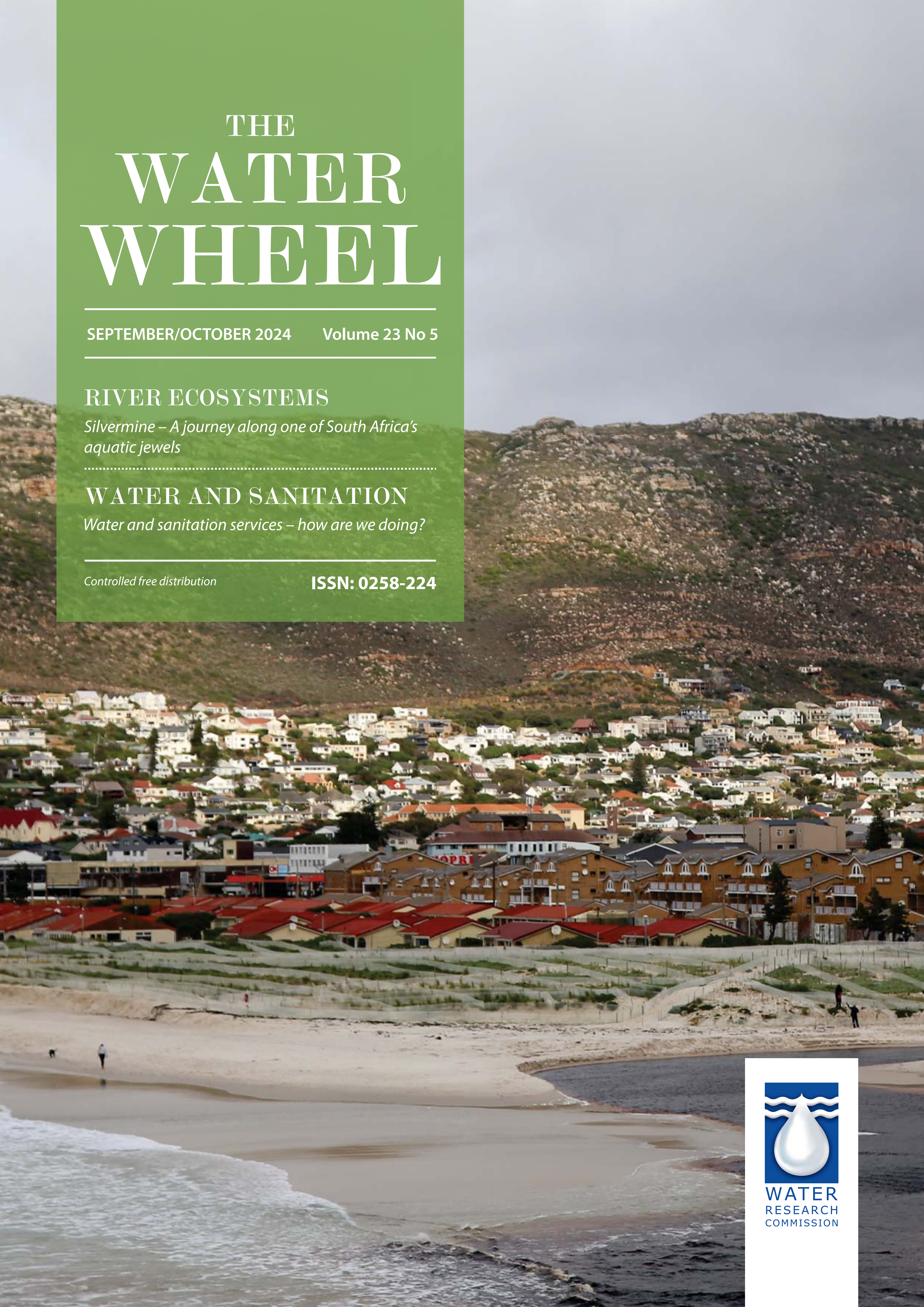

THE WATER WHEEL

SEPTEMBER/OCTOBER 2024 Volume 23 No 5

RIVER ECOSYSTEMS

Silvermine – A journey along one of South Africa's aquatic jewels

WATER AND SANITATION

Water and sanitation services – how are we doing?

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WATER RESEARCH COMMISSION

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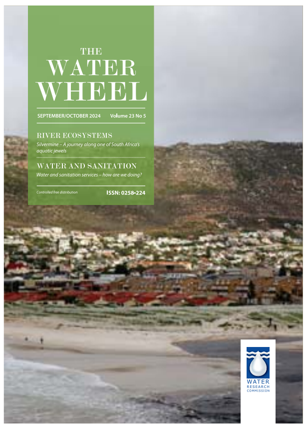

Take a journey along the Silvermine River, in Cape Town. See story on page 12.

NEWS

New isotope hydrology technique reveals secrets of river flow

Researchers used isotope hydrology techniques to develop a pioneering method to assess how different sources of water sources contribute to river flow dynamics.

Dr Andrew Watson, a post-doctoral fellow in the School for Climate Studies at Stellenbosch University, collaborated with researchers from the International Atomic Energy Agency (IAEA) to advance this new method. The result, published in ***Nature Water*** recently, is an important breakthrough in the understanding and prediction of deep water drainage (aquifer recharge) and flooding risk.

For this study, the researchers analysed data from 136 perennial rivers and 45 large catchments globally, including the Orange and Thukela rivers in South Africa and the Congo River in west-central Africa. They used measures of the stable isotopes of oxygen and hydrogen making up water molecules to characterise the fraction of river flow that is due to young 'water' (i.e., water derived from recent rainfall events), compared to 'old water' (ranging from a few months to hundreds and even thousands of years).

The study was also able to characterise river flow dynamics through developing a dynamic water retention indicator.

In rivers with high dynamic retention, water moves through the catchment slowly, indicating a slower response to hydroclimate events. The study further attributed these indicators to key factors such as land cover (e.g. crop and forest cover) and climate (such as air temperature and precipitation).

In the case of the African rivers, all three had low dynamic water retention capability, implying that they will be more susceptible to hydrological extremes like droughts and floods, Dr Watson explains.

Rivers flow long after rain has fallen and can flow far from the origin of the rain and snow that supplies rivers with water. This is because rain and melted snow can follow a complex path through a catchment, over the surface, or via storage in the soil or even deeper in aquifers. Water is also evaporated or transpired by plant roots.

The fractions of all these varies from river to river and these fractions can be used to predict how a river will respond to changing conditions. "With climate and land-use change now significantly altering how water moves through river catchments, this approach offers a new tool for risk assessment and water planning purposes," commented Prof Guy Midgley, interim director of the School for Climate Studies. "This will be valuable in climate change adaptation across the world and has direct relevance in South Africa and the southern African region."

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WRC celebrates achievements of its research managers



(Jay Bhagwan, Bonani Madikizela and Sylvester Mpandeli)

The WRC congratulates three of its research managers for achieving remarkable achievements recently.

Senior research manager Jay Bhagwan has been appointed as a Fellow in the International Water Association (IWA). This honour is bestowed on people for outstanding contributions to the water sector and their commitment to advancing the strategic goals of international organisation.

The IWA Fellows and Distinguished Fellows Community is a global network of influential water professionals who have demonstrated exceptional leadership, innovation, and dedication in the field.

In the meantime, senior research manager, Prof Sylvester Mpandeli, has been appointed as a Professor Extraordinaire in the Faculty of Science at the Tshwane University of Technology (TUT). In this honorary appointment, Dr Mpandeli will be able to contribute to research, teaching and community engagement activities as well as supervise postgraduate students.

Further, research manager in the area of water quality and health, Bonani Madikizela, has been appointed to the Executive Committee of the Southern African Society for Aquatic Scientists (SASAQS). SASAQS is a learned society concerned with the research, management and conservation of inland waters.

Addressing Africa's sustainability challenges through the WEF nexus

Africa's pursuit of sustainable development is challenged by complex and interconnected issues such as climate change, rising water scarcity, environmental degradation, population growth, increasing inequality and poverty, and rising food insecurity and health concerns. Addressing these systematic challenges requires innovative, transdisciplinary approaches that support and amplify locally driven, integrated solutions.

The water-energy-food (WEF) nexus is a framework that captures the inter-relations, synergies and trade-offs between the demand on water, energy and food, in the context of the emerging constraints of sustainable development in particular regions or systems. On 19-20 August, the Water Research Commission (WRC) and its partners, under the auspices of the WEF Nexus Community of Practice, convened a regional summit titled 'accelerating progress towards achieving the SDGs through broadening the WEF+ nexus' at the CSIR in Pretoria.

On the second day of the summit, participants endorsed a statement outlining key pathways to accelerate progress towards the SDGs in the region. They affirmed their commitment to the central role of water, energy, food, environment and health in sustainable development, socio-ecological and socio-economic sustainability, and overall wellbeing.

Climate change bill signing welcomed

The Minister of Forestry, Fisheries and the Environment, Dr Dion George, has welcomed the climate change bill assent into law by President Cyril Ramaphosa.

"The President's signing of the climate change bill into law marks a significant milestone in our nation's commitment to addressing climate change. The Act sets out a national climate change response, including mitigation and adaptation actions, which also constitutes South Africa's fair contribution to the global climate change response," noted Dr George. "This legislation provides a comprehensive framework for climate action across our society and economy. We are now poised to move forward with its implementation."

The law also sets out to enhance South Africa's ability and capacity over time to reduce greenhouse gas emissions, and build climate resilience, while reducing the risk of job losses, and promoting opportunities for new job opportunities in the emerging green economy. The Act will also strengthen coordination between national departments and provide policy setting and decision-making to enable South Africa to meet the commitments in Nationally Determined Contribution (NDC) under the Paris agreement.

"Through the Act, we aim to show leadership, and we look forward to collaborating with all stakeholders to ensure its equitable and ambitious implementation," said Dr George.

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THE WATER WHEEL

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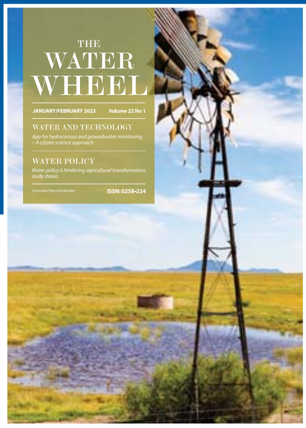

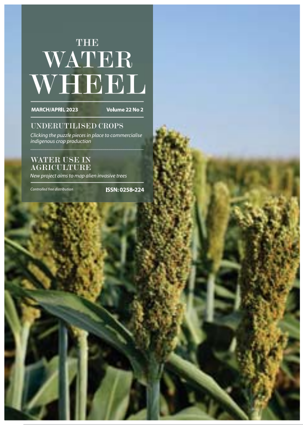

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SA sanitation programme wins international award

The Clear recirculating toilet, one of the innovative sanitation solutions being rolled out to schools.

A South African sanitation innovation programme has won an international award, bringing global attention to its achievements.

The South African Technology Enterprise Programme (SASTEP), led by the Water Research Commission (WRC), is a collaborative initiative involving government departments, municipalities, universities, and key funder, the Bill & Melinda Gates Foundation. The programme won the bronze Market-Changing Water Technology and Infrastructure Award at the prestigious Innovation Awards which took place as part of the International Water Association (IWA) World Water Congress, held in Toronto, Canada, from 11 to 15 August.

The award acknowledges SASTEP's groundbreaking approach to alternative sanitation technologies, which has shown remarkable impact on the lives of countless people, especially children. The programme has been instrumental in developing and implementing sustainable sanitation solutions that are tailored to the specific needs of South African communities.

One of SASTEP's initiatives involves a partnership with the Presidency and Department of Basic Education towards the adoption of innovative sanitation solutions for schools. Through this partnership schools such as Maria-Linden Primary School in Matatiele, in the Eastern Cape have been provided with safe toilet facilities for its 470 learners.

The school was provided with the Clear Enviroloo recirculating toilet. The system is a modular unit that is easy to transport, install and commission. It requires no connection to a sewer system and is energy- efficient, using solar panels. It offers an off-grid solution thus works well in areas with little water supply. The system collects waste stream (including excreta, urine, and flushing water) from a flushing toilet, treats the waste stream, disinfects and recovers the water. The recovered water is stored and used for flushing. The unit at Maria-Linden Primary School is one of twelve non-sewered sanitation systems that have been locally manufactured and demonstrated in a school setting in South Africa within the last two years.

"Being recognised on the world stage is a testament to the hard work and dedication of our team and partners," said Jennifer Molwantwa, CEO of the WRC. "SASTEP is more than just a programme; it's a catalyst for change, facilitating acceleration of technology and innovation development and adoption, driving sustainable development and economic growth in South Africa."

Maggie Clout, Senior Programme Officer of Water, Sanitation and Hygiene at the Bill & Melinda Gates Foundation, expressed the foundation's enthusiasm for the achievement: "We … are thrilled to see our partners at the WRC and SASTEP honoured for their diligent work in bringing transformative sanitation solutions to marginalised communities in South Africa. Innovative, localised efforts like this one – to scale climate-resilient, inclusive technologies for local markets, and make them affordable for those who need them – are crucial to achieving safe and dignified sanitation for all."

The IWA World Water Congress is a global platform for showcasing cutting-edge water and wastewater technologies. SASTEP's bronze award is a significant milestone for South Africa and highlights the country's commitment to addressing water and sanitation challenges through innovation and collaboration.

Dr Jennifer Molwantwa, CEO of the WRC, Doulaye Kone, Interim Director, water, sanitation and hygiene at the Bill & Melinda Gates Foundation, and WRC Senior Research Manager Jay Bhagwan at the IWA Innovation Awards.

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GLOBAL

Four billion people lack safe water

More than half the global population were estimated to lack safely managed drinking water services, a recently published study has revealed.

The research, lead by Eawag, used machine learning based on data from household surveys and data derived from Earth observations.

Safe drinking water access is a human right and one of the United Nations Sustainable Development Goals. However, data on the number of people using safely managed drinking water services is lacking for more than half the world's population. "With our work we aim to help close this information gap," says Esther Greenwood, PhD student at Eawag and lead author of the study funded by the Swiss National Science Foundation.

The team developed models to estimate the use of safely managed drinking water services in 135 low- and middle-income countries (LMICS). The models were developed using machine learning based on existing datasets from household surveys and data derived from Earth observations. A main finding of the study: only one in three people in LMICS countries used safely managed drinking water services in 2020. The study also found that faecal matter polluted the drinking water of almost half of the population in these countries, and a third of people needed to fetch water from a shared water point.

The global maps produced show where the drinking water services are lacking: in rural areas of low-income countries with high temperatures and strong fluctuations in rainfall. The maps suggest that in several countries in sub-Saharan Africa less than 10% of the populations used safely managed drinking water.

"We estimated that over four billion people worldwide do not use adequate drinking water services," noted Greenwood. This is a notable result because this figure is more than twice as high as the previous estimate of the World Health Organization and the United Nations International Children's Emergency Fund (Unicef).

• To access the original study, visit https://www.science.org/doi/10.1126/science.adh9578

Project to reduce PFAS pollution wins global junior water prize

Christopher Whitfield and Wenqi (Jonathan) Zhao from the United Kingdom have received the prestigious Stockholm Junior Water Prize 2024 for their work on per- and polyfluoroalkyl substances (PFAS) in the Thames river basin.

PFAS pollution is a growing concern worldwide. Focusing on the Thames river basin, Whitfield and Zhao developed a geospatial neural network, predicting PFAS values to within 10% of experimentally validated values. For this, they won the Stockholm Junior Water Prize, an international competition where students between the ages of 15 and 20 present solutions to major water challenges.

The jury noted that Whitfield and Zhao "find a way to take data and turn it into actionable knowledge. [They have] identified PFAS hotspots using machine learning, field tested their results, developed a cost-effective filtration system, and reached out to local governments and environmental organisations to raise awareness."

The winners were presented with their prize during an award ceremony at World Water Week by HRH Crown Princess Victoria of Sweden, the prize's official patron.

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One in five people in Africa going hungry, global study shows

Around 733 million people faced hunger in 2023, equivalent to one in eleven people globally and one in five in Africa. This is according to the latest ***State of Food Security and Nutrition in the World*** report published earlier this year by five United Nations agencies.

The report warns that the world is falling significantly short of achieving Sustainable Development Goal 2, Zero Hunger, by 2030. The reports shows that the world has been set back 15 years, with levels of undernourishment comparable to those in 2008/09.

Regional trends vary significantly. The percentage of the population facing hunger continues to rise in Africa (20,4%), remains stable in Asia (8.1%), though still representing a significant challenge as the region is home to more than half of those facing hunger worldwide – and shows progress in Latin America (6.2%). From 2022 to 2023, hunger increased in Western Asia, the Caribbean and most African subregions.

If current trends continue, about 582 million people will be chronically undernourished in 2030, half of them in Africa, the report warns.

Food insecurity and malnutrition are worsening due to a combination of factors, including persisting food price inflation that continues to erode economic gains for people in several countries. Major drivers such as climate change and economic downturns are becoming more frequent and severe.

These issues, along with underlying factors such as unaffordable healthy diets, unhealthy food environments and persistent inequality, are now coinciding simultaneously, amplifying their individual effects.

• To access the report, visit: https://www.wfp.org/publications/state-food-security-and-nutrition-world-sofi-report

New method removes 98% of nanoplastics from water

Much smaller in size than the diameter of an average human hair, nanoplastics are invisible to the naked eye.

Linked to cardiovascular and respiratory diseases in people, nanoplastics continue to build up, largely unnoticed, in the world's bodies of water. The challenge remains to develop a cost-effective solution to get rid of nanoplastics while leaving clean water behind.

New research has created a liquid-based solution that eliminates more than 98% of these microplastic particles from water. "Nanoplastics can disrupt aquatic ecosystems and enter the food chain, posing risks to both wildlife and humans," noted Piyuni Ishtaweera, who led the study while earning her PhD in nano and materials chemistry at the University of Missouri, in the US.

The method – using water-repelling solvents made from natural ingredients – not only offers a practical solution to the pressing issue of nanoplastic pollution but also paves the way for further research and development in advanced water purification technologies. "Our strategy uses a small amount of designer solvent to absorb plastic particles from a large volume of water," explained Gary Bakes, associate professor in the University of Missouri chemistry department and co-author. "Currently, the capacity of these solvents is not well understood. In future work, we aim to determine the maximum capacity of the solvent. Additionally, we will explore methods to recycle the solvents, enabling their reuse multiple times if necessary."

Initially, the solvent sits on the water's surface the way oil floats on water. Once mixed with water and allowed to reseparate, the solvent floats back to the surface, carrying the nanoplastics within its molecular structure.

The research was published in ***ACS Applied Engineering Materials.*** To access the original study, visit: https://pubs.acs.org/doi/10.1021/acsaenm.4c00159

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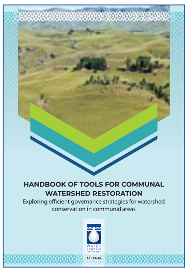
NEW WRC REPORTS



Handbook of tools for communal watershed restoration – Exploring efficient governance strategies for watershed conservation in communal areas

This handbook is a compilation of the experiences and lessons learned from over two decades of community engagement and implementation of various programmes based on identified landscape and livelihood needs in the Upper Umzimbuvu River cachment. Primarily, what has been captured are interventions involving a locally-based NGO, Environmental and Rural Solutions (ERS), their youth outreach team and several implementing partners in the catchment. The handbook captures and acknowledges the multifaceted nature of governance in rural landscapes, addressing the structures and the processes that shape decision-making. It recognises that effective governance requires a holistic approach encompassing institutional frameworks and the practical aspects of steering processes within those institutions. It also acknowledges meaningful engagement, effective action and visible change.

WRC report no. SP 174/24

Link: https://bit.ly/4cT4VeB

Exploring rangeland integrity to support ecosystem-based livelihoods in the Eastern Cape

Rangelands are multi-purpose and in Southern Africa they comprise of Grassland, Arid savannah, Semi-arid savannah, Thicket, Nama Karroo, Succulent Karroo, Desert, and Fynbos biomes, with different management practices. It is believed that the colonial past and subsequent management regime have combined to define the current rangeland status in Southern Africa. This study determined rangeland integrity in communal rangelands of the Tsitsa River Catchment, Eastern Cape province, South Africa using direct, destructive sampling and non-destructive methods, such as remote sensing and ground-based measurements, hydrological modelling, household interviews and workshops that facilitated traditional rangeland management.

WRC report no. 3148/1/24

Link: https://bit.ly/4e5fsV2

Modelling uncertainty and reliability for water resource assessment in South Africa

Hydrological modelling has become central to water resources management and catchment management in South Africa. With ever-growing pressure on the nation's water-supply systems, basing decisions on reliable estimates of surface and groundwater resource availability is critical. At the same time South Africa's meteorological and hydrological monitoring infrastructure has declined severely in recent decades. These data are critical for the validation of models, hence declining monitoring infrastructure is increasing the uncertainty of model outputs. This project focused on participatory research into model uncertainty across the modelling sector, with a particular focus on modeller decisions and structural uncertainty. This was complemented by activities to foster discussion across the modelling community on how to practically address these issues.

WRC report no. 3149/1/24

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

A combination of chemical analysis and stakeholder's participation in addressing the Hennops River pollution in Gauteng Province, South Africa

This report presents the findings of a large endeavour engaging a multidisciplinary approach to address the highly polluted Hennops River basin. Combining stakeholder engagement and chemistry analyses, this project considered the state of pollution of the Hennops River basin in Gauteng. At the same time a study of possible interventions engaging different stakeholders was conducted to better understand and address the situation on the ground. Root causes and subsequent effects of the pollution were specifically considered including how, effective engagement activities and interventions are. Chemical analyses added value and qualified findings from ground-truthing and fieldwork. The findings of this study suggest that the root causes of the challenges observed with the Hennops River basin are related to governance and the overall management of the Hennops River basin.

WRC report no. 3109/1/23

Link: https://bit.ly/4eam30f

Opportunistic fungal pathogens in the Plankenbrug / Eersterivier system within the Stellenbosch region

The AIDS pandemic is associated with a global increase in the incidence of mycosis, a disease caused by several opportunistic pathogenic fungi, which normally reside in the natural environment. Knowledge of the environmental prevalence and interactions of these opportunistic fungal pathogens is thus important to ameliorate their impact on humans, especially on the poor living in ever expanding informal settlements. The rapid expansion of these informal settlements on the outskirts of cities and towns has resulted in an increase in the volume of untreated polluted urban runoff that flows into various river systems. Although such polluted waters are known to harbour numerous opportunistic pathogenic fungi, including yeasts, relatively little is known about the occurrence and interactions of these fungi in South African urban river systems. This study therefore aimed to determine the presence, identity, and antifungal resistance of potentially pathogenic fungi, especially clinically relevant yeast species, in the Plankenbrug / Eersterivier system in Stellenbosch. In addition, the health risks associated with using the river water for domestic use and drinking is exemplified here through a provisional quantitative microbial risk assessment (QMRA).

WRC report no. 3101/1/23

Link: https://bit.ly/4eam6ZZ

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Integrating water quality-health impacts into an integrated water resources management decision-support system (inwards) for early warning in the Inkomati basin

This work covers a two-year period from 2021 to March 2023. The study area comprises the Crocodile River Catchment which forms part of the Inkomati-Usuthu Water Management Area (WMA) and the transboundary Inkomati River Basin shared with Mozambique and eSwatini. The study area also considered the City of Mbombela, which reflects the shared functions regarding water quality and health and disaster management. The work responds to a need of water resource managers and partners in the Inkomati River Catchment to understand the implications of non-compliance with select water quality standards (such as Resource Quality Objectives or RQOs and the Reserve) for risks to human health. This is because water resource and disaster managers have to make complex decisions regarding water use licences, actions for Compliance Monitoring and Enforcement (CME) and disaster preparedness within the context of understanding what risks this might pose downstream.

WRC report no. 3099/1/23

Link: https://bit.ly/3Tf9pVY

Quick reference booklet to groundwater resource management and groundwater governance for municipalities in south africa

Groundwater is a vital resource and many nations depend on it for their water supply. Accelerated development over the past few decades has resulted in great social and economic benefits, by providing low-cost, drought reliable and high-quality water supplies for both urban and rural populations and for irrigation of crops. In South Africa, most water supplies in small towns, originate from groundwater sources. It is geographically widespread and almost two-thirds of South Africa's population depend on it for drinking water supply and domestic use. Therefore awareness and understanding will assist with the proactive management of groundwater in South Africa (Knüppe, 2010). The management of groundwater resources for beneficial use means the intervention in matters concerning water that could include planning, design and operation of hydraulic works. It assumes that an authority exist that will be influential enough to impose decisions upon individuals or influence people's behaviour.

WRC report no. TT 937/24

Link: https://bit.ly/3Mz6yn1

Systematic review of the occurrence and health risk assessment of antiretroviral drugs (ARVDs) in Africa water resources

ARVDs are among the emerging environmental contaminants that has raised concern among researchers and public health experts in the recent times. Unabated release of pharmaceutical product residue into the water resources, especially in the developing countries, is a major threat to public health. The quality of water resources is steadily declining globally due to unabated release of contaminants into the river systems, despite a remarkable global awareness to improve water quality. This is due to discharge of toxic chemicals and emerging contaminants in the environment. Polluted wastewater and river systems pose serious public health risks, especially to resource constrained communities and those residing in informal settlements. This study investigated the levels of ARVDs in water resources in Africa with the view to understand their associated environmental and public health risks.

WRC report no. 3104/1/23

Link: https://bit.ly/3XdxrSa

Developing long- and short-term technical solutions, mitigation measures and decision support strategies that will improve water quality in the Grootdraai Dam catchment

The upper Vaal River catchment, and Grootdraai Dam catchment within it, has significance within the country as a result of the industry, energy generation, and agriculture within the catchment. Historically the catchment has had good water quality, such that water from the Grootdraai Dam, which lies near Standerton at the base of the catchment, was suitable for a number of users. However, more recently, a trend to varying water quality has been observed. The drivers of water quality change are many: agricultural land use, mining, or semi or untreated sewage release. This is compounded by factors such as climate change, differences between regulators, different legal frameworks, etc. Progress has been stalled by the lack of a means of predicting the changes needed, and exploring scenarios for amelioration. The overall objective of this study was to predict current and future water quality changes in the Grootdraai catchment because of various activities both (present and planned) as well as varying scenarios that are likely to occur.

WRC report no. 3158/1/24

Link: https://bit.ly/3MvhnX3

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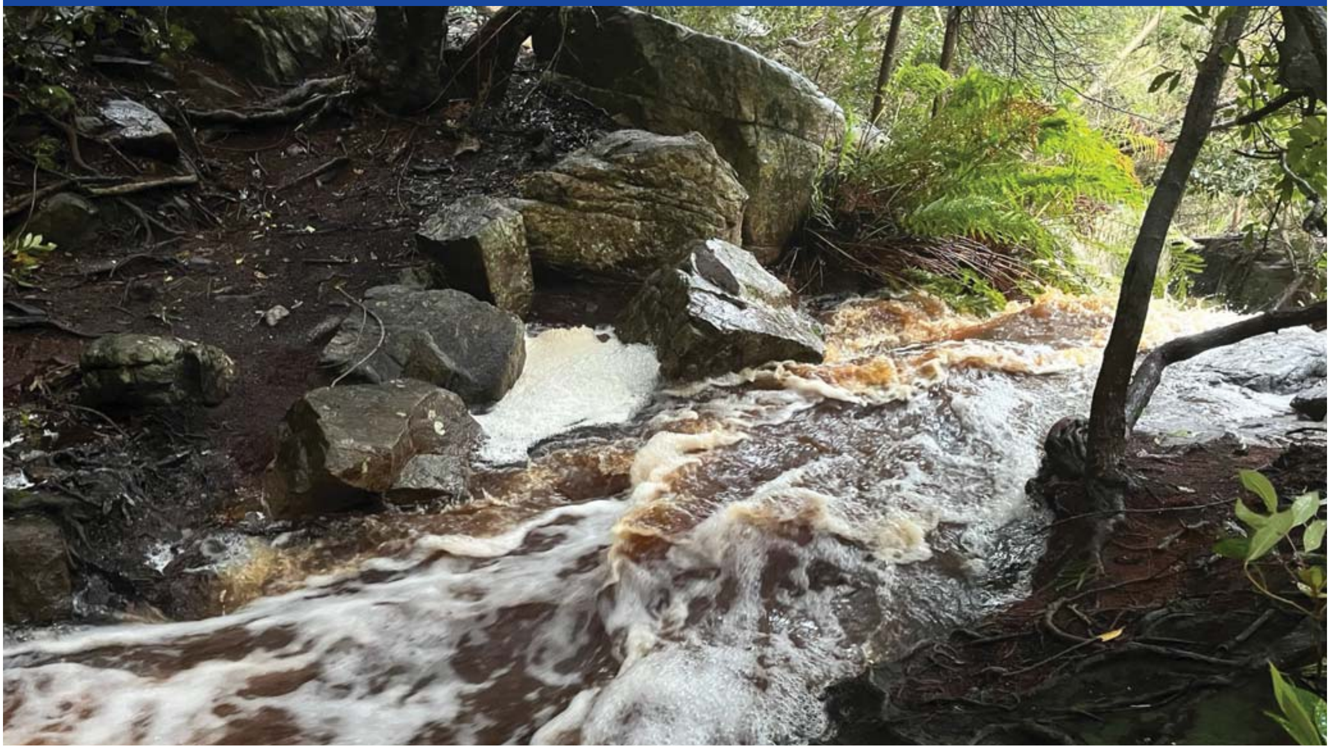
RIVER ECOSYSTEMS

Silvermine – A journey along one of South Africa's aquatic jewels

Petro Kotzé journeys along the Silvermine River, one of only a handful of rivers in South Africa that runs its course without going through a developed area.

Roule le Roux



Cape Town's Silvermine River, which today falls in the Table Mountain National Park (TMNP) winds from its source in Steenberg Mountain to Clovelly Beach, next to Fish Hoek Beach in the city's southern suburbs. Following its course is to hike through the history of a popular section of Cape Town and a journey through South Africa's differing approaches to water management.

The source and the beginning

Water flows to the 12.3 km Silvermine River from a catchment area of over 2 000 ha. Starting at an altitude of 640 m, the river flows southeasterly across the Steenberg Plateau, formed during faulting and uplift in the early Tertiary, some 30 million years ago. An information board at the river mouth tells the tale of the early inhabitants of this area. A combination of rock shelters, high-protein marine foods, abundant seasonal game, and ***veldkos*** (wild plants) attracted people to the mountains, valleys, and shore of False Bay. It's easy to imagine that the river was also part of the appeal.

At the local museum, Margaret Gundry, a Fish Hoek Valley Museum volunteer is just putting the final touches on her upcoming talk about the Peers family, who excavated the famous Peers Cave (or ***Skildergat***) in the 1920s. Located in the Fishhoek Valley, the cave contained remnants of the people who once lived here during the Later Stone Age, close to the river. The remains of nine people were found, including two nearly complete female skeletons, four children and the famous 'Fish

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Hoek Man' as well as ostrich-eggshell beads, bone awls, arrow points, bored stones, and even a small leather bag filled with herbs.

For clues about the animals that roamed here before the arrival of European settlers, researchers Boshoff and Kerley used historical accounts and habitat requirements. They mapped the likely distribution of larger mammals in the Cape Floristic region for the period. These indicate that caracal, brown hyena, African wild cat, Cape Fox, black-backed jackal, red hartebeest, steenbok and eland could have been seasonal visitors around the Silvermine area (or occurred in small groups distributed in patches). Leopard, chacma baboons, porcupines, Cape Mountain Zebra, klipspringer, grysbok and grey rhebok could have occurred in significant numbers year-round.

Today, of these, only the caracal, the chacma baboon, the porcupine and the cape fox are still listed as present in the larger area. (Larger antelope species such as Eland, Red Hartebeest and Bontebok can be found in the TMNP Cape of Good Hope section).

The river's upper reaches saw the first substantial human manipulation when an 82 000 000 L dam was constructed across a shallow valley on the Steenbeg Plateau in 1898. The historical event, as it was later described, would have had a pronounced effect on the lower part of the Silvermine River, retaining most of the upper catchment runoff. The dam's unfiltered, brown water was the main supply of Muizenberg and Kalkbay. The dam was decommissioned for potable water around 1920 when the coastal areas were linked to the supply from Steenbras Dam. After that, the Silvermine Reservoir overflow, known as 'brown water', was used to irrigate the Westlake golf course, an agreement that lasted almost five decades.

When author Jose Burman walked the river for a series written for ***The Cape Argus*** in the sixties, he describes a "pretty, tree-lined reservoir across the valley" into which small rivulets run down from the mountains. He lamented that people weren't allowed access without permission when it would be an excellent amenity for swimming, boating and probably fishing.

Much has changed for the benefit of the river since then. The greater Silvermine area was declared a Nature Reserve in 1965. Table Mountain National Park was established in 1998 and inscribed in 2004 as part of the UNESCO serial Cape Floral Region Protected Area World Heritage Site. It includes the Steenberg plateau and the now, much loved Silvermine Dam.

Petro Kotzé

The Silvermine River estuary has been rehabilitated and made an asset to the area.

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Water provision to the golf course ceased, and the stream gushes downstream, especially after a wet, winter rainy season in Cape Town, tumbling over impressive waterfalls at places. The well-wooded ravine is now known as the river walk.

Some of Burman's wishes have come true. SANParks Regional Communications Manager, Lauren Clayton, says between 30 000 and 80 000 people pass the pay point closest to the reservoir every year. There is plenty to do, including swimming in the lake, picnicking, birding and hiking.

From the Steenberg Plateau to the Silvermine Valley
Burman described the river as "wild" and flowing through some of the peninsula's most remote portions. Today, Ou Kaapse Weg, a road opened in 1968 that runs over the Silvermine mountains across the river, will bring you comfortably close, even to the upper reaches. From the Steenberg Plateau, the river now flows under the road and cuts southwards through a deeply incised valley, picking up several small seasonal streams that drain the surrounding mountains.

Burman further described the kloof as continuing southward, dropping sharply towards the Silvermine Valley. "It is a wild, rugged ravine", he said, "and for long stretches, there are not the remotest signs of civilisation — the land looks like it must have done before 1652." The ravine is still rugged enough that one does not attempt to venture down it, and most demarcated hiking trails stay well away. Ou Kaapse Weg has, however, changed the land significantly, and the constant hum of traffic between Noordhoek and Steenberg permeates the air and mingles with the calls of frogs and birds after the light burst of rain earlier the day.

Burman described the river plunging in a series of drops over a seventy-foot fall to create another favourite picnic site. On the back of one of the wettest months in Cape Town in over six decades, the tea-coloured falls were roaring, and the wind whipped spray into us on the day. It's easily accessible, too, and the area is popular with hikers and trail runners. Not far from the falls, there are still ruins of the old ***kruithuis*** (powder house). The Duch military allegedly stored gunpowder here for a possible British invasion, which took place in June 1795 at the Battle of Muizenberg.

Reports say that the Silvermine Valley has always been a strategic access point to the South Peninsula. The heights above are good lookout points, and the valley was historically used for grazing cattle. Defensive positions were built in 1805, and the first farms in the valley were granted three years later, enjoying a reasonable water supply.

Silvermine Farm lay along the upper banks of the Lower Silvermine River. The farm had grazing for two hundred cows and was cultivated for vegetables. The farmers, the Smiths, used to deliver milk to Simons Town and Crons Diary in Fish Hoek with a two-horse wagon. Gundry remembers their vegetable shop in Fish Hoek Main Road.

At the time of Burman's visit, massive oaks lined the river's west bank perhaps dating back to the time of Simon van der Stel. It is also here where the mystery of the river's name is solved. Old silver mine shafts excavated in 1687 – were apparently the inspiration for the name of the river and the mountain range. The story goes that until 1741 the river was known as Esselstein (Ysselstein Bay was the original name of Simon's Bay). By 1813, it had been renamed the Zilvermyn River, and the mountains behind it were the Zilvermyn Mountains (although museum volunteers placed a question mark over the truthfulness of the tale).

"Historically, the Silvermine Estuary comprised a series of shallow seasonal pans and vleis that periodically formed behind a low barrier dune just above the high water mark."

Roule le Roux

The brown water of the Silvermine plunges over the falls on its way towards the Silvermine Valley.

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Roule le Roux

Remnants of the old farm buildings tell stories of the development of the past.

The mine tunnels are still indicated on old maps and accessible to those who know where to find them, but we were warned that, after all the rain, this would be a dirty affair. On his way there, Burman plodded along the farm track between rows of vegetables. Today, the way is overgrown and runs somewhere past the fence of South African National Parks' (SANParks's) Sunbird Education Centre – the old farmhouse. According to SANParks, the centre is based on Barend Nicolas Petrus van der Poll's renovated homestead, built in 1904, on the farm ***Klein Silvermyn***. The original farm was named after the local silver prospecting sites despite no silver ever being found.

A large part of the upper farm was expropriated to construct the new Ou Kaapse Weg. The remaining farm was later sold to a group that returned the property to its natural state and ran it as the Sunbird Nature Reserve. The valley was transferred to the Table Mountain Nature Reserve in 1998. The development was to be fateful for the river. There were plans to build a dam here once, but they never materialised. Now, the area is being conserved, letting the river run undisturbed further downstream – at least for now.

The river passes the Clovelly Country Club a short distance further and then into an estuary and the sea. It is written that historically, the Silvermine Estuary comprised a series of shallow seasonal pans and vleis that periodically formed behind a low barrier dune just above the high water mark. The estuary would have covered an area between 50 and 60 ha, under which conditions it would have been a haven for fish and birds.

The mouth used to be a windswept stretch of desolate sand across which the river moved. There are plenty of stories about the danger of the mouth. The most famous is that an English officer lost his horse and barely escaped with his own life, nearly sinking into the quicksands. This wild, roving river mouth was restricted when the road and railway bridges were built at Clovelly in 1876 and 1890, respectively. Together with the impact of the dam upstream, these severely reduced the size of the estuary.

The upstream course of the river has also been constricted to accommodate a series of bridges. The railways built an embankment on the southern bank in 1900 to prevent flooding

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Roule le Roux

The Silvermine Dam, constructed in the 1890s, is now a popular destination for a dip or a hike in the surrounding protected area.

into the village, but the system was being destabilised. Sand from the coastal dunes blocked the railway line, so they planted marram grass first and later levelled and stabilised the dunes with stone chippings.

However, the river kept interfering with expanding development. Over time, irregular floods plagued developments on the river's old floodplains and plans were made to canalise it. Local conservationists stepped in to rehabilitate the broken estuary instead. Starting in 2000, over two years, engineering works included redefining the floodplain with gabion structures and earth berms, creating stilling basins to attenuate floodwaters, filling some adjacent properties to prevent their flooding, extensive planting of indigenous wetland vegetation and building walkways. Now, the wetland is a popular 5.5-hectare recreational area.

The river still tries to return to its natural flow dynamics at the mouth and, when open for extended periods, tends to migrate across the beach towards the embankment that protects the railway, which has prompted officials to bulldoze the outflow channel straight again.

Still, many describe the Silvermine as a wild river and one of the most pristine on the peninsula. And, while people have left their mark over generations, future ones might ensure it remains that way.

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WATER PERSONALITY

After a lifelong commitment to research, a crowning chapter concludes at 80

For most, research, the diligent and systematic enquiry into a subject, is a long-term undertaking. It has been a lifelong journey for Dr Meiring du Plessis, and he realised his most outstanding achievement only recently, just prior to his 80th birthday. This May, du Plessis, an expert in water quality, received his PhD in Soil Science at the University of Pretoria (UP) autumn graduation season for, according to one thesis examiner, a first-of-a-kind, novel decision support system, with which to assess the fitness-for-use of irrigation water. Petro Kotzé spoke to him about this remarkable achievement.

The project took a decade to complete. It resulted in a tool to substantially improve water management in South Africa and an example to inspire a young generation of researchers. Dr Samkelisiwe Hlophe-Ginindza, Assistant Research Manager for the Water Research Commission (WRC), which funded the project, says his journey should inspire South Africa's future problem solvers. According to du Plessis, the first token of advice he can offer them is to train themselves well in the basic science of their choice, in the direction they love and that excites them. Secondly, they should apply their knowledge to practical problems that will improve other people's lives.

His entire career has been a case in point. It started at an extraordinary time for water management in South Africa.

A young researcher steps into water management

Despite the country's social and political turmoil and international isolation, the sixties saw extraordinary economic growth fuelled by gold, wetting the state's appetite for mega water infrastructure projects, including multi-purpose schemes and dams. At the same time, crippling droughts wreaked havoc on the economy and predicted water scarcity threatened to make water supply to agriculture a major political issue. The sector was, by far, the country's primary water user. According to the Commission of Enquiry into Water Matters (reported in 1970), irrigation and stock farming used 70% of available surface water, and 83% of freshwater intake was used for irrigation.

South Africa needed technical experts to help. Du Plessis had just finished his BSc in Chemistry and Geology with a bursary from the then Public Service Commission. He explains that he didn't have many opportunities to further his studies, but the Department of Agriculture announced funding for students who would become the country's necessary agricultural specialists. Focusing on his background in geology, du Plessis secured a bursary and switched direction to agriculture.

The choice set the course for his career, which he started at the Soil and Irrigation Research Institute of the then Department of Agricultural Technical Services. He remembers with a chuckle that his first annual salary as an Assistant Professional Officer in 1965 was a handsome R1 410! He spent years as the head of the water quality section and progressed to become the Deputy Director responsible for soil surveys and irrigation planning. With a focus on research, du Plessis remembers this career stage as "a most interesting and very rewarding period" of his life.

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There was plenty to sink his teeth into. For one, the mega Great Fish River Irrigation Scheme was in development. The scheme would be supplied with water from the Orange River diverted from the Gariep Dam on the Eastern Cape and Free State border via an 83 km-long tunnel (the second longest water supply tunnel in the world when constructed). The water was destined for several irrigation schemes and metropolitan areas in the Eastern Cape.

Du Plessis was part of a multidisciplinary team that quantified the potential effect of irrigation water quality on the soil. He explains that the water from the Great Fish River was of relatively poor quality and had a high salinity and sodium content. In contrast, the water from the Orange River was very fresh and was expected to affect the soil's infiltration capacity negatively. Their work resulted in a model to calculate how to mitigate the problem, for example, how much gypsum a farmer would have to apply to the soil to ameliorate negative impacts due to irrigation water quality.

A second memorable project was developing a model to predict the salinisation of rivers due to irrigation return flow. "The salinisation of rivers is a natural, largely unavoidable impact of irrigation," he explains, but the aim is to try to reduce that as far as possible. The resultant model predicted the impact of irrigating with the fresher water from the Orange River, leaching of the salts in the soil from the previous, and more saline water from the Fish River.

His years in research prepared him well for the next chapter in his career when he took up the post of Research Manager at the WRC in 1987. While he mainly worked on water quality for the first part of his career, the scope of water management issues he became involved in grew exponentially as time went on. It further cemented the central theme of his career and development – managing freshwater research in South Africa.

Managing water research

Du Plessis says that the projects under his helm tackled various aspects, like agriculture salinisation and the impact of agricultural nonpoint sources. He was also responsible for most of the mining-related research at the WRC. Later, he managed the domain of water and the economy, an area of research that investigated, for example, economic incentives to reduce industrial pollution and how water and the country's economy interact.

Photo supplied

Prof John Annandale from the UP Department of Plant and Soil Sciences with Dr Meiring du Plessis.

"When I became a research manager at the WRC, I could put myself in the researchers' shoes," du Plessis explains. He understood that undertaking research was not always easy and straightforward. This considerate approach to managing projects earned him the respect of many researchers and colleagues.

When the WRC celebrated its 40th anniversary with a special issue of ***the Water Wheel*** in 2011, du Plessis's name got a honourable mention in several articles. Microbiologist, Prof Eugene Cloete (these days the chief of staff at the Cape Higher Education Consortium), thanked him for "his dedication to making a difference with the research he directed." Dr Ralph Heath (now MD of WSP in Africa) listed du Plessis as one of three people from whom he, and ultimately the South African water industry, gained the most, precisely due to his stoic support of passive minewater treatment. Former WRC Director of water-centred Knowledge, Dr Heidi Snyman, said that of the many people she has worked with who have left an impression, du Plessis was one of the standouts from whom she learned the most.

Prof John Annadale, from the UP Department of Plant and Soil Sciences, worked with du Plessis on a few WRC-funded projects. He remembers du Plessis as being always well prepared and able to quickly get to the crucial issue, despite much debate and diversion from team and reference group members. According to Prof Annandale, Meiring is quiet and unassuming, and when he decides to speak, it is best to listen carefully, or one will miss out. "He is easily one of the best research managers I have dealt with over my four decades of association with the WRC."

For du Plessis, some of his most important contributions during this time were the many students who obtained higher degrees through their involvement with projects he managed. He retired from the WRC in 2009, but, as he puts it, he did not exactly "go to the beach and watch the seagulls". Best described as semi-retirement, du Plessis has participated on ongoing projects at the WRC (as a researcher this time), while serving on the reference groups of others.

A decision support system for assessing fitness-for-use of irrigation water

In 2014, du Plessis became involved with the project that would eventually lead to his PhD. The Department of Water and Sanitation approached the WRC to assist them with revising the 1996 water quality guidelines, one of the most widely used tools in water quality management, but significantly outdated.

These new guidelines would primarily establish water quality requirements for water bodies. They were expected to express the degree of risk involved with using a specific water, consider site-specific conditions, and extend the range of water constituents considered. It was decided to use the irrigation water use sector as the first to develop new water quality guidelines. It fell on Dr Gerhard Backeberg, then the WRC Director of Water Utilisation in Agriculture, to initiate and manage the project.

The WRC's call for project proposals was successfully met

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The Orange-Fish tunnel inlet in the Gariep Dam. One of Dr Meiring du Plessis's first tasks at the Soil and Irrigation Research Institute in the 1960s was to quantify the potential effect of Orange River irrigation water quality on the soil in the Fish River catchment, to which it was to be transferred.

by the mentioned Department of Plant Production and Soil Science under the leadership of Prof Annandale. Du Plessis was appointed as the project's principal researcher. He was already 70, and the project seemed almost like a mountain too high to climb, he says. But, Annadale convinced him otherwise. "His decades of practical and academic experience in soil and water chemistry and meticulous attention to detail made him the ideal person to update and improve the 1996 irrigation water quality guidelines, making them much more powerful and user-friendly."

Du Plessis laughs when asked how his participation in the project led to his PhD. "I was bullied into it!" He explains that the WRC strongly advocates for their projects to contribute to post-graduate qualifications, but their high-level project did not allow for much basic research. While aware that there is no need for a PhD to further your career when you retire, his colleagues encouraged him to realise that since he was already doing the research work, he might as well use it to obtain a PhD.

"In the process, Meiring fundamentally changed the question we have always asked" notes Prof Annandale from, "Is this water suitable for irrigation?" to "Are there conditions under which this water can be used for irrigation?".

The design and establishment of the Decision Support System that forms the core of his thesis would be a major undertaking and, as far as could be ascertained, a world first. The user-friendly system provides water resource managers and users with guidance about the risks associated with using water of a particular composition for irrigation under site-specific and generic conditions. The DSS assesses the effect of irrigation water composition on soil quality, crop yield and quality, and irrigation equipment.

The DSS has been designed to cater for two diverging applications. The first, more conventional application assesses the fitness-for-use of a water of known composition (water analysis) by determining its fitness-for-use category. The second application is to determine the threshold water composition for a specific fitness-for-use category. This application, Hlophe-Ginindza explains, is used by water resource managers and users when deliberating on the setting of water quality requirements for a given user of a water resource (river stretch or surface or groundwater body).

In short, Hlophe-Ginindza explains that the DSS allows irrigation farmers or government officials to determine if the water they can access is fit for irrigating the crop they intend to grow in a particular site. If this is not the case, farmers can choose a different crop that may be suitable.

Du Plessis adds that the DSS uses a soil water balance model and long-term site-specific climate data to calculate the water use (and thus irrigation requirement) of a crop as well as the redistribution of water constituents within a soil. The DSS then calculates how soil and crop quality and crop yield can be expected to respond to these conditions, over time. Since simulations are run for periods spanning decades, the DSS provides the user with information about how crop yield and other indicators are predicted to vary over time, as a result of climate variability.

It's the first time water quality in irrigation has been captured as comprehensively as this. Prof Annandale says other countries will undoubtedly carefully examine and emulate his contribution when they decide to update their guidelines. "The DSS he developed is a wonderful legacy he leaves for us, as it neatly and accessibly packages much of what he has learned over his long and illustrious career."

The DSS will be housed at the WRC, which will be the tool's custodian and responsible for ongoing maintenance and future improvements.

Now that his PhD is done, du Plessis is ready to slow down, though he mentions that there are still a couple of students to mentor. For this next generation, he recommends doing their PhDs too, though earlier, to equip themselves for their research careers. "Choose something you enjoy," he says, "because you will spend the rest of your life doing it."

The decision support system, developed as part of Dr du Plessis's PhD, provides water resource managers and users with guidance about the risks associated with using water of a particular composition for irrigation under site-specific and generic conditions.

To read ***Risk-based, site-specific, irrigation water quality guidelines*** visit, https://wrcwebsite.azurewebsites.net/wp-content/uploads/mdocs/TT%20727-17.pdf

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WATER AND SANITATION

Water and sanitation services – how are we doing?

The results of three Statistics South Africa (StatsSA) surveys show how far we've come, but also reveal room for improvement. Article by Sue Matthews.

Over the past few months, StatsSA has released a raft of publications on the findings of three different surveys. The main results from Census 2022, giving national and provincial totals for various demographic and socio-economic indicators, were published on 10 October 2023. More detailed 'Provincial profiles', drilling down to municipal level, were released on 27 June 2024.

In the interim, the preliminary results of the 'Non-financial census of municipalities for the year ended 30 June 2022' were published on 26 March 2024. This census, designed to measure selected aspects of service delivery of municipalities, has taken place every year since 2002. All South Africa's 257 municipalities – 205 local municipalities (LM), 44 district municipalities (DM) and 8 metro municipalities (MM) – participated in the 2022 survey.

And then there's the annual General Household Survey (GHS), which collected data from 20 927 households countrywide in 2023. These were the households successfully interviewed from a sample of about 33 000 dwelling units, distributed in 3 324 primary sampling units (PSUs) designed to be representative at provincial level, metro and non-metro level as well as urban, tribal and farm level. The report presenting the GHS 2023 results was published on 23 May 2024.

Census 2022

One of the key takeaways is that 82.4% of households countrywide had piped water inside their dwelling or their yard in 2022, compared to 61.3% in 2001. Although 8.9% had access to piped water outside their yard or on a community stand in 2022, this could be more than a kilometre away, requiring a long

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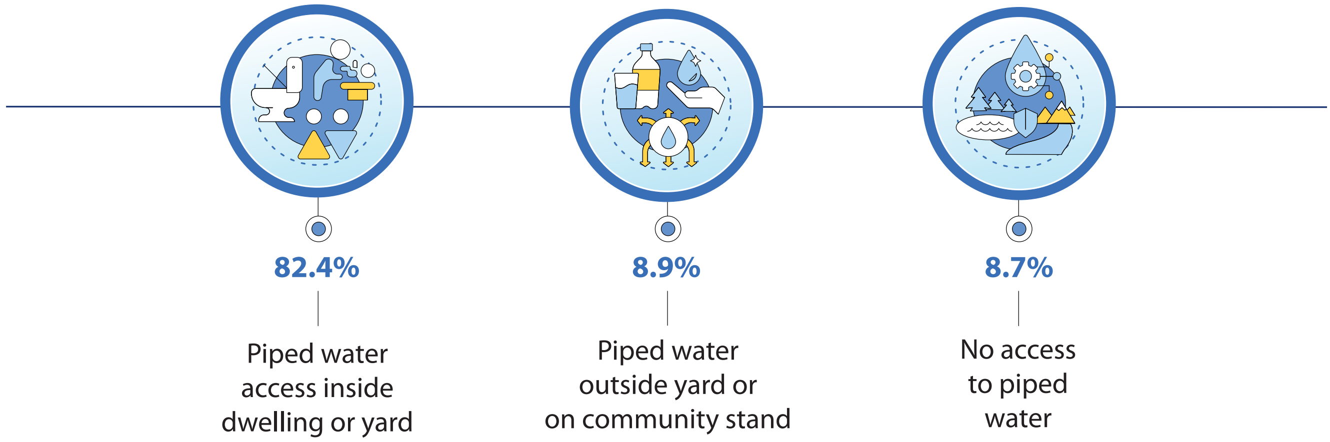

Access to piped water by households (2022).

walk to fetch water. Some 8.7% had no access to piped water at all, but this is at least an improvement over the 15.5% of 2001.

Comparing the provinces, the Western Cape was the clear leader in terms of households with piped water inside the dwelling (85.5%), followed by Gauteng (75%) and the Northern Cape (54.5%). The Free State had the highest percentage of households with piped water inside the yard (43.2%), while Limpopo stood out with the highest percentage of access via piped water on community stands (18.3%), the highest percentage with no access to piped water at all (20.5%, closely followed by the Eastern Cape at 19.5%), and the lowest percentage of piped water inside the dwelling (31.4%).

Even in the Western Cape and Gauteng, though, access is not consistent between municipalities. It's not unexpected that 92.7% of households in the City of Cape Town had access to piped water inside the dwelling or yard, but its extensive informal settlements mean that it was overshadowed by the Central Karoo District Municipality (DM) at 99.4%. In fact, only the Overberg DM ranked lower than the City of Cape Town, and this is entirely due to Theewaterskloof Local Municipality (LM), where only 84.5% of households had access to piped water inside the dwelling or yard. It is somewhat ironic that the Western Cape's largest dam lies in this municipality, while the Central Karoo is the driest part of the province.

Perhaps unsurprisingly, the same trend is observed in respect of households with access to flush toilets. The Central Karoo DM had a much higher percentage of households with access to flush toilets (97.5%) than the City of Cape Town (93.4%). Among the local municipalities, Theewaterskloof (84.0%) had the lowest percentage of flush toilets, but Cederberg in the West Coast DM and Kannaland and Oudtshoorn in the Garden Route DM also fell well below the provincial average of 93.9%.

Almost 70 000 households in the Western Cape listed bucket toilets as their main type of toilet facility, and just over 76% of those were in the City of Cape Town, even though only 3.7% of households relied on them as their main type of toilet facility. Oudtshoorn (4.2%) and Kannaland (3.9%) had a higher percentage of bucket toilets, while households with no access to toilet facilities at all were most common in Theewaterskloof (10.9%), Cederberg (5.8%) and Oudtshoorn (2.4%).

Turning to Gauteng, the smallest province by land area but the largest by population size, the municipalities with best access to piped water inside dwellings or yards were Sedibeng DM (96.9%) and City of Johannesburg MM (95.4%), which also had the highest levels of access to flush toilets (95.3% and 93% respectively). The City of Tshwane MM had lowest levels of access to piped water in dwellings/yards (91.5%) and flush toilets (81.5%), and almost 12% of households depended on a pit latrine without a ventilation pipe. Reliance on bucket toilets was highest in the City of Ekurhuleni MM (4.1%), but 135 124 households throughout the province still depended on this type of toilet. Only 0.4% of households had no form of toilet, with Rand West City LM (0.8%) and City of Tshwane (0.7%) being the worst off.

Considering toilet facilities in the remaining provinces, Limpopo had the lowest percentage of flush toilets (35.2%), and by far the highest percentage of pit latrines, whether VIP (21.1%) or without ventilation pipe (36.8%). KwaZulu-Natal had the highest percentage of chemical toilets (7.0%), while the Northern Cape stood out for households relying on bucket toilets (4.5%) or having no toilet facilities at all (4.5%).

Although these statistics seem bleak, there has been considerable progress over the past two decades. In 2001, only 51.9% of households countrywide had flush toilets, but this improved to 70.8% in 2022. Dependence on pit toilets without ventilation almost halved (22.8% to 12.5%) and the same can be said for bucket toilets (4.1% to 2.1%), although this still translates to more than 371 000 households relying on bucket toilets. The most important change, however, was the decline in percentage of households with no form of toilet facility from 13.6% to 1.6%.

Non-financial census

The 'statistical release' includes revised figures for 2021 and preliminary results for 2022 that will be updated in the next report where applicable. It presents data at provincial level and by municipal categories – metro, local and district – without identifying individual municipalities. That data is only available from StatsSA subject to a successful PAIA submission.

The results are not directly comparable with Census 2022, partly due to different reporting periods but also because municipalities record 'consumer units' or 'billing units' and do

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not have a system for identifying multiple households served by a single such unit. Also, the number of bucket toilets refers only to those provided by municipalities. So while Census 2022 found that 135 124 households in Gauteng relied on bucket toilets, the non-financial census shows that municipalities in Gauteng reported zero provision of bucket toilets in the year ending June 2022, as did those in KwaZulu-Natal, Limpopo and Mpumalanga. Free State municipalities provided the most bucket toilets (25 381), followed by Eastern Cape (12 300), Northern Cape (5 062), North West (2 499) and Western Cape (537) municipalities. Nationally, bucket toilets represented 0.35% of domestic consumer units receiving sewerage and sanitation services.

Data on the number of consumer units receiving water services from municipalities reveals that approximately 7.0% of domestic consumer units nationally were served through a delivery point located more than 200 m from their yard, with those in KwaZulu-Natal (15.2%), Limpopo (11.6%), Eastern Cape (11.4%) and North West (10.5%) exceeding this average.

Some 19.2% of domestic consumer units were receiving free basic water services in 2022 and 19.8% were receiving free basic sewerage and sanitation services. Among all categories of municipality, the metropolitan municipality in the Western Cape – in other words, the City of Cape Town – had the highest proportion of consumer units benefiting from free basic services (62.0% for water and 76.2% for sewerage and sanitation), followed by the metropolitan municipality in KwaZulu-Natal (eThekwini, at 48.3% and 50.4% respectively). Note that these figures are the percentage of total consumer units rather than only domestic ones.

General Household Survey 2023

The GHS report provides some additional insights about water and sanitation access in South Africa, although the findings sometimes conflict with those of Census 2022. For example, while the Census found that 82.4% of households countrywide had piped water inside their dwelling or their yard in 2022, GHS results put this at 75.8% in 2022 and 75% in 2023.

The report provides comparisons at provincial and metropolitan municipality level in which the categories representing access to piped or tap water in dwellings, on-site (yard) and off-site (neighbour's tap or public/communal tap) are combined. This reveals a worrying decline in access to safe and readily available water in the Eastern Cape and Limpopo since 2014. Amongst the metros, the lowest access in 2023 was in Nelson Mandela Bay MM (87.6%) in the Eastern Cape and Mangaung MM (91.7%) in the Free State.

If water is not available in the dwelling or yard, fetching water from the closest collection point can be difficult and time-consuming, especially for the 3.3% of households who still had to water from rivers, streams, stagnant water pools, dams, wells and springs in 2023. While 74.8% of households took less than 30 minutes from setting out to fetch water to returning home, 18.8% took up to an hour. In the Free State, 2.4% of households needing to fetch water faced a round trip of more than 90 minutes!

During the survey, respondents were asked how often they drank bottled water. Nationally, 10.2% of households drank bottled water every day, 8.4% often, 34.6% sometimes and 46.8% never. Drinking bottled water every day was most common in the Northern Cape (23.9%) and least common in Limpopo (4.8%), where 57.6% of households never drank bottled water. Summing the first three categories, the Western Cape had the highest level of bottled water consumption (65.1%), which is likely a reflection of affluent lifestyles in the main urban centres.

With respect to sanitation facilities, the report shows the percentage of households with access to 'improved' sanitation, defined as flush toilets connected to a public sewerage system or a septic tank, or a pit toilet with a ventilation pipe – the so-called

Dan Mitler

VIP toilets at a primary school. Access to improved sanitation has increased from 61.7% in 2002 to 83.3% in 2023.

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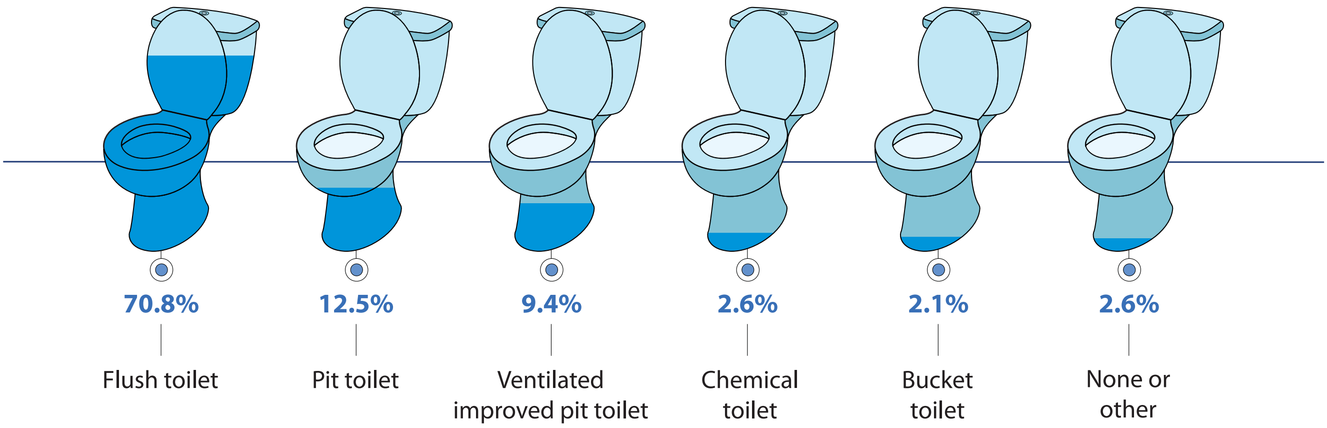

Household access to sanitation according to the Census 2022.

VIP latrine. Access had increased from 61.7% in 2002 to 83.3% in 2023, by which time the Eastern Cape had the third highest access after the Western Cape and Gauteng. This is attributed to the widespread installation of VIP toilets in the Eastern Cape and is presumably why Nelson Mandela Bay is the top metropolitan municipality countrywide, with 96.2% of households having improved sanitation.

There is an interesting analysis of households' handwashing behaviour after using the toilet for the years 2019 to 2023, which shows that the good hygiene practices adopted in 2020 because of the COVID pandemic have not been sustained. While members of 61.4% of households washed hands with soap and water in 2020 (up from 43.6% in 2019), this declined to 55.3% in 2023.

At the back of the report there are tables with a detailed breakdown of the main source of water by province, by population group, by sex of the household head, as well as by the distance households of the various population groups have to travel to fetch water, if they don't have a water source in their dwellings or yard. Similarly, the types of sanitation facility are analysed by province, by population group and by type of dwelling. Here, bucket toilets are split into those collected by the municipality (approximately 156 000 households countrywide) and those emptied by the household (29 000 households).

There is also a separate GHS report "Selected development indicators, Metros" that provides water and sanitation variables by metropolitan municipality. This reveals that some 61 000 households in eThekwini, 56 000 in City of Tshwane and 47 000 in Nelson Mandela Bay had no water supply infrastructure in 2023. Although Mangaung had the highest percentage of households with substandard toilet facility, this amounted to 54 000 households, of which 28 000 used bucket toilets, while City of Tshwane had 180 000 households with substandard toilet facility, of which 59 000 relied on bucket toilets.

Eradicating bucket toilets

In early August the Minister of Water and Sanitation, Ms Pemmy Majodina, addressed the matter of bucket toilets during a media briefing on departmental plans and priorities for the coming year. She noted that the Bucket Eradication Programme still had about 10 000 buckets to be eradicated in seven incomplete projects in the Free State and 596 buckets in one incomplete project in the Northern Cape, but that approximately 44 000 buckets had been eradicated in these two provinces. She explained that the programme focused only on eradicating buckets identified in certain towns in particular provinces in 2012.

A look back at Portfolio Committee minutes and reports available on the Parliamentary Monitoring Group (PMG) website reveals that the programme targeted bucket toilets in formal areas of four provinces -- the Eastern Cape, Free State, Northern Cape and North West. By November 2018, the only outstanding works involved 12 221 toilets in the Free State and Northern Cape that had been built but were awaiting construction of collector pipes, bulk sewer mains and pump stations.

Shockingly, an updated report showing the backlog as of March 2023 gives exactly the same figure, which means that no progress was made in over four years! The same report states that municipalities provide informal settlements with bucket or chemical toilets as temporary sanitation solutions, because legislation does not allow municipal investment in infrastructure development in informal settlements. Bucket toilets also keep increasing in formal areas due to the formalisation of informal settlements.

The Minister addressed this during the media briefing in August, noting that Cabinet has recently approved a National Sanitation Framework providing the basis for new national minimum norms and standards for sanitation that will prohibit the use of the bucket system in both formal and informal settlements. Indeed, the proposed norms and standards were gazetted for public comment on 12 January 2024, and they cater for innovative solutions, providing they adhere to the requirements of SANS 30500 for Non-Sewered Sanitation Systems.

"Working together with the Water Research Commission, the department is developing new safe, dignified, on-site and non-sewered sanitation systems," said the Minister. "These solutions will use much less water than water-borne sewered sanitation systems, which is necessary in a water scarce country such as South Africa. Such systems will need to be implemented by municipalities."

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WATER AND WETLANDS

NASA Bioreach field campaign for assessing the capabilities of remote sensing blue Africa

A project to understand biodiversity and habitat change across the estuaries in the Western Cape is yielding results. Article by Heidi van Deventer, Anthony Campbell, Laven Naidoo, Atticus Stovall, Kyle Smith, Pati Thakali, Elhadi Adam, Daniel Jensen, Abigail Barenblitt, Lola Fatoyinbo.

Estuaries, together with inland wetlands, are considered the most threatened ecosystem in South Africa (Skowno et al., 2019). Less than 43% of habitat maps out of the 290 estuarine functional zones (EFZs) and less than 10 of the 42 micro-estuaries have been digitised by various ecologists in the country to date (Van Deventer et al., in review). The images of several space-borne, remote sensing instruments, including RapidEye, Sentinel-1 and -2, and WorldView has proven useful to distinguish some wetland vegetation communities in the country, however, the use of different Light Detection and Radar (LiDAR) and hyperspectral images at higher spatial resolutions, remains to be assessed.

The National Aeronautics and Space Administration (NASA) funded an aerial campaign of four instruments integrated on two airborne platforms (outlined in Table 1) to capture biodiversity in the Western Cape in 2023. The NASA BioSCape campaign resulted from discussions that commenced over seven years ago. With the primary focus on assessing biodiversity of the Greater Cape Floristic Region, the campaign consisted of 19 sub-projects, each with a particular focus on various realms and biomes. One of these is the NASA BioReach subproject, led by Dr Anthony Campbell from NASA Goddard Space Flight Centre and the University of Maryland, Baltimore County. The aim of the NASA BioReach project was to understand biodiversity and habitat change across the estuaries in the Western Cape.

The NASA Bioreach project collaborates with 23 South African institutions, ranging from science councils to universities and the South African National Parks (SANParks) conservation agency. In May 2023, a workshop was held with initial discussions and planning for the fieldwork campaign later in the year (see Figure 1).

Figure 1. Participants at the NASA BioSCape Applications Workshop at Houw Hoek Hotel, Grabouw, Western Cape, South Africa, 22-26 May 2023 (from Forbes et al., 2023).

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Table 1: Table with the airborne sensors that form part of the NASA Bioscape campaign

Instrument/ platform	Time-frame	Platform	Spectral Range (# bands)	Application	URL
Airborne Visible InfraRed Imaging Spectrometer - Next Generation (AVIRIS-NG)	2023	Gulfstream	380-2 510 nm (426)	Land cover classification; plant functional type and trait maps	https://www.jpl.nasa.gov/missions/airborne-visible-infrared-imaging-spectrometer-next-generation-aviris-ng
Portable Remote Imaging Spectrometer (PRISM)	2023	Gulfstream	350-1 050 nm (3)	Bathymetry and submerged aquatic vegetation	https://airbornescience.nasa.gov/instrument/PRISM
Hyperspectral Thermal Emissions Spectrometer (HyTES)	2023	Gulfstream	7 500-12 000 nm (256)	Land surface temperature	https://airbornescience.nasa.gov/instrument/HyTES
Land, Vegetation and Ice Sensor (LVIS)	2023	Gulfstream	1 064 nm (Waveform)	Hydrogeomorphic characterisation and vegetation structure	https://airbornescience.nasa.gov/instrument/LVIS

Between October and November 2023, the fieldwork campaigns were undertaken in several estuaries at the time of the sensor's overflight. The first week was spent in and around Sedgefield in the Western Cape, followed by the second phase at Langebaan on the West Coast. Plots were sampled within the blue carbon habitats, including salt marshes and seagrasses (e.g. Figure 2 and 3), while adjacent ecotonal freshwater ecosystems were also explored. 'An ecotone is a transition area between two biological communities (Senft, 2009), where two communities meet and integrate (Pearl et al., 2011)' according to Wikipedia (2024). Ecotones are crucial for estuarine habitats and contribute to habitat function and integrity. In each plot the plant species composition and vegetation height recorded, and sediment cores were periodically taken to assess the ecological condition and carbon storage of the biodiversity types. The outputs are currently being processed while the team is waiting for the aerial data to be pre-processed and released. Thereafter, the habitat mapping and analysis will be done, with several papers planned as follow-up work to assess the variation in the characteristics and ecological condition of the ecosystem types.

The vegetation survey was done at four of the Garden Route estuaries: the Knysna Estuarine Bay, Swartvlei, the Touws Estuary and Wilderness Lakes (Figures 4-7). Surveys started at low tide in the intertidal zone, and subsequently shifted with the tides, and would soon end up in the reeds and supratidal vegetation bordering the lakes and estuaries. Swartvlei and other less readily accessible locations in the estuary were accessed by boat. Stands of ***Phragmites australis,*** which towered over the team and made passage difficult, were also surveyed, and at Rondvlei the Sawgrass left its mark in the form of tattered measuring tapes, and plots of spiny rush (***Juncus spp.***) which lived up to their name puncturing shirts and piercing pant legs. Though the marsh vegetation is less than hospitable to humans it is critical to the function of the local ecosystem as it reduces flooding and sequesters carbon.

The team collected both above and below ground measurements, including soil cores, terrestrial laser scans, and spectral reflectance. The Analytical Spectral Device FieldSpec4 was provided by Prof Elhadi Adam from the University of the Witwatersrand (WITS; see Figure 8). The field spectrometer, manufactured by Malvern Panalytical, measures radiance and reflectance across the electromagnetic spectrum from 300 nm to 2 500 nm allowing us to relate ground measurements directly to the sensors flying overhead.

LiDAR technology was utilised in two forms for this project both on the ground with a Terrestrial Laser Scanner (TLS; Figure 9) and LVIS in the air. LiDAR can be used to determine the elevation of the ground and height of vegetation based on the time it takes for light to transit back to the sensor. In our study the TLS scans will be coupled with plot measurements and aerial LiDAR to understand how vegetation structure affects biodiversity in these low stature coastal environments.

Figure 2: Dr Anthony Campbell on the right, and Mr Pati Thakali (WITS) on the left, doing a transect in the submerged macrophytes or seagrasses at Sedgefield.

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Figure 3: Close-up photograph of Zostera capensis *as a submerged macrophyte, which is a threatened species in the country.*

Figure 4: Field validation of inland water habitats at Sedgefield. From left to right: Mr Kyle Smith (SANParks), Dr Anthony Campbell (Goddard Space Flight Center, USA), Dr Atticus Stovall (Goddard Space Flight Center; University of Maryland, USA), Mr Pati Thakali (University of the Witwatersrand), Mr Petri Oberholster (volunteer from University of the Free State) and Ms Larize Nel (volunteer).

Figure 5: Beautiful view from the Sedgefield Estuary looking inland, showing the Zostera capensis *patches that are small in extent as a blue carbon habitat and therefore challenging to map with coarse-scale satellite images. The landscape shows the transition to coastal dunes with terrestrial vegetation on both sides of the estuary.*

*Figure 6: The homogeneity of the salt marsh in the front (*Juncus spp.*) and the reeds (*Phragmites australis*) at Swartvlei at the time of the field campaign. Submerged macrophytes are visible between the lake water on the far right.*

Figure 7: Narrow patches of salt marsh vegetation co-occur with terrestrial vegetation at Swartvlei, which makes it very challenging for space-borne sensors, with a medium spatial resolution to accurately delineate and monitor these vegetation communities.

Figure 8: Fieldwork sampling at Langebaan using the field spectrometer (on the far right). From left to right: Dr Keith Gaddis (NASA Headquarters), Dr Woody Turner (NASA Headquarters), Dr Lola Fatoyinbo (NASA Goddard Space Flight Center), Dr Daniel Jensen (JPL-Caltec), Abigail Barenblitt (NASA Goddard Space Flight Center), Mr Pati Thakali (WITS), Dr Anthony Campbell (NASA Goddard Space Flight Center, USA), Danielle Wood (MIT), Dr Laven Naidoo (GCRO) and Prof Elhadi Adam (WITS).

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Figure 9: Dr Atticus Stovall collecting 3D data with a terrestrial laser scanner for mapping wetland topography and vegetation structure in the tidal estuary ecosystem.

The knowledge exchange between the researchers from the different countries, and between the researchers and other organisations, has enriched the understanding of the systems, while also offering increased creativity in new approaches. Subsequently, meetings have been held every two weeks in 2024 with the expanded team, which facilitated the refinement of the knowledge gaps and research approach towards the outputs. The intention is that the outputs will provide a greater understanding of the fragmented distribution and structure of blue carbon biodiversity in the estuaries of South Africa and can serve as a reference record to map and monitor changes in these systems.

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CITIZEN SCIENCE

Remote learning – exploring a new frontier in citizen science

Citizen science has received increased interest over the years, acknowledged within academia and policy as a bottom-up approach to scientific research due to its ability to increase public participation in citizen science. This, far from novel, the idea has deep roots, dating back to the 1800s, when the public was involved in nature observation and documentation of plants, animals and weather patterns. Article by Nkosi Sithole.

The most historic written account of citizen science is the Christmas Bird Count, which has been an annual event since the 1900s. These labours of public documentation continue through efforts such as the Bird Atlas projects and iNaturalist events, which now help us make sense of global ecological changes and impacts on biodiversity. While definitions vary, citizen science has been acknowledged as an effective tool to bring public policy mandates into effect and for bridging the gap between scientific research and citizens. In addition, citizen science tools have been acknowledged by the United Nations (UN) as instrumental in contributing to reporting against SDG 6 by encouraging citizens to be proactive where water quality management is concerned.

The essential power of citizen science lies in democratising science through empowering communities, co-developing scientific knowledge, increasing social innovation, improving data collection and fostering a sense of confidence within individuals which builds a stronger social fabric within communities. However, the current definition of citizen science has been criticized for not taking into account the diverse forms, scales and varied contexts in which citizen science can exist.

The COVID-19 pandemic was a wake-up call to change the approach to citizen science learning, which was predominantly conducted in person. Citizen science learning and monitoring of water-related issues drastically decreased during this time, which affected the amount of data collected and subsequently reported against SDG 6. This emphasised the need to explore other citizen science learning approaches.

As a response to these challenges, a remote learning platform for citizen science learning for biological monitoring of water systems with the goal of empowering communities being trained in citizen science was developed and piloted with a marginalised community. To select the community, a GIS desktop-based application known as a Multi-Criteria Analysis (MCA) was performed to highlight a community that met the

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following criteria: limited access to technology, significant water and social issues, a need to maintain their water resources, and have had a pre-existing relationship with GroundTruth, and be willing to participate in the research (this was confirmed through engagements with the relevant authorised leaders within the community). The Tribal Authorities of Zikhali and Mabasa, located around Lake Sibayi in the Maputaland area, emerged as the selected community through this process.

To action this goal, GroundTruth was tasked with adapting and simplifying the current citizen science toolbox to suit online learning. This included the adaptation of existing instructional manuals into simple picture-based learning materials with supporting video-based content. Two additional citizen science tools were included in this effort as they add value when used with the other citizen science tools in the toolbox. These were the E. coli water test and the Dragonfly Biotic Index.

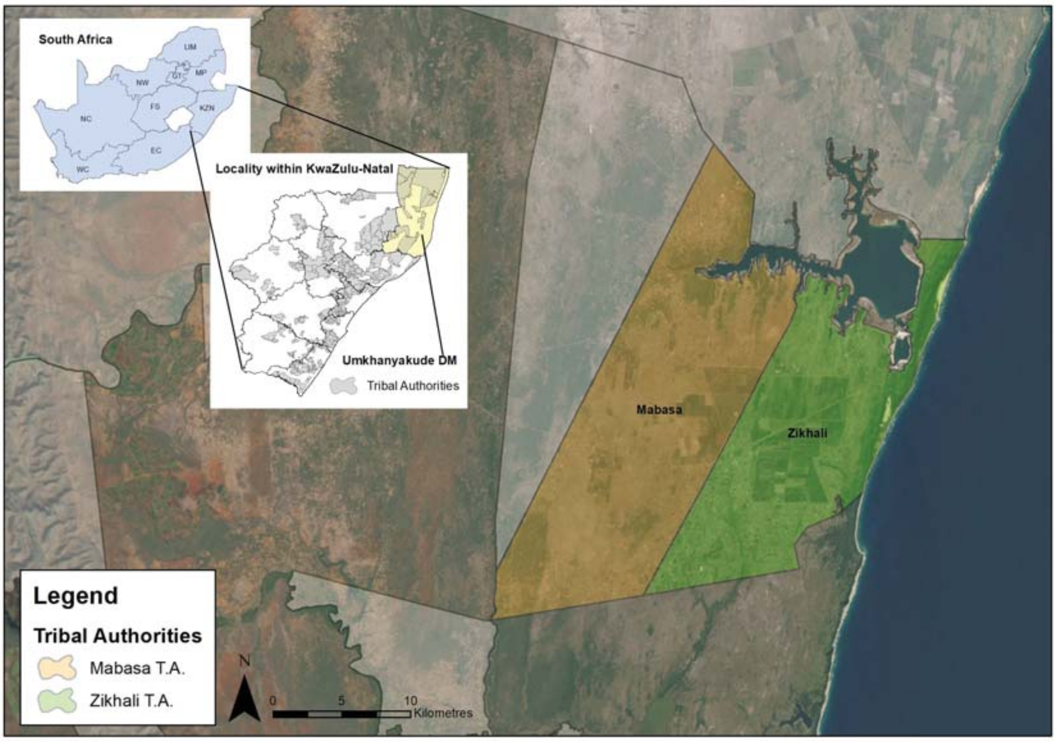
To pilot the remote learning system, the project applied an Action-Orientated Research Approach, which included three phases. Each phase was focused on the following objectives, respectively: understanding how citizen science learning was currently taking place and the tools currently being used; designing the remote learning platform for citizen science learning whilst retaining the learning principles that emerged from phase one and identifying applications to support remote learning; and piloting the remote learning platform in a marginalised community while concurrently assessing how the learning is taking place to inform the refinement and improvement of the remote learning platform.
To assess the learning experience of the participants, a summative assessment was conducted. The following emerging principles were identified and informed the design of the remote learning platform:

1. Relationships between the facilitators and participants and between the participants themselves need to be organically developed and maintained.
2. Learning should be situated in the context of the participant and linked to their experiences and needs.
3. Commonly shared environmental concerns should be explored using the Action Learning approach and assessed through the lens of indigenous/local practices.
4. Citizen science can then be introduced as a monitoring and evaluation tool to assess the change in the environment over time.
5. Citizen Science learning should be contextually relevant, action-based, and regularly practised.
6. Learning about citizen science should be gently scaffolded, building on the existing knowledge of the participants to expand the discourse within their community.
7. Participants need to feel that they are making a significant difference within their community.
8. The remote citizen science learning platform needs to be accessible, user-friendly and include the charge of the internet.

The learning journey of the participants was documented and evaluated, and the findings were used to simultaneously and continuously adapt the online learning programme to improve its functionality. Once participants from the two groups had both completed the course, a final evaluation was carried out and key learnings from the process were summarised into a case study.

The main recommendations from this are summarised below:

- **Visual learning content was effective in supporting remote citizen science learning:** Video and image-based learning material proved to be most effective for



Locality map of Zikhali and Mabasa Tribal Authorities.

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online citizen science learning as participants learnt more about the tools through observing them being practically demonstrated. The videos also allowed participants to rewatch the demonstration of the tools, which facilitated a deeper learning to take place.

- **The translation of learning materials to other South African languages increased access to citizen science learning:** The citizen science learning material was translated into three other South African languages, namely Sesotho, Afrikaans and isiZulu, to increase access and understanding of communities or individuals who were not English-speaking. The participants expressed gratitude for this effort, as they reported that by moving between identical materials in English and their home language, they were able to gain a deeper understanding of the concepts. The development of learning material in other South African languages has widened the scope and reach of online citizen science learning, which is useful within the South African context. The translation process is not complete; with the help of volunteer citizen science groups from wider regions in South Africa, the materials are currently being translated into even more languages, which will be added to the online learning tools.

- **Participants demonstrated an increased level of confidence:** Participants noted that partaking in the remote citizen science learning course helped them gain increased confidence and developed their personal agency. The participants also highlighted that the design of the in-person component, which included the participants needing to do presentations, group activities, and interpret citizen science data, challenged them to overcome obstacles such as fear of public speaking and develop their scientific communication skills. In addition, the participants felt that the knowledge they had gained empowered them to make changes in how they interact with the environment and gave them the confidence to teach others.

- **Participants were able to overcome the challenge of access to the internet through creatively working together:** Participants were able to overcome the challenge of internet charges to view or download the learning content through creatively working together. The project made provision for an initial internet connection for participants to download the Pluto LMS app and associated learning materials. Thereafter no additional provision was made for internet connection, which meant that the participants had to work together to find means of completing the course, as quizzes needed to be done online. Many participants used the public library as it had a free Wi-Fi connection to complete their online tasks. This highlights the importance of local libraries in communities, and more so, in rural communities, as they offer educational support through the provision of free and publicly accessible computers and Wi-Fi. In addition, some participants shared the cost of purchasing data among themselves and used the downloaded content collaboratively to ensure that everyone had access to it. Their creative efforts to overcome the challenge of the cost of internet use would not have been possible if the groups had not been able to form social bonds during the course.

- **Facilitating the space for social learning is vital**: The above example brings to light the value of facilitating social learning, even within the online learning space. Social discourse, interaction, and purposeful engagements with others were facilitated through the use of WhatsApp groups, online forums, group assignments, and the "Change Project" task. Participants in each of the groups reported that they valued the connections that they made with other participants greatly, and many said that they felt that they could not have completed the course without the help of others. They reported that they learnt more from each other than from what was represented in the online materials and that they felt that the practical in-person field demonstrations helped them the most in gaining a deep understanding of the citizen science tools.

These learnings are important aspects to consider for other facilitators hoping to use the online learning materials GroundTruth have developed. The researchers involved in this project have compiled a Best Practice Guide (visit: https://www.groundtruth.co.za/olt) that summarises how to use and apply what we have learnt in this process.

In conclusion, the piloting of a remote learning platform for citizen science learning in a remote community was successful due to the willingness of the participants to engage with the content. This spoke to their need to improve their personal circumstances and the challenges faced by their immediate environment. Their individual drive was evident in the participants' ability to overcome challenges through working together and exploring innovative ways of engaging with the learning platform, bringing to light the importance of public infrastructure like community libraries and the provision made by the facilitators to foster social connectivity within the online learning space. The outcomes of this research highlighted the importance of designing citizen science learning using an Action Learning approach in a way that facilitates social learning processes. With careful consideration and conscious effort, citizen science learning can take place effectively using an online platform within a South African context.

• To read more about the project, view the report, 'Citizen science online training and learning system', here https://bit.ly/3B0uD3o

The COVID-19 pandemic was a wake-up call to change the approach to citizen science learning, which was predominantly conducted in person.

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