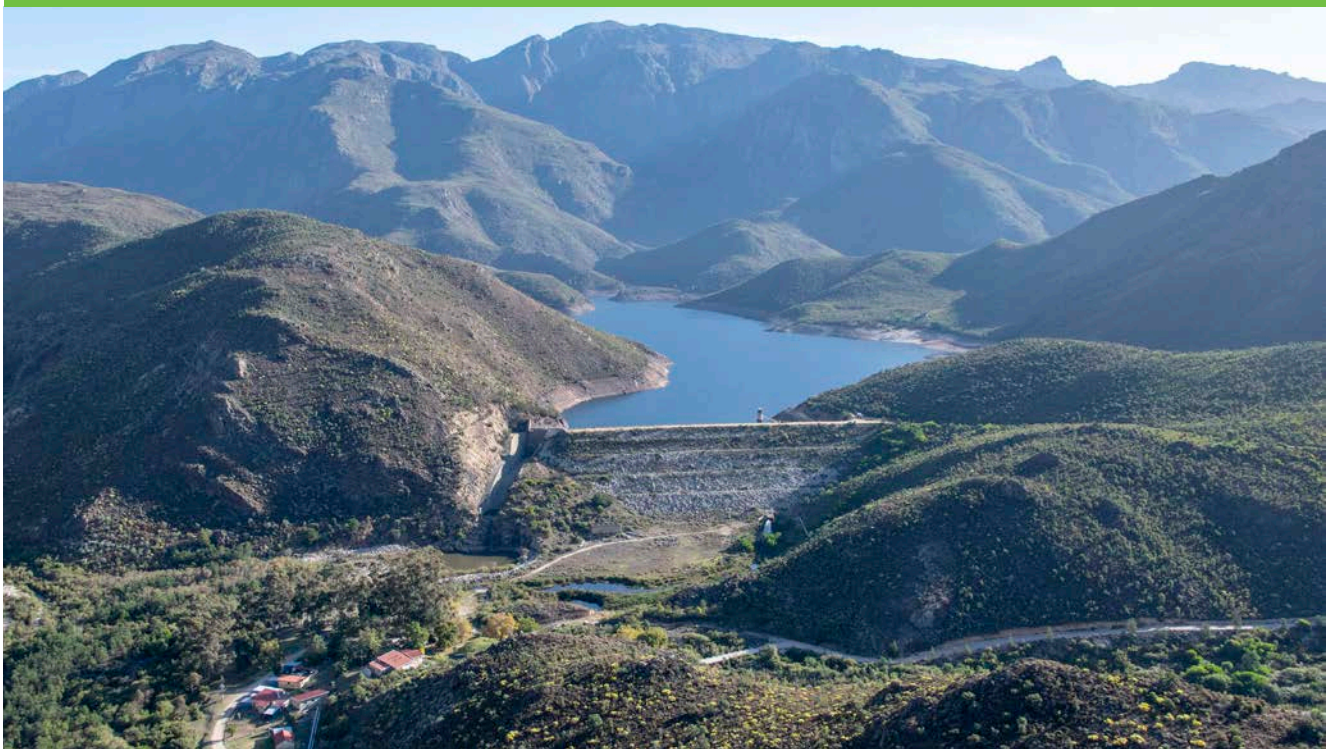
BACK TO TOP

WATER RESOURCE MANAGEMENT

Holsloot River: The hidden waterway behind the Cape's fruit and wine heartland

The Holsloot River plays a vital role in sustaining farms and towns in the Breede River Valley. Article by Sue Matthews.

Jean Tresfon

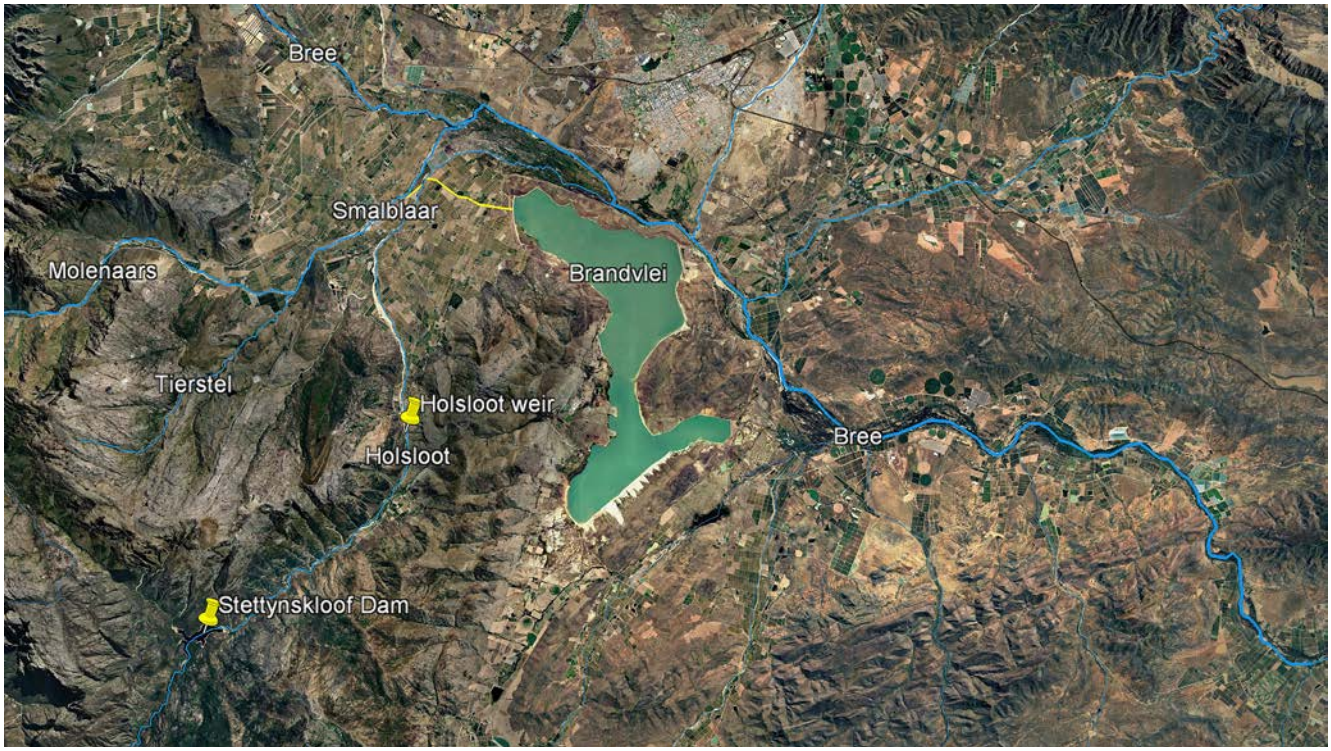


Tucked away in the mountains south-west of Worcester in the Western Cape is a small tributary of the Breede River that punches above its weight as a focus for applied research and infrastructure investment. Over the past decade, the Holsloot River has been the subject of a series of technical studies and government-led interventions to improve water security in the Breede Valley.

The first project to be completed was the Holsloot weir and diversion works, which the provincial government's Minister of Agriculture officially handed over to the Holsloot Water User Association (WUA) in May 2021. Next was the raising of the feeder canal from the Holsloot River to Brandvlei Dam, which was completed in October 2022 and formally launched by national government's Minister of Water and Sanitation in February 2023. More recently, local government in the form of the Breede Valley Municipality commissioned a feasibility study on increasing water storage in the Stettynskloof Dam, which impounds the river's upper reaches.

The dam is the main water supply for Worcester and Rawsonville, but most people beyond the area have never seen or heard of either it or the river, although both are well-known to flyfishers in the Western Cape. In years past the river was stocked with rainbow and brown trout, which established self-sustaining populations. A 7 km stretch of river immediately below the dam has been divided into six fishing beats controlled by the Cape Piscatorial Society in conjunction with Cape Nature, while access further downstream is arranged through a small resort, the Dwarsberg Trout Hideaway. In mid to late summer, when other rivers are running warm and low, this is considered the river to fish for rainbow trout, because bottom-water releases from the dam for irrigation and environmental flows keep the upper reaches cool and at a more constant level.

BACK TO TOP



Google Earth

Technical studies and infrastructure investments on the Stettynskloof Dam, Holsloot weir and Brandvlei feeder canal (yellow line) have brought the Holsloot River into sharp focus in recent years.

Stettynskloof Dam

Construction of the dam began in 1952, and it was officially opened in 1955. Originally a 30 m-high concrete gravity dam, it was raised in 1981 by adding a 48 m-high clay core earth and rockfill embankment against the downstream wall. The dam takes its name from the Stettyn mountain range along its eastern flank, which bears the distinction of having the highest southern-most peak in Africa – in other words, there is no higher mountain south of Stettyn Peak, at just over 1 820 m. The range, in turn, is named after the farm on the other side of it, which is today a wine estate. In 1714, the Governor of the Dutch East India Company granted the land to two Free Burghers, one of whom was from the eastern European town of Stettin, renamed Szczecin after its transferral from Germany to Poland in 1945.

Raising the dam wall will be a multi-year project with an estimated cost of almost R208 million, but the intention is to start with an interim option that will increase the existing full supply level by 4 m.

The dam, which is owned and operated by the Breede Valley Municipality, has a gross storage capacity of 15 million m^3, and a catchment area of 55 km^2. There is a water treatment works on site with a capacity of 60 Ml/day, and the potable water is then piped to reservoirs at Rawsonville and Worcester, which are approximately 32 km from the dam.

As the population of these towns has grown and water services have been expanded to communities that were previously without access, water demand has inevitably increased. A few years ago, following an options analysis study, the municipality appointed Ingerop South Africa to investigate the feasibility of increasing the dam's storage by raising the dam wall. In its news bulletin published in the last quarter of 2025, the municipality explained that this initiative could be expected to meet projected domestic and irrigation demand until 2042, while enhancing the region's climate resilience. Like many other parts of the Western Cape, the Breede Valley has experienced below-average rainfall since last winter, and by April 2026 the dam's storage level had dropped below 40%, despite Level 2 water restrictions having been in place since mid-January.

Raising the dam wall will be a multi-year project with an estimated cost of almost R208 million, but the intention is to start with an interim option that will increase the existing full supply level by 4 m. The details have not yet been made public, but according to the SAHRIS heritage case file, the proposals include installing gates on the spillway crest, raising the existing spillway, and constructing a metre-high parapet wall along the dam crest to prevent waves from overtopping the dam during severe storms and floods. It is not clear which of these interventions form part of the interim works and which belong to the broader project, but detailed design and procurement are only scheduled to take place in 2027.

Well-known hydraulic engineer Gerrit Basson, Professor Emeritus in Stellenbosch University's Department of Civil Engineering and Managing Director of ASP Tech, has been involved in the feasibility study, having carried out a 1:40 scale physical model study in the university's Hydraulics Laboratory to evaluate the raising options for the spillway, as well as energy dissipation by its ski-jump and plunge pool.

BACK TO TOP

Gerrit Basson

A 1:40 scale physical model of the Stettynskloof Dam spillway was built at Stellenbosch University's Hydraulics Laboratory to evaluate raising options as well as energy dissipation by its ski-jump and plunge pool.

Casidra

The Holsloot weir in July 2021, two months after the handover ceremony. At far right is the pipeline that conveys water from Stettynskloof Dam to Rawsonville and Worcester.

Holsloot weir

Basson likewise collaborated with Ingerop on the Holsloot weir and diversion works, 11 km downstream of the dam wall. Previously there were three small rockfill weirs spaced along the river to divert water for the Holsloot WUA, but these were frequently damaged during floods, which also eroded banks, clogged abstraction intakes and swept away pumps. The local landowners would typically use earthmoving equipment – the "yellow machines" – to effect repairs, but with the promulgation of the 2010 NEMA EIA Regulations these activities required environmental authorisation unless they were in accordance with a maintenance management plan (MMP) agreed to by the competent authority.

In November 2013, widespread flooding caused by a cut-off low over the Western Cape led to a provincial disaster declaration, triggering the allocation of disaster-relief funding from National Treasury. The Holsloot River had broken its banks during the flood event and caused severe damage, destroying millions of Rands worth of infrastructure and farmland. The provincial environmental and agriculture departments then agreed that a more sustainable solution to the ongoing challenge of flood damage was the replacement of the three weirs with a properly designed and constructed one, using some of the disaster-relief funding. The hydraulic design was carried out by Stellenbosch University, while Ingerop was responsible for the structural and geotechnical design. These aspects are comprehensively detailed in a paper by Vonkeman and co-authors, 'Design and construction of the Holsloot diversion works on an alluvial foundation', presented at the 2019 Conference of the South African National Committee on Large Dams (SANCOLD).

In short, a 1:40 scale physical model study conducted at the Stellenbosch University Hydraulics Laboratory together with a geotechnical investigation of the site guided the construction of a 55 m long notch weir, which includes a 10 m low-notch section set 180 mm below the rest of the crest. A concrete roller-bucket with a 4.3 m radius extends along the entire structure to dissipate hydraulic energy, and a riprap zone downstream of it protects the riverbed against erosion and undercutting. The intake for the diversion works is protected from sedimentation by a gravel trap and two sand traps, with the head provided by the low notch helping to flush the traps during small floods so that they are self-scouring. The diverted water is piped to a chamber a little over a kilometre away and then distributed by the WUA through existing channels. A pedestrian bridge above the weir allows access to the diversion works from the road to Stettynskloof Dam.

The bridge was one of the factors that later caused contention, because it had not been considered in the Basic Assessment Report (BAR), which was submitted to the provincial environmental authority in February 2017. It was added to the design after environmental authorisation was granted in May 2017, approving Site C for the weir – the furthest downstream of three alternatives and not the best site proposed during the feasibility study from a hydraulic perspective – and with the diversion works on the left bank to minimise disturbance to both traffic and fynbos. The bridge design, which includes two supporting pillars in the river channel, was incorporated into the 1:40 scale physical model and tests were done to ensure accumulated debris would not affect the weir's stability during floods.

A more significant point of contention arose from the scale of construction activities upstream of the weir. Authorisation had been granted for a small footprint covering only the size of the weir, diversion works and riprap zone downstream, while the Construction Environmental Management Programme (EMPr) stipulated that access to the river and its floodplain by workers and machinery should be limited to an area extending 10 m upstream and not more than 70 m downstream. No construction camps or stockpiles of material were to be allowed below the 1:100-year floodplain or closer than 30 m from the flood channel. The EMPr included a section on flow diversion and dewatering of the construction area, but what was done by the contractor – explained and illustrated in the Vonkeman et al. paper – resulted in extensive vegetation clearance, earthmoving, infilling and excavation over an area 20 times larger than anticipated, with construction camps and stockpiles clearly located within the floodplain.

Work had begun in early April 2019, and an environmental control officer (ECO) had been appointed to oversee the project and ensure compliance with the BAR, EMPr and other environmental legislation. After becoming aware of the unauthorised activities and non-compliance with the environmental authorisation's conditions, the environmental assessment practitioner and freshwater consultant who had prepared the BAR and EMPr submitted a formal complaint to the

BACK TO TOP

Casidra

By January 2026, indigenous vegetation above and below the weir site was becoming well established after intensive rehabilitation work.

provincial environmental authority in February 2021.

A Compliance Notice to rehabilitate the site was only issued to Casidra, the provincial SOC that had implemented the project on behalf of the Department of Agriculture, in September 2022 – well over a year after the construction had been completed. Casidra appointed an alien-clearing contractor, a freshwater ecologist and a botanist to carry out the rehabilitation work, as well as an independent ECO to monitor progress in line with an approved rehabilitation plan, a botanical assessment and the Compliance Notice requirements. Over the following three years, alien invasive vegetation was removed, areas prone to erosion were stabilised, and disturbed areas were revegetated, using a combination of seeds and cuttings collected from adjacent plant communities and more than 1 200 nursery-grown reeds, bulrushes, shrubs and groundcovers. Compacted soils at the river edge were contoured to create shallow depressions and flow paths before being planted with wetland species such as palmiet, and natural recolonisation by sedges and grasses has since occurred. The ECO's post-rehabilitation audit report indicates that by February 2026 the rehabilitation of approximately 4 ha of disturbed riverine habitat had been completed, with partial restoration of the wetland's ecological function.

The site has now been handed back to the WUA, which agreed to maintain alien-clearing upstream of the weir for 7 km of river corridor covering just under 200 ha, in terms of an MMP approved by the environmental authority in 2017. The initial clearing was conducted by the Department of Agriculture during 2019–2020, after which the WUA took responsibility for follow-up clearing, funded through a levy on WUA members' water use. Downstream of the weir, landowners who draw water directly from the river pay for alien-clearing along a 13.7 km stretch to the confluence with the Breede River, also agreed as part of the MMP.

This commitment to alien-clearing – and the strengthened environmental stewardship it represents – is viewed as one of the most positive outcomes of the weir's authorisation and construction. Another is the prevention of erosion downstream and the reduced need for earthmoving with the "yellow machines", although maintenance activities are permitted under both the MMP and a General Authorisation (G. 49833; GoN 4167) gazetted in December 2023. As of March 2026, two major flood events have occurred since the completion of the weir, with no significant damage to riverbanks or infrastructure reported, which has been attributed to the weir's ability to attenuate flows.

The weir also enables accurate monitoring of water abstraction by the WUA, ensuring it is compliant with the water use licence. The WUA abstracts its allocation over 180 days, and not all of this water emanates from Stettynskloof Dam. There is an agreement that all inflows to the dam between 16 November and 15 March are allocated to the WUA, which may release water as needed, but there are several streams discharging into the Holsloot River downstream of the dam wall – in fact, the catchment of the weir is 129 km^2 compared to the dam's 55 km^2. Most of the streams dry up in late summer, but they gush during winter and after storms, contributing a large volume of flow.

Google Earth

Surplus winter flows are diverted from the Smallblaar River into the Holsloot River, and then into the Brandvlei feeder canal.

BACK TO TOP

Google Earth

The Holsloot weir site in August 2018 (left), before construction began and with the site infested with alien plants; October 2019 (middle), six months after construction began; and December 2025 (right), after the rehabilitation work had been completed.

Brandvlei Feeder Canal

Some 11 km downstream of the weir, surplus winter flows in the Holsloot River – together with those from the Smallblaar River – are diverted into the feeder canal to the Brandvlei Dam. The original dam was completed on the farm Brandvlei in 1922, and named Lake Marais after JP (Kowie) Marais, a Robertson farmer who was instrumental in lobbying for its construction and establishing the Breede River Conservation Board in 1913. It was raised in 1950 and then again when it was merged with the adjacent Kwaggaskloof Dam, completed in 1972, to create the Greater Brandvlei Dam. The then Department of Water Affairs took ownership of the dams in 1973 for this work as part of the development of the Greater Brandvlei Government Water Scheme, which included upgrading the canals and constructing the Papenkuils Pump Station to pump water from the Breede River into the dam. The scheme was completed in the early 1980s, but the dam's current storage of approximately 450 million m^3 was limited to about 72% of total capacity by the feeder canal. This was because water backed up in the canal when the dam reached a certain level, necessitating the closure of gates at the canal's entrance on the Holsloot River to avoid flooding surrounding farmland.

The main purpose of the Greater Brandvlei Scheme is to support agricultural irrigation.

The raising of the canal's walls by 30 cm over its entire length of 4 km – completed in October 2022 at a cost of R20 million – reduces this problem and allows an additional 33 million m^3 to be stored in the dam. Vonkeman and Basson conducted the hydraulic investigation for this work too, as detailed in their paper 'Hydraulic design aspects of the proposed Holsloot-Brandvlei Dam diversion upgrade in the Western Cape', presented at the 2018 SANCOLD Conference.

The additional water storage allowed the Breede-Olifants Catchment Management Agency (BOCMA) to consider applications for water use licences for the use of this water, with the first phase focusing on 100% B-BBEE applications and the second considering partnerships of 30–50% B-BBEE. A number of licences have been issued, unlocking further economic development in the area.

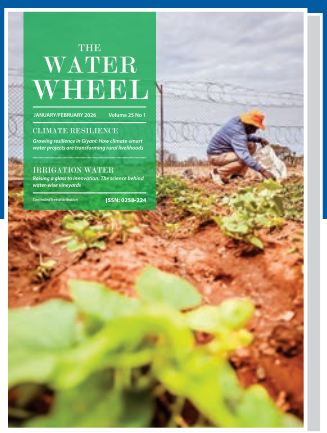
While the main purpose of the Greater Brandvlei Scheme is to support agricultural irrigation, with stored water released during summer both directly into canals and into the Breede River for abstraction downstream, it also supplies domestic water for the towns of Robertson, Ashton, Montagu and Bonnievale in the Langeberg Municipality. An additional allocation of 10 million m^3 of water per year is reserved for "freshening releases" to dilute the Breede River's high salinity in summer, caused by the underlying geology and irrigation return flows.

All of this means that the little Holsloot River exerts an influence far beyond its secluded upper reaches. It acts as a linchpin for the Breede River valley, sustaining farmlands, communities and ecosystems that depend on its freshwater flows. And given that this is South Africa's largest fruit and wine-producing region, the Holsloot's contribution helps ensure the valley's abundance reaches households across the country and beyond – proof that even small tributaries can shape the prosperity of an entire landscape.

BACK TO TOP

THE WATER WHEEL

SUBSCRIPTION



Contact Details

Name: _____

Company: _____

Designation: _____

Tel: _____

Fax: _____

E-mail: _____

What would your like to read more about in the Water Wheel?

_____

_____

_____

_____

WATER RESEARCH COMMISSION

The Water Wheel

Tel: +27 (0) 12 761-9300
E-mail: laniv@wrc.org.za /www.wrc.org.za

BACK TO TOP

CITIZEN SCIENCE AND CLIMATE CHANGE

Project builds bridge to climate resilience through citizen science

A recently concluded project, funded by the Water Research Commission (WRC), is showing how indigenous knowledge, citizen science, and modern technology can work together to strengthen climate resilience and build more effective early warning systems for communities. Article by Lani van Vuuren.

Peter Luhanga/Groundup

In many South African communities, the signs of changing weather have long been read not from satellites or smartphone apps, but from the land itself. The movement of birds, the flowering of certain trees, the appearance of stars, and even the behaviour of insects have helped communities predict rainfall, droughts, storms, and seasonal shifts for generations.

But climate change is beginning to disrupt these age-old signals. Rain now arrives later than expected or in great angry bursts that cause flooding and devastation. Droughts last longer. Heatwaves are becoming more intense. Plants flower at unusual times and animal behaviour is changing.

A three-year research project led by the South African Weather Service (SAWS), together with the universities of KwaZulu-Natal and Cape Town, has worked to preserve indigenous knowledge about weather and climate while integrating it with modern science to improve climate resilience and early warning systems. The project, titled ***Citizen science early warning tools for weather and climate risk awareness*** (**WRC report no. 3244/1/26**), was carried out in communities across Limpopo, KwaZulu-Natal, the Eastern Cape, Gauteng, and the Western Cape. (An article on the first phase of the study is available in the Water Wheel November/December 2023, https://bit.ly/4udPLcE)

BACK TO TOP

Climate change is rewriting local weather knowledge
For generations, indigenous knowledge systems have helped communities understand weather patterns and survive in harsh environments. Farmers observed the timing of bird migrations, the flowering of trees, the behaviour of livestock, and the position of the moon and stars to guide planting, harvesting, and preparation for extreme weather.

The project found that communities in Swayimane (KwaZulu-Natal), Cofimvaba (Eastern Cape), and Malamulele (Limpopo) still rely heavily on this knowledge. Participants shared meteorological, ecological, and astronomical indicators used to forecast changing weather conditions. These local forecasting systems are deeply rooted in lived experience and cultural practice. In many cases, they provide highly localised observations that scientific forecasts may not always capture.

However, the researchers found that climate change is increasingly disrupting these traditional indicators. Communities reported that seasons are no longer behaving predictably. Rainfall patterns have shifted, temperatures are rising, and extreme weather events such as floods, droughts, hailstorms, and heatwaves are becoming more frequent and severe.

This has serious implications for indigenous knowledge systems. "Climate change disrupts environmental cycles that indigenous knowledge is based on, making traditional weather forecasting less accurate," explains project leader Dr Michael Mengistu, of SAWS. "Astronomical indicators, such as seasonal star alignments, cloud patterns and biological indicators (plant and animal behaviours) that indigenous communities have relied on for generations no longer match the predicted weather outcomes as historical baselines shift."

The project further identified several threats to the survival of traditional climate knowledge. These include climate change itself, urbanisation and modernisation, weak transfer of knowledge between generations, loss of experienced knowledge holders, disappearance of important indicator species and land-use change and environmental degradation.

GCIS

Damage caused by floods in Nkomazi, Mpumalanga, earlier this year. Extreme weather events such as floods, droughts, hailstorms, and heatwaves are becoming more frequent and severe in South Africa.

In some cases, species traditionally used as weather indicators are disappearing or behaving differently because of changing environmental conditions. Elders who hold valuable climate knowledge are ageing, while younger generations are increasingly disconnected from traditional environmental practices. The researchers warn that without active documentation and preservation, valuable indigenous knowledge could be lost.

The study thus sought not to replace indigenous knowledge systems in these communities, but rather to enhance it. "Indigenous communities in South Africa employ a combination of meteorological, ecological and astronomical indigenous knowledge systems (IKS) to monitor local weather patterns, extreme events, and seasonal climate variations. These traditional knowledge systems are particularly valuable for predicting and interpreting climate phenomena in areas where formal forecasts may be unavailable," notes Dr Mengistu. "Integrating indigenous and scientific weather forecasting knowledge offers a practical pathway for enhancing climate resilience, providing more precise, context-specific forecasts that can guide local decision-making and policy."

Communities on the frontline of climate impacts
The project highlighted how vulnerable many South African communities are to climate-related disasters. The five study sites, namely Swayimane in KwaZulu-Natal, Cofimvaba in the Eastern Cape, Malamulele in Limpopo, Cullinan in Gauteng, and Manenberg in the Western Cape, have all experienced severe weather events that damaged homes, infrastructure, crops, and livestock.

These events have had devastating consequences for livelihoods and food security. Communities reported crop losses, weakened livestock, water shortages, damage to homes and infrastructure, and rising farming costs. Farmers, in particular, stressed the need for reliable and localised early warning systems that can help them prepare for extreme weather.

The study found that communities already possess strong local knowledge about climate risks and coping strategies. What is often missing is access to accurate, timely, and understandable weather information.

"The biggest challenges communities face in accessing and understanding early warning information during extreme weather events include lack of awareness of risks, communication and dissemination of warning to remote communities, language barriers, distrust in forecasting systems, and inadequate community response capabilities," says Dr Mengistu.

Instead of a purely top-down approach where experts issue warnings from afar, the project promoted a people-centred model where communities help generate, interpret, and share information. This creates stronger ownership, greater trust, and more meaningful local action.

BACK TO TOP

Photo supplied

A major component of the project involved installing low-cost citizen weather stations in communities and schools. These stations allowed citizen scientists to collect real-time local weather data, including rainfall, temperature, humidity, wind speed, and solar radiation.

Citizen science gives communities a voice

This led to one of most innovative aspects of the project, namely the use of citizen science. Citizen science involves ordinary people participating in scientific research by collecting observations, monitoring environmental conditions, and sharing local knowledge.

In this project, citizen scientists included learners, youth, teachers, farmers, extension officers and science communicators. Around 15 to 25 volunteers were selected from each study site (more than 400 people in total) and trained to monitor weather conditions, interpret forecasts, and share climate information within their communities.

Rather than treating communities as passive recipients of information, the project placed them at the centre of climate monitoring and early warning efforts. Workshops were held to help participants understand, among other things, weather and climate terminology; seasonal forecasts; climate change projections; early warning systems; disaster preparedness; and indigenous weather indicators.

Importantly, the project also focused on simplifying technical weather information so that communities could engage meaningfully with forecasts and warnings. The project team recognised that scientific terminology can often be inaccessible, limiting public understanding and preparedness. Through training and engagement, citizen scientists became active contributors to climate resilience rather than simply recipients of expert advice.

An important feature of the project was its strong focus on youth engagement. Schools and science centres served as major hubs for citizen science activities, with learners participating directly in weather monitoring and climate discussions. This helped build scientific literacy while also encouraging intergenerational knowledge sharing.

Building local climate monitoring networks

A major component of the project involved installing low-cost citizen weather stations in communities and schools. These stations allowed citizen scientists to collect real-time local weather data, including rainfall, temperature, humidity, wind speed, and solar radiation. "Citizen scientists provided observations and local weather data using the stations. The data was used to verify the forecast issued by SAWS for the study sites," explains Dr Mengistu. "This empowered communities to understand their local weather and use this knowledge to prepare for and respond to weather-related hazards."

The results were encouraging. Measurements for temperature and humidity showed strong agreement with professional stations, demonstrating that low-cost technology can provide valuable local climate information. While rainfall and wind measurements were less accurate in some cases, the study concluded that several of the citizen weather stations performed well enough to support community-based weather monitoring.

BACK TO TOP

Citizen scientists used platforms such as WhatsApp to share warnings, observations, and weather updates. Communities identified WhatsApp as one of the most effective tools for rapid communication during extreme weather events. This is especially important in South Africa, where mobile phone access is widespread even in many low-income communities.

However, the study also cautioned that technology alone is not enough. Information overload, limited internet access, language barriers, and digital exclusion can still prevent warnings from reaching vulnerable groups. As a result, the researchers recommended using multiple communication channels, including radio, schools, community leaders, and local organisations.

The project has important implications for South Africa, where many rural and underserved areas have limited weather monitoring infrastructure. By expanding local monitoring networks through citizen science, communities can help fill critical data gaps while improving the accuracy of local weather forecasts and warnings. "This local weather data will enhance national forecasting models through verification and validation, and will assist vulnerable communities by providing impact-based forecasts of extreme weather events," explains Dr Mengistu.

Indigenous knowledge and modern science can work together

One of the project's strongest messages is that indigenous knowledge and scientific forecasting should not compete; they should complement each other. The researchers found that integrating local knowledge with scientific weather systems can improve both trust and relevance.

For example, citizen scientists in Malamulele reported that a rainfall warning issued for their area proved inaccurate because the weather remained sunny and dry. This type of local feedback is valuable because it helps meteorologists verify forecasts and understand highly localised conditions that national systems may miss.

The project highlighted the importance of combining scientific forecasting models, local environmental observations, indigenous weather indicators and community experiences and feedback.

The final report recommends that future work should focus on systematically documenting indigenous indicators such as animal behaviour, plant changes, and astronomical observations, while linking these with formal meteorological systems. This approach could create more inclusive and culturally grounded early warning systems that communities trust and understand.

One of the project's most important contributions is its recognition that indigenous climate knowledge is both scientifically valuable and culturally significant. As climate change accelerates, communities are not only losing environmental stability, they also risk losing generations of accumulated wisdom about living with nature. The project argues that documenting and preserving indigenous knowledge is urgent.

Perhaps the main message is that climate resilience is strongest when communities, scientists, educators, and institutions work together. In a rapidly changing climate, no single system has all the answers. Satellites and weather models are essential, but so too are the lived experiences of people who know their landscapes intimately.

"South Africa has many communities that remain highly vulnerable to extreme weather and climate-related hazards. The lessons and insights generated through this citizen science project should be scaled up and replicated across additional schools and communities to strengthen people-centred early warning systems in diverse geographic and socio-economic contexts," maintains Dr Mengistu. "Future research should prioritise community-based disaster risk education programmes delivered in local languages and through culturally appropriate platforms. Integrating indigenous and local risk knowledge with scientific and technical information is essential to improving hazard awareness, risk perception, and preparedness at the community level."

By bringing together indigenous knowledge and modern science, the project offers a powerful model for how South Africa can build more inclusive, localised, and effective responses to climate change. And in communities where the weather has always spoken through the land, the challenge now is ensuring those voices are not lost.

On 5 June, a special event was held in Cofimvaba, Eastern Cape, to celebrate community members who had been trained during the project on monitoring weather and climate change. The event was hosted by the WRC and attended by, among others, WRC Board member, Dr Harrison Pienaar, CEO, Dr Jennifer Molwantwa, and Executive: Research, Development and Innovation, Dr Stanley Liphadzi.

BACK TO TOP

SMALLHOLDER FARMING

No water, no crops: irrigation schemes could be a powerful way for South Africa's smallholder farmers to adapt to climate change

Across South Africa's rural landscape, thousands of hectares of fertile land lie unused. Irrigation systems have collapsed, water no longer reaches crops reliably, and many farmers lack the support needed to keep production going. So writes Thulasizwe Mkhabela, research fellow and ad hoc lecturer at the University of KwaZulu-Natal.

This is evident in one of the country's most impoverished provinces, the Eastern Cape, where more than 53% of the communal land with irrigation installed is currently unused. (Most of this land falls under communal tenure and is farmed by smallholders on fragmented plots where they grow produce for household consumption and to sell at local markets.) Despite significant public investment over several decades, many irrigation schemes have fallen into disrepair, water delivery has become unreliable, and large areas of farmland have been abandoned.

As an agricultural economist specialising in land systems, irrigation, and food security, I examined whether revitalising smallholder irrigation schemes in the Eastern Cape is economically and socially viable, and what actually makes them work.

The study, titled 'Evaluating the socio-economic viability of revitalising communal irrigation schemes in the Eastern Cape, South Africa: an analytic hierarchy process approach to land-system governance', published in the journal, ***Critical Insights in Agriculture***, examined 10 irrigation schemes in the Eastern Cape, covering over 9 400 ha of land. Mkhabela went into the field to see how the projects were working, interviewed irrigation experts and used a systematic method to compare what matters most:

- infrastructure condition
- good management

BACK TO TOP

- reliability of water delivery to farmers.

The research found that irrigation schemes don't only fail when they break down. Unstable arrangements to use land and weak day-to-day management stop water from flowing regularly and consistently. This matters because as rainfall becomes more erratic and droughts more frequent, farmers relying on rainfed agriculture will need to be able to irrigate crops. If their irrigation systems fail, farmers will be left fully exposed to climate shocks.

Failed communal irrigation schemes are also a missed opportunity. If revived properly, these could become a powerful tool for climate adaptation.

How irrigation for communally owned land is supposed to work

Between the 1940s and 1980s, the apartheid government set up large, state-run irrigation systems as part of the Bantustan or homeland system. After South Africa's first democratic elections in 1994, the new democratic government tried to move control of these systems from the state directly into the hands of the local farmers and communities. The post-apartheid government also began trying to revitalise smallholder farmer irrigation systems.

The idea was that the irrigation systems would help industrialise agriculture and ensure food security in rural areas where jobs were scarce and unemployment rates and poverty were high.

A communal irrigation scheme in the Eastern Cape typically consists of shared infrastructure – such as canals, pumps and pipelines – serving multiple farmers. It is supposed to be kept in good working condition through a combination of government support, farmers working together in water user associations, and local management committees. Communal irrigation schemes in the Eastern Cape typically draw water from rivers, dams, or springs via gravity-fed canals and electric pumps.

Financially, the system is a shared responsibility. The government generally pays for large-scale infrastructure and major rehabilitation. Farmers, organised into water user associations, are responsible for daily operational costs like electricity, fuel, and minor maintenance.

The real problem isn't just broken pipes

Over the last 30 years, many communal irrigation schemes across South Africa have been plagued by chronic underperformance and system collapse, leading smallholder farmers to abandon farming. Hundreds of millions of Rand of irrigation equipment lies derelict due to low productivity, broken infrastructure and the desertion of farmland by the people meant to use it.

The people interviewed told the research team that government efforts over the years have focused heavily on repairing physical infrastructure. But this study found that even when infrastructure exists, or management structures are in place, breakdowns in coordination, maintenance, or operation still disrupt water supplies. For example, blocked canals, poor scheduling, or uneven use of water prevent irrigation from reaching crops.

Managers became stuck in administrative bureaucracy and conflict resolution rather than the technical and logistical reality of farming. Their core function was to oversee the schemes, but they frequently lacked the specialised technical skills or the budget for constant repairs. They could hold meetings, but they couldn't guarantee that water would reach the crops.

What needs to happen next

The following recommendations emanate from the study:

- First and foremost, maintenance must be prioritised: Funding must be specifically allocated to routine repairs and spare parts.
- Water delivery must be scheduled. Managers must follow precise calendars that dictate who gets water and when. This helps ensure that the system isn't overwhelmed or unevenly used.
- Technical support on the ground. Schemes need dedicated 'water masters' or technicians. They should be at work every day, managing water flow levels. Distant committees that only meet to discuss problems after they occur aren't working out.
- Systems must be suitable: Instead of generic high-tech systems, irrigation projects should be tailored to what the local farmers can actually afford to operate and fix themselves.

In short, the focus must shift from "Is the pipe in the ground?" to "Is there water in the pipe today?"

The key lesson from the research is that irrigation should be treated as a service, not just as infrastructure.

The way communal land in the Eastern Cape is governed must also change. Land-use rights for individual farmers are unclear when land is managed by traditional authorities. Legally, communal land is held in trust under customary systems, but in practice, individual farmers have informal or insecure use rights. They can't invest in their farms if they don't have secure and predictable access to land.

Stronger coordination between the government departments responsible for water, agriculture and land is also essential. Fragmented decision-making has been a major barrier in the past. South Africa has already invested heavily in smallholder irrigation schemes. The challenge now is to revive them and make them work.

Some of the 10 Eastern Cape irrigation systems are still in working order and deliver water fairly reliably. They also have formal agreements to use the land. The government should get these projects working at full capacity. For those schemes that are derelict, the government must first negotiate formal agreements between farmers and traditional authorities. This will stabilise them.

Partnerships between smallholder farmers and private agribusinesses could bring skills, market access and funding as long as they're fair and do not weaken smallholder land rights.

- This article was first published in The Conversation.
- To view the original study, visit: https://bit.ly/4uQl4un

BACK TO TOP

WATER RESEARCH COMMISSION
55 YEARS
Supporting Sustainable Water Futures
1971-2026

Join the Water Research Commission (WRC) at the

BIENNIAL CONFERENCE OF THE WATER INSTITUTE OF SOUTHERN AFRICA (WISA)

to be held from 22 to 24 July 2026 at the Cape Town International Conference Centre.

Session 1: System approach to ensure water reliance,
led by Dr Shafick Adams

Session 2: Water efficient sanitation solutions in South Africa,
led by Mr Jay Bhagwan

Session 3: Advancements in non-revenue water,
led by Jay Bhagwan and Shanna Nienaber

Session 4: South Africa's water research agenda,
led by Dr Jennifer Molwantwa, CEO of the WRC

Session 5: Indigenous crops as climate change adaptation strategy,
led by Prof Sylvester Mpandeli

Session 6: Innovations in water – building resilience and reducing vulnerability in the sector, ***led by Dr Valerie Naidoo***

Session 7: Citizen science and river rehabilitation,
led by Mr Bonani Madikizela

Session 8: Strengthening soft skills and professional networks for Young Water Professionals (YWPs),
led by Dr Mamohloding Maahlo and Ms Boitumelo Matshediso (YWP)

For more information, and to register for the conference, visit https://www.wisaconference.co.za/

BACK TO TOP

DEEPLY ROOTED IN SOUTH AFRICA WATER SOCIETY

www.wrc.org.za

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

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

The WRC Vision is to have highly informed water decision-making through science and technology at all levels, in all stakeholder groups, in innovative water solutions through research and development for South Africa, Africa and the world.

FOLLOW US ON

WATER RESEARCH COMMISSION

THE POWER OF KNOWLEDGE TO THE PEOPLE