THE WATER WHEEL

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WATER POLICY

How research helped break the deadlock in updating SA's outdated raw water pricing strategy

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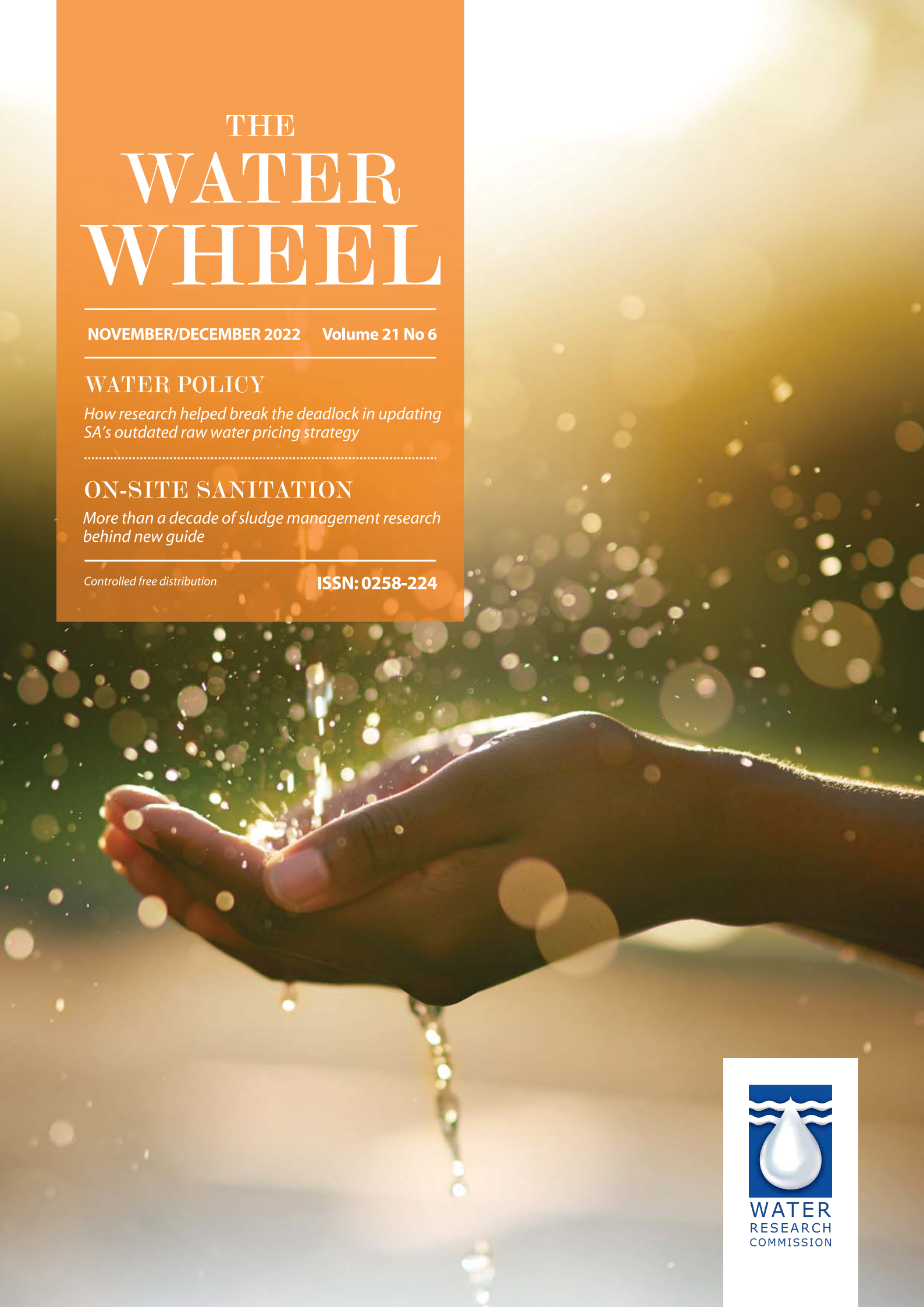

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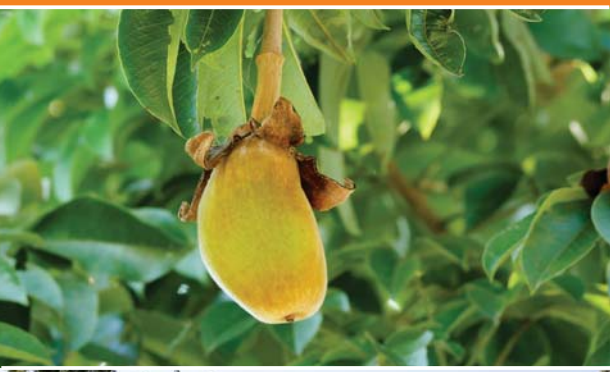

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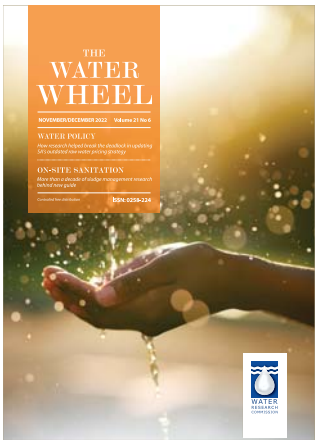

Petro Kotzé reports on the new raw water price strategy and the impact of research. See story on page 10.

NEWS

WRC CEO acknowledged at SA water symposium

Water Research Commission (WRC) CEO, Dr Jennifer Molwantwa, was awarded a Senior Fellowship of the Water Institute of Southern Africa (WISA) at the institute's Biennial Conference & Exhibition, held at the Sandton Convention Centre from 28 – 30 September.

Senior Fellows are considered ambassadors of WISA and are honoured and recognised for their outstanding contribution to the sector and society in general. Dr Molwantwa's "leadership and vision" were put forward in her nomination for Senior Fellowship. She has also been commended for being a role model for particularly young black engineers and scientists.

Prior to her appointment to the Commission earlier this year, she was an Executive Manager of the Inkomati-Usuthu Catchment Management Agency. She holds a PhD in Biotechnology and a Postgraduate Diploma in Enterprise Management. She is also a registered Professional Natural Scientist. She has served on several boards, including those of WISA and the Environmental Assessment Practitioners Association of South Africa (EAPASA). In addition, she is a member of the Department of Fisheries Forestry and the Environment (DFFE) Sub-Committee appointed to develop the National Implementation Plan (NIP) for the management of chemicals in South Africa.

Dr Molwantwa has also served as a Commissioner in the National Planning Commission. She feels passionate about capacity building and the transformation of the water sector and, through her various leadership roles, she has championed the attraction of young women in particular to participate in STEM (science, technology, engineering, and mathematics). It is her firm belief that the path towards equal participation of men and women in all levels of the economy, science and technology, knowledge generation and business, depends on the opportunities created by men and women before them.

Environment department launches biodiversity sector investment portal

The Department of Forestry, Fisheries and the Environment (DFFE) has launched a biodiversity sector investment portal to link investors with bankable projects as a means of growing the biodiversity economy.

Development of the investment portal by the department has been supported the United Nations Development Programme (UNDP) and the Biodiversity Finance Initiative (BIOFIN). It promotes investment opportunities in the biodiversity sector and encourages the development of connections between communities and investor ready and bankable intermediaries that will ensure the sector is able to contribute to the growth of the economy, and the well-being of society while conserving South Africa's rich biodiversity.

Speaking at the launch earlier this year, the Director-General of the DFFE, Nomfundo Tshabalala, pointed out that South Africa's biodiversity was not only a national asset, but is also a source of economic prosperity through the sustainable use of a wide variety of plants, and our wildlife. Thus, the need to ensure that the sustainable use of nature does not destroy the environment.

"By encouraging investment into businesses that fall within the broader Biodiversity Economy we can promote much-needed economic and social development, and secure our country's critical natural capital," said Tshabalala. "Transformation of the biodiversity sector is key to creating an inclusive approach in which all levels of society and all key stakeholders can assist in addressing the triple challenges of inequality, poverty and joblessness. This can be achieved through greater investment in a largely under-developed sector."

"Biodiversity conservation targets cannot be achieved by public finance alone. Mobilisation of private finance via regulatory frameworks, smart incentives and awareness of inclusive and sustainable business models are essential. United Nations Development Programme remains committed to working with the Government of South Africa as a technical partner to meet the country's development goals," said Gabriel Dava, UNDP Resident Representative.

To access the investment opportunities, visit: https://www.biodiversityinvestment.co.za/

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South Africa "not running out of water" – Minister

Minister of Water and Sanitation, Senzo Mchunu, has allayed fears of water outages in South Africa and reiterated that his department is working towards ensuring water security in the country. He was speaking during the Water Institute of Southern Africa (WISA) Biennial Conference & Exhibition, held at the Sandton Convention Centre from 28 – 30 September.

Mchunu reiterated his call for prudent water use by all water users, saying South Africa remains a water scarce country. Highlighting some of the interventions being carried undertaken in water strained communities such as the Nelson Mandela Bay Metro, Mchunu said private partnerships were needed to strengthen efforts of a water secure country. "There is a need to increase participation of private sector partnerships through finance and skills enrichment in the water sector.

Besides this, we are strengthening our role in regulating, supporting, and intervening in municipalities where municipal water and sanitation services are deteriorating, linked to the reinstatement of blue, green and no drop regulatory monitoring tools," he said.

He also spoke sternly on the status of water in the country, while allaying fears of the country facing a possible severe water outage. Minister Mchunu said that there was no need for citizens to be alarmed, saying the country would not run of water. He admitted that there are water scarcity concerns in different parts of the country but maintained that total water outage would not happen in the near future. "I can state, categorically, that we do not have an immediate threat of water outage. However, this does not mean we are not a water scarce country, and that people should not use water sparingly. We do not have an immediate water crisis so to say, but we should not lower our guard," Mchunu noted.

WATER DIARY

Antimicrobial awareness
21 – 22 November
The World Antimicrobial Awareness Week (WAAW) Research Symposium will take place at Stellenbosch University and virtually.
Visit: https://www.nwu.ac.za/date/world-antimicrobial-awareness-week-waaw-research-symposium-2022

Water storage and hydropower
29 November – 1 December 2022
The 4th International Conference and Exhibition on Water Storage and Hydropower will be held in Lake Victoria, Uganda.
Visit: https://hydropower-dams.com/africa-2022/

Water reuse
15-19 January 2023
The 13th International Water Association Conference on Water Reclamation and Reuse will take place in Chennai, India. The central theme of the conference is 'Water reuse: overcoming challenges of growth and climate change'.
Visit: https://iwareuse2023.com/

Resource recovery
15 – 18 January 2023
The 8th International Water Association Water Resource Recovery Modelling Seminar will be held in Stellenbosch. Topics will include activated sludge and biofilm processes, advances in sludge treatment and management of solids, resource recovery, separation processes, and aquatic chemistry (including micropollutants of concern), among others.
Visit: www.iwawrrmod2022.co.za

World Wetlands Day
2 February 2023
World Wetlands Day will be celebrated around the world on 2 February.
Visit: https://www.worldwetlandsday.org/en/

Hydrogeology
17-22 September 2023
The 50th Congress of the International Association of Hydrogeologists will be hosted at the Cape Town International Convention Centre.
Visit: https://iah2023.org.za/

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GLOBAL

Innovation platforms aim to speed the pace of technology transfer in the water sector

Today, water utilities have a wide variety of technology solutions available to help them solve various challenges: from trenchless automated leak repair technologies, to artificial intelligence that can predict the risk of failures and leaks in water distribution networks, to an autonomous microbiology analyzer for in situ water quality monitoring. So why is it that these solutions are not deployed more widely?

An analysis of the innovation ecosystem in the water sector by the World Bank found that it frequently fails to effectively bring the know-how of innovators together with potential end-users.

To address this, the bank has launched Water Innovation Platforms (WIPs) to match technological innovators working in the water space with water and sanitation (WSS) service providers based on the utilities' key challenges, then facilitate technology adoption. To date, two WIPs have been launched in Africa and Latin America and the Caribbean.

Following an initial selection of WIP participants for each region, a technology needs assessment was carried out to identify both the challenges faced by utilities that could be addressed by a technological solution, as well as the broader ecosystem challenges of accessing and scaling new technologies within local WSS markets.

In Africa, utilities zeroed in on two key priorities: energy demand reduction and the reduction of non-revenue water (NRW), which is essentially water that is lost somewhere in the water distribution system that either never reaches its destination or is not billed. In Latin America and the Caribbean, utilities pointed to identifying and repairing leaks alongside deploying internet of things (IoT) solutions for real-time system monitoring as their top priorities.

These findings informed the selection of a cross-section of technology solution providers. In a participatory process, the utilities voted to determine which companies were invited to present their technologies directly to WIP members.

The next step, the most challenging to date, is to select utility-technology matches in each region that will receive more targeted support on technology adoption. Lessons learned from previous efforts in this space revealed that although initiatives are often successful in connecting technology companies and utilities, translating this interest into a technology pilot is a major challenge. To pre-empt this, the initial matchmaking is extremely focused, targeting three utility-technology pairs in each region. By keeping the initial cohort small, the World Bank can provide more tailored support and ensure utilities' capacities can support their ambitions.

Ultimately, the goal of WIP is to support WSS utilities to leverage technological innovation to meet the challenges inherent in today's operational environment.

Sanitation workers knowledge and learning hub launched

A new knowledge and learning hub has been launched for sanitation workers.

Sanitation workers are involved in several steps of the faecal waste management chain, including emptying of pits and septic tanks; cleaning toilets, sewers and manholes; and operating pumping stations and treatment plants. They provide a fundamental public service, yet often face extreme health hazards and safety risks on the job, as well as social discrimination and stigma.

The Initiative for Sanitation Workers undertaken by partners including the World Health Organisation, WaterAid, International Labour Organisation, the Netherlands Development Organisation (SNV) and the World Bank, with support from the Bill & Melinda Gates Foundation, collaborated with the Sustainable Sanitation Alliance to develop and launch the Sanitation Workers Learning and Knowledge Hub.

The platform aims at disseminating and exchanging resources and information related to sanitation workers. It comprises a library of publications, research, reports and other resources, forum posts, events, a photo library as well as opinion columns on sanitation workers.

To view the hub, visit: https://sanitationworkers.susana.org/#

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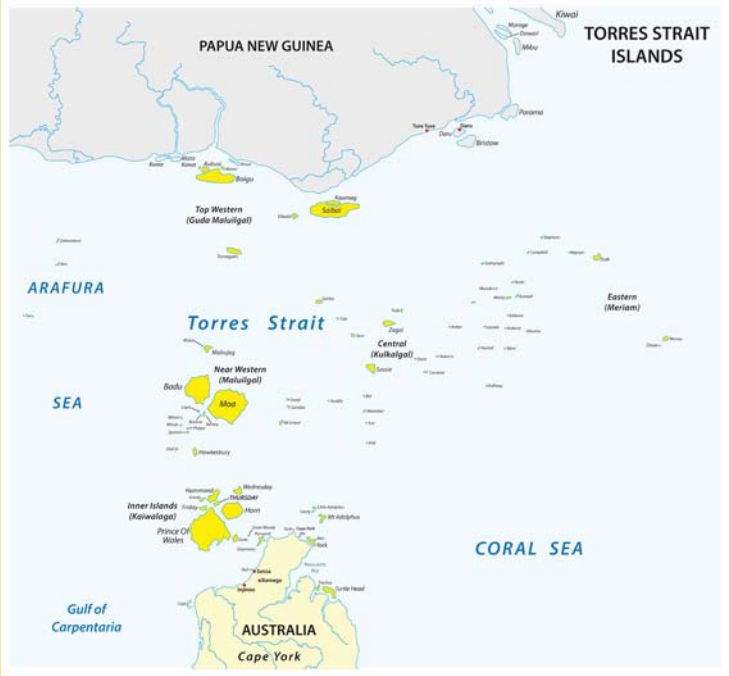
UN rules in favour of islanders in climate change case



In a landmark case, the United Nations Human Rights Committee has found that the Australian government violated the rights of the people living on four islands in the Torres Strait and has ordered it to pay for the harm caused.

Nature reports that the committee ruled that the country had failed to protect islanders from the effects of climate change, making their claim the first successful one of its kind.

The Torres Strait islands off the northern tip of Australia are already being impacted by the effects of climate change, most notably, rising sea levels, coastal erosion and flooding.

The committee, which monitors compliance with the International Covenant on Civil and Political Rights, found that the Australian government violated the islanders' rights in failing to implement adaptation measures to protect their homes, private lives and families – as well as their ability to maintain their traditional way of life, and to pass on their culture and traditions to future generations. It also decided that the Torres Strait islanders were entitled to compensation for the harm they have suffered.

The case could potentially have implications for other island states which are threatened by climate change.

Source. www.nature.com

New species of air-breathing catfish discovered in Congo

Scientists have identified a new species of air-breathing catfish, ***Clarias monsembulai***, in the Democratic Republic of Congo's (DRC's) Salonga National Park.

According to news service, Mongabay, this is the first species of catfish in the Clarius genus to be described in 42 years. The discovery was made by Raoul Monsembula, for whom the new species has been named. Monsembula is a biology professor at the University of Kinshasha and the Greenpeace regional coordinator in Central Africa. The newly named fish species is recognised by its exceptionally long, white barbels.

The DRC's Salonga National Park, which is recognised as an UNESCO World Heritage Site, is a large tract of protected rainforest spanning more than 36 000 km^2. It houses endemic species such as the endangered bonobo or pygmy chimpanzee (***Pan paniscus***) and the critically endangered forest elephant (***Loxodonta cyclotis***). The park's forests and peatlands are also known to be important carbon sinks. It is estimated that there are about 600 tree species and 10 000 animal species in the Congo Basin, including 400 species of mammals, 1 000 species of birds and 700 species of fish.

With the description of C. monsembulai, there are now 61 recognised species of catfish within the Clarias genus, including 32 endemic to African freshwater regions.

Source: Mongabay

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NEW WRC REPORTS

Risk assessment on nano- and macro-scale emerging contaminants in freshwater systems using experimental and modelling techniques

The increasing presence of different classes of emerging contaminants (ECs) in environmental systems together with their unknown impacts to the environment and human health is of great concern. These emerging contaminants of concern include engineered nanomaterials (ENMs), pesticides, and personal care products (PCPs), amongst others. To date, there is limited data on the fate and effects of ECs particularly the categories, namely ENMs, pesticides and PCPs with specific reference to their mixtures in the ecological systems. Although it is challenging to address the impacts of individual chemicals in the selected classes, particularly in the environment, their co-existence as mixtures, their interactions with each other as well as the influence of abiotic factors render evaluation of their fate and toxicity highly complex. Of importance to note is the fact that such studies in South Africa were lacking for both individual and their mixtures. Thus, in order to effectively manage these chemicals motivates the need to carry out a systematic evaluation of their exposure and hazard both for their individual chemicals as well as their resultant mixtures. This project aimed to investigate the effects, distribution, fate and behaviour of emerging contaminant mixtures using experimental and modelling tools.

WRC report no. 2509/1/22 (Volume 1) and 2509/2/22 (Volume 2)

Web link: https://bit.ly/3VU2wZR(Volume 1) and https://bit.ly/3SuXHmE(Volume 2)

Further development, updating and assessment of the SCS-SA model for design flood estimation in South Africa using a continuous simulation approach

The assessment of flood risk by associating a flood event with the probability of an exceedance or return period is the standard approach to design flood estimation (DFE) in most countries. These design flood estimates are essential for designing hydraulic infrastructure such as dams, bridges, culverts and other drainage structures. A National Flood Studies Programme (NFSP) has been initiated to overhaul DFE procedures used in South Africa. Some of the recommendations in the NFSP include the further development and assessment of a continuous simulation modelling (CSM) approach to DFE in South Africa, and updating and modernising the SCS-SA method. The aims of this project were, among others, to refine and update the SCS-SA model for design flood estimation to account for antecedent moisture conditions and the joint association of rainfall and runoff using the results and methodology from a CSM system; compare the performance of the CSM system to the traditional and updated SCS-SA models; and further develop and assess the CSM approach, including the potential incorporation and assessment of improved daily rainfall disaggregation methods to account for the temporal distribution of daily rainfall.

WRC report no. 2926/1/22

Web link: https://bit.ly/3Drvrxl

Critical catchment model intercomparison and model use guidance development

Catchment hydrological modelling has become a central component of water resources management in South Africa. Models are regularly used for a range of applications, including predicting inflows to supply reservoirs, helping to delineate flood lines, and assessing the probable impacts of land cover and climate change. A plethora of modelling tools are available, each with differing approaches to representing hydrological processes. Given the reliance on modelling to inform weighty decisions, continuous research and capacity building is needed to enable the water sector to take advantage of and make wise use of the diversity of strategies and tools. This project aimed to contribute to this field by producing accessible information and guidance that can assist modellers in the process of selecting and applying modelling tools for typical use cases. This was informed by reviewing the structural differences across several commonly used modelling tools in South Africa and exploring the implications of these differences in various settings.

WRC report no. 2927/1/22

Web link: https://bit.ly/3N0b915

Refinement of the world's first fertilizer-producing urinal

Urine is rich in three key ingredients required for fertilizer production: nitrogen, phosphorus and potassium, contributing about 80% of the nitrogen, 55% of the phosphorus and 60% of the potassium typically found in domestic wastewater streams. In addition to being rich in nutrients, the urine stream only makes up 1% of the volume of domestic wastewater streams. Waterless urinals offer an excellent method for separating urine and are well suited for office blocks because they (i) use no water for flushing, (ii) can reduce operating costs for buildings, (iii) water utilities can offer building owners fee discounts and (iv) can provide novel nutrient recovery opportunities. Calcium hydroxide has been identified as a cost-effective and passive stabilization method to prevent the degradation of urea. It also produces a solid calcium phosphate fertilizer that has shown to be as effective as conventionally produced fertilizers. The project team recently constructed the world's first fertilizer producing urinal but have identified that it requires further development. The current prototype does not look aesthetically pleasing and the next version needs to look more like a conventional urinal. The current prototype also requires daily manual mixing which is not practical. This project aimed at developing a mixing solution that effectively maintains the pH above 12. The other challenge with nutrient recovery from urine is that urine is 97% water. This makes it expensive to transport.

WRC Report No. 2892/1/22

Web link: https://bit.ly/3D3OL1V

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Scoping of a citizen science monitoring and evaluation platform for the state of sanitation services in South Africa

The Water Research Commission (WRC) recognises that citizen science tools have the potential to close the perceived gaps between government's role in service delivery and that of citizens in responding to and supporting different aspects of service delivery. Hence, the application of citizen science in the water, sanitation and hygiene (WASH) sector is aptly placed to assist South Africa with effectively and efficiently collecting, storing, analysing and reporting data and information on the state of WASH, while at the same time contributing to national and international mandates of stakeholder participation, transparency, accountability, access to basic services and addressing basic human rights. The aim of this study was to scope the application of citizen science in sanitation in the gathering, analysing and reporting data and information about the state of sanitation infrastructure in South Africa, utilising a scientifically reliable and inexpensive participatory technique through an existing technology.

WRC report no. 3013/1/22

Web link: https://bit.ly/3fntRTN

Prototype development of a real-time monitoring system for groundwater level and quality using the geography of things

Groundwater level and quality monitoring are essential for the sustenance of water resources, especially in an arid and/or semi-arid country like South Africa. Groundwater level and quality data collections from remote areas are currently undertaken once or twice a year using hand-held tape to measure the depth. Samples are taken for laboratory analysis. Although this data is valuable to understanding the resource usage, they are not available in a timely fashion or at the frequency (days to weeks) that water resource managers need them to make relevant decisions such as planning and adaptability. The objective of this project was to develop a system for acquiring, transferring, analysing and displaying real-time information to manage groundwater level and quality resources from a geographically distributed network of wells. This project entailed the development of a portable, lowcost, real-time, Geography of Things (GoT) sensor prototype system for monitoring groundwater level and quality. The use of an Internet of Things (IoT) analytical platform to remotely monitor the stated groundwater parameters, coupled with a battery monitoring system, as well as location parameters, brought about convenience to the water managers and ultimately aided proactive decision-making.

WRC report no. 3032/1/22

Web link: https://bit.ly/3zVoUc7

Microplastics as emerging contaminants: Method development, ecotoxicity testing and biomonitoring in South African water resources

The increases in the production of plastic materials globally have led to their ubiquity in the environment. To date, plastics of all sizes have been reported to be present in all type of environments, including marine, freshwater, terrestrial, agricultural lands, drinking water, and air. The ubiquity of plastic materials within the environment coupled with the fact that they are not easily degradable have raised serious concerns about the ecological and human health risk posed. Current empirical evidence suggests that the ecological and human health risk posed by plastics is influenced by several factors which include the physical and chemical properties of the plastic material, the vulnerability of the impacted biological agent, as well as concentration and distribution of plastics in the environment. In South Africa, microplastics have been reported to occur in river systems, however, not much work has been done to examine the potential toxicity and effects of microplastics on biological systems at environmentally realistic concentrations. To this end, methods for quantifying microplastics effects or their toxicity have not been well-established, although standard toxicity testing methods could be adapted. This project thus fills an important knowledge gap by investigating the occurrence and distribution of microplastics in the Swartkops and Buffalo River systems in the Eastern Cape, as well as the ecotoxicity of microplastics and plasticisers on selected test organisms at environmentally realistic concentrations.

WRC report no. 2919/1/22

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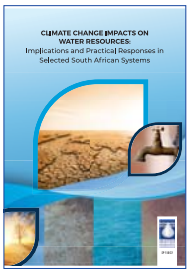

Climate change impacts on water resources: Implications and practical responses in selected South African systems

The WRC's climate change research programme regularly assesses the role and impact of climate on water resources while also characterising itscontribution to climate induced disasters. This programme is implemented through a flagship programme (the so-called Climate Change Lighthouse) which has operationalised collaborative research on priority water-related climate issues with partnerships forged along the innovation value-chain to enhance water research and development to address the water sector challenges in light of the changing climate. The ultimate goal is to ensure empowerment of people and communities to increase resilience, and to develop the knowledge base for climate adaptation and decision support tools, together with guidance and building a framework for sectoral response. This publication provides feedback on such studies while reflecting on their impact on development and policy. It also provides a glimpse of a set of toolboxes that will contribute to increasing the resilience of the water sector to climate change. The publication is a culmination of a series of research conducted collaboratively with the WRC's partners, and aims to provide the necessary direction and advice in dealing with the consequences for climate change. The focus in this case is on rivers, wetlands, the coastal zone and practical case studies at a catchment scale within inland ecosystems.

Web link: https://bit.ly/3sKFlUE
Hard copies available on request.

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

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WATER POLICY

How research helped break the deadlock in updating SA's outdated raw water pricing strategy

Effective management of South Africa's water, and the ability to use the resource as a tool for pursuing social justice and sustainable development, are closely linked to who pays, and how much they pay for the water. Should a small-scale farmer, for example, pay the same price as a large commercial farming operation? While the details are legally debatable in South Africa, it is widely recognised that the current price tags for raw water do not achieve these goals, reports Petro Kotzé.

Instead, the pricing strategy for raw water – untreated water extracted from water resources, such as rivers and groundwater, water supplied from government waterworks, and the discharge of water into a water resource or onto land – is benefiting select users, while not generating enough income to cover the costs of managing the resource.

A new strategy has been in the works since 2015, but its implementation has been stalled because of disagreements on the finer details. As a result, the outdated strategy of 2007 that it must replace, still stands. The impact on raw water users has been "huge", says John Dini, Research Manager at the Water Research Commission (WRC). "The 15-year-old strategy has become completely stale since so much has changed in the meantime," he notes. The WRC recently commissioned four research projects tailor-made to help move the impasse forward, proving the value of research as a mutual broker to bring different people and groups together.

Pricing raw water in South Africa

The pricing of raw water in South Africa is guided by a strategy enabled under the National Water Act of 1998. Over and above the efficient management of water for equitable and sustainable growth, the correct pricing strategy can support reform in the sector and provide water users with transparency, and predictable water costs. The Act allows for the pricing strategy to be revised and refined according to the needs of the developing country and, after the first pricing strategy was developed in 1999, another followed in 2007. However, this one contained a number of challenges.

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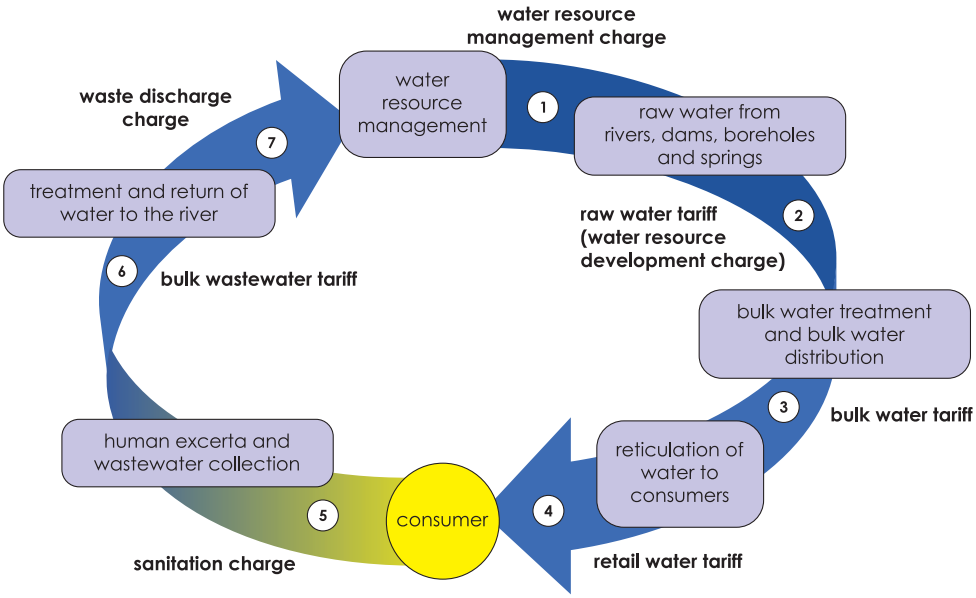

South Africa's full water pricing value chain. The Pricing Strategy for Raw Water Use charges focuses on water resource management charges (1) that include waste discharge charges (7); and water resource development / infrastructure, raw water charge (2). In addition, the National Water Resource Pricing Strategy provides for non-consumptive use which includes impeding or diverting the flow in a watercourse; engaging in a controlled activity; or altering the bed, banks, course or characteristics of a watercourse.

For one, it gives a blanket subsidy to some water user groups. Dini explains that the 2007 strategy introduced caps on the water resource management and infrastructure charges for certain sectors such as agriculture and forestry. The tariffs do not necessarily reflect the cost of producing or managing the water, but they were artificially kept at a certain level to gradually introduce the then-novel costs to the affected sectors. It became an implicit subsidy from the fiscus to agriculture and forestry, Dini says, but was seen as a temporary measure. Over time, it has resulted in substantial under-recovery of costs.

The 2007 strategy thus makes it impossible for the Department of Water and Sanitation (DWS) to set charges that reflect the full cost of delivering water, and this results in insufficient revenue for water resource management and sustainable infrastructure asset management. It also fails to provide a robust method to generate revenue for the development of social infrastructure – those that meet the basic water supply requirements of municipal users in rural areas – and economic stimulus infrastructure – which provides for future economic water use or development.

Furthermore, the DWS now has to make subsidy decisions that should rightfully be made by other departments, such as the Department of Agriculture, Land Reform and Rural Development, given that the activities fall under their oversight. Over and above that, the 2007 strategy does not provide enough protection for the poor against water prices that increase due to infrastructure development.

Sizani Moshidi, Chief Director for Economic and Social Regulation of the DWS, says this is particularly relevant to the agricultural sector. "At the moment, our farmers are all paying the same rate for water, whether they are small-scale growers, medium-scale growers or commercial growers," she says, "but they have cried foul." She adds that more concerns from water users include that the 2007 strategy provides for municipalities and industry, for example, to pay the same price for water.

The new pricing strategy benefits.

User Group	Improvements to the previous strategy	
	Equity	Application of business principles
High assurance users	Ensures that those users who get the highest assurance of supply pay for the privilege	
Industrial users	Ensures that users who use water for commercial purposes pay the full cost of water	
Municipal users	Subsidises the water resource-related costs of providing a basic water supply, which are not covered in the equitable share	Ensures the costs of providing water to the municipality above 50 L per person per day for the indigent population are fully covered by water use charges
Agricultural users	Phases in water charges for resource poor farmers over ten years to enable them to establish themselves effectively before having to pay the full costs Phases in the future infrastructure build charge to commercial farmers over ten years to enable them to adjust to the increase in tariffs	Ensures that commercial agriculture users pay the full cost of water with transparent and targeted subsidies determined by DAFF and Treasury in relation to national agricultural objectives

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The agricultural sector is one of those more seriously affected by the outdated water pricing strategy, with certain farmers crying foul.

The 2015 draft revised pricing strategy sought to correct these and other challenges. It also, for example, considered the financing of the nine Catchment Management Agencies to be established. However, the consultation process prompted numerous comments that highlighted queries, issues, and concerns. Eventually, an impasse developed between the departments of the Minister of Water and Sanitation, whom the Act provides with the power to set the price, and the Minister of Finance, with whom agreement must be reached. "When we did the first round of consultations in 2015, our colleagues at National Treasury were not happy with some of the elements in the strategy," Moshidi says and, after years of negotiation, meetings and revisions, the process eventually reached a deadlock.

We needed an independent voice to cut through the disagreements, Moshidi says.

Last year, the DWS and National Treasury approached the WRC with four specific issues that they could not find common ground on, which led to a stalemate in finalising the strategy. "If we could not agree with each other on these four issues, we would never reach concurrence," Moshidi says. "The four most contentious issues required a little bit more evidence to be to be generated, to support the choices," Dini says. Based on these, the WRC commissioned four research projects.

Four dealbreakers are unpacked with research

The first issue related to the implementation of the Waste Discharge Charge System (WDCS), an economic instrument to support water quality management developed in response to the poor water quality of strategic catchments. In development for over a decade, implementation of the system is critical to improving the quality of our water resources. The new strategy provides the framework for implementing the WDCS, but further work was required to clarify and strengthen its expression through the strategy.

The second issue is related to the classification of social and commercial infrastructure. The 2015 draft pricing strategy makes provision for water resource infrastructure to be classified as either social or commercial, in essence determining the funding model and the implication for the raw water user charges. However, the strategy lacked the appropriate theoretical basis required to define such water resource users, as well as clear and objective guidelines to classify the social and commercial components of large raw water projects.

The third research project tackled the public interest functions of water resource management activities. The 2015 draft pricing strategy affirms the principle that DWS will provide financial support for core national and public interest functions undertaken by water management institutions, the cost of which cannot be recovered fully through water use charges. To finalise the strategy, it was necessary to strengthen the way in which the public interest functions of water resource management activities are defined and quantified.

The last issue on the table was the Future Infrastructure Build Charge (FIBC), introduced in the 2015 draft pricing strategy. Replacing the Return on Assets Charge included in previous drats, the FIBC is a progressive instrument designed to fund the development of social and economic development stimulus infrastructure, by providing for the costs of investigating, planning, designing, constructing and pre-financing new infrastructure and improving existing infrastructure. The researchers focused on further developing the concept, its purpose and calculation.

The studies were submitted to the DWS and National Treasury in December 2021 and, while at the time of writing this article the two departments were yet to formally share opinions on their findings and suggestions, Moshidi says, based on their interactions so far, they are now "fairly aligned" on the issues.

Dini too says he is comfortable stating that they broadly achieved their objectives. "It's a good lesson to learn for researchers," he says, in reference to the process they followed, and their results. According to the stipulations of the Terms of Reference for the four studies, for example, the final reports included proposed text that could be directly included in the draft strategy. The documents were written in formats more similar to pieces of policy advice than traditional academic outputs, Dini says. Feedback included that the work was very much client-focused, he says, which was extremely helpful to the officials on the receiving end. "If you put yourself in the mind of the people who have to work through the policy document, you can make it far easier for them, and put yourself in a much more powerful position," Dini says.

Petro Kotzé

Raw water includes water extracted from water resources such as groundwater.

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Petro Kotzé

The updated strategy also supports for improved water quality management in South Africa.

Onwards to the finish line

The updated draft strategy has been now been made available for public comment again (the deadline for comment is 3 November) and, Moshidi says, this process has thrown new curveballs their way, particularly surrounding the concept of equity. However, she is of the opinion that this is a good development. Different than the first round of public consultations, this time, they are also meeting in so-called rural areas, after they found that the voices of resource-poor farmers and forest growers were not adequately represented in the agricultural organizations the department previously consulted with, and were not able to attend previous meetings often held in urban areas.

"Now we are getting a different picture again," she says. For example, these farmers have pointed out that the ten years over which water charges for resource-poor farmers are phased in are not enough to establish themselves effectively before having to pay the full costs. "They have asked us to consider the concept of equity, differently, from a resource-poor perspective," she says, "which was not part of the discussions in 2015."

"We might have to go back to the drawing board again," she says adding that this might entail approaching the WRC for help once more. "What I have learned with the four studies is the actual value of an independent viewpoint in a discussion," she adds.

Still, Moshidi is positive that any coming challenges will be manageable since the largest stumbling blocks are already out of the way. "Ultimately, we have thought very long and hard about the principles and objectives at stake, what equity is, what fairness is, what efficiency is, as well as the issue of predictability, that will be introduced with a multi-year tariff." Once the strategy is approved, it will be implemented at the start of the new financial year.

"We're on the right track," Moshidi says but, admits that the draft strategy does not address all challenges related to the pricing and payment of water in South Africa. For one, the department is addressing serious administrative challenges, such as cleaning up the invoicing system. Furthermore, the strategy still does not clarify and provide solutions for non-payment and debt management. This question will be addressed as part of a broader process taking place regarding the pricing of all water (raw, bulk, and retail) in South Africa, and whether this responsibility should lie with an economic regulator for the water sector.

Dini says that in support, the WRC is in the process of developing a prioritised research agenda for economic regulation in the water sector. "There remains a need for a systematic assessment of knowledge gaps and research needs across the entire water pricing chain," he says. Moshidi agrees. "We cannot regulate without strong research," she concludes.

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COVID SURVEILLANCE

Poop scoop: world honours for SA study

A groundbreaking Water Research Commission (WRC) funded project using novel sampling methods to trace the spread of the coronavirus in informal settlements has won international acclaim. Matthew Hattingh reports.

All photographs supplied

We are what we eat. Or taken to its logical conclusion and put more bluntly, our poop can talk.

For a long time, researchers have collected samples at municipal wastewater treatment works to reveal fascinating and useful insights into public health. Many of the things we ingest as well as the illnesses we contract show up in tiny, but discernible, traces in our faecal matter and urine. This spans a host of things, from the illicit drugs and pharmaceuticals some of us use, to the diseases coursing through our bodies.

Sewage surveillance offers a number of benefits over clinical testing and the diagnosis of individual patients. It's done anonymously and because it studies populations en masse, fewer trained personnel and less specialised equipment and facilities are needed, simplifying logistics and slashing costs.

By using molecular techniques to analyse samples, researchers can develop a snapshot of the health of an entire community, including how many people are carrying a particular infection, regardless of whether they are showing symptoms. Sewage surveillance helped scientists in many countries, including South Africa, respond early to the Covid-19 pandemic and to keep tabs on the SARS-CoV-2 virus, including emerging variants. It assisted authorities to track rising infection and predict hospital admissions.

The National Institute of Communicable Diseases and partners

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have been monitoring 85 wastewater treatment works across the country, covering many hotspots. The trouble is, about one-third of our countrymen don't have sewered toilets, so sampling only wastewater plants, although convenient and proven, provides an incomplete picture of public health in our cities and towns. But what if rather than relying solely on samples grabbed at the heads of wastewater plants, collections were made from runoff and rivers in informal settlements, where human waste tends to collect?

"This has been the largest non-sewered surveillance programme undertaken globally"

That, in a nutshell, is what a WRC-funded study has succeeded in doing. Gina Pocock, Leanne Coetzee, Bettina Genthe, Karabo Simelane and Prof Janet Mans reckon their study has shown how non-sewered surveillance for SARS-CoV-2 could be done across multiple sites. And they provided a framework to guide citywide research in other developing countries.

"To the authors' knowledge, this has been the largest non-sewered surveillance programme undertaken globally," said the team, who represent private company Waterlab and the University of Pretoria. But don't just take their word for it.

A poster-presentation that summed up their work shared top honours at the International Water Association's World Water Congress in Copenhagen, in September, finishing ahead of more than 500 other submissions. The team was honoured in the poster category along with two other teams: from the Indian Institute of Technology Roorkee, for their presentation on efforts to rejuvenate that country's Ganga River basin; and from Hokkaido University, Japan, for their work on decomposition of the contaminant 1,4-Dioxane.

Jay Bhagwan, executive manager at the WRC, said: "This is a significant acknowledgment of this pioneering work at the highest level, which offered inclusivity and established a pathway and opportunity for broader environmental water quality monitoring."

WRC research manager, Dr Sudhir Pillay, who attended the congress in the Danish capital and learnt of the award a few hours before the presentation at the closing ceremony, said the team was delighted. Paying tribute to his colleagues, Pillay said: "It showed the work was unique and valuable… recognition of the top researchers that we have in the country.

"We have great researchers; it's world-leading stuff," he said, hoping the award would encourage others working in water to stretch themselves. "Because something is difficult or challenging, it doesn't mean we shouldn't try."

What were some of these challenges? Pocock, the lead researcher, told ***The Water Wheel*** that getting hold of the samples proved to be the biggest difficulty – at least initially. "You can't just arrive and start sampling outside someone's shack. People find it threatening," she said, explaining that people in the study areas were aware the team was looking for Covid, which carries a certain stigma.

The solution, she said, lay in getting the community's trust, which they did by piggybacking on "networks and contact in the field". Earlier proof-of-concept studies meant the team knew they were on the right track. They understood samples

The project team (left to right) are Ms Leanne Coetzee, Prof Janet Mans, Dr Gina Pocock and Ms Karabo Simelane (Photo insert: Fellow team member, Bettina Genthe)

The WRC-funded study illustrated how non-sewered surveillance for SARS-CoV-2 could be done across multiple sites.

Sampling took place at 22 sites across four provinces. Samples were gathered mainly from river and surface water.

from greywater and streams at informal settlements could vary considerably more than samples from wastewater plants. They had already figured out how best to go about sample processing and analysis, with nucleic acid extraction and viral amplification work, to detect and quantify viruses, entrusted to the University of Pretoria's Department of Medical Virology.

The team set to work at 22 sites across four provinces. Sample gathering – mainly from river and surface water – continued from March to September of 2021. Thereafter, the study was extended for a further 12 weeks at a number of existing and new sites, to see if further lessons emerged.

Efforts to sample sludge from individual urine-diverting dry toilets were abandoned after proving unfruitful, expensive and impractical. These off-sewer toilets, in outlying eThekwini, failed to yield positive signals of SARS-CoV-2.

Sewage surveillance is fairly straightforward at wastewater treatment works, where staff are well versed in taking grab samples and their proper care. But in informal settlements, and with so many sites, the team sought a different approach.

With the help of river action groups, community leaders, universities and research facilitators, they took grab samples and tethered passive sampling devices to the banks of streams as well as in channels between shacks. Sampling was done up- and downstream of settlements so the researchers could take into account any viruses already in the water before it passed a particular settlement.

Passive sampling proved a better, faster and cheaper way to gather data than grab sampling in informal settlements. Immersing the devices for about 24 hours worked best, making up for times when the water might be diluted, typically from rain. But leaving the torpedo-shaped devices (3D-printed in plastic and containing medical gauze) in for longer risked fouling.

It all entailed a lot of "very challenging" logistics and project management work, said Pocock. Sampling teams had to be trained or put in place with the help of partners. Cooler boxes of samples had to be collected by Waterlab or couriered back and forth between the company's Pretoria offices and the sites in Gauteng, Mpumalanga, the Western Cape and KwaZulu-Natal. And the samplers were kept on the hop, making regular visits to install and retrieve the devices, which on a few occasions went missing.

But in the end, said Pocock, "It worked very well; it was worth it." She said the results were less detailed than those from wastewater treatment works, but did succeed in detecting Covid in wastewater specific to non-sewered communities. This complemented findings from conventional wastewater sampling and clinical testing.

"The inclusion of non-sewered surveillance within city-wide

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surveillance programmes ensures that everyone benefits from surveillance programmes and health outcomes," the authors said. The methodology they developed was expected to support officials monitoring Covid-19 and planning the timing of interventions to tackle infection spikes.

"Regular screening of these sample points will also be useful to assist in early detection of the re-emergence of the virus… in communities, where there is both the risk of rapid spread and low likelihood of conventional testing," the study said. Pillay said the work was also included as a case study in the World Health Organisation's Interim Guidance document on environmental surveillance for SARS-COV-2. These highlight good practice, for the benefit of researchers internationally.

Beyond its value in assisting the authorities manage the pandemic, Pocock saw wider applications for their methodology and hoped it would "help other developing countries as we face future health challenges".

It provided a "new place for sampling", allowing the monitoring of other diseases, such as norovirus and hepatitis E – which were widely detected in the study. There were also opportunities to learn about emerging contaminants, lifestyle indicators, and antimicrobial resistance in communities. All this and more, and with few of the ethical concerns that often complicate research.

Regular screening of sample points are useful to assist in early detection of the re-emergence of the virus, especially in communities where there is both the risk of rapid spread and low likelihood of conventional testing.

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SUSTAINABLE AGRICULTURE

Could SA's food secure future lie in the fruit of its indigenous trees?

Indigenous fruit trees could help feed our hungry and create jobs. But how water-wise are these 'Cinderella species'? A new study provides some answers. Matthew Hattingh reports.

Fruit is fab. Eating the fleshy seed-bearing structures of angiosperms can do wonders for one's health, a slew of studies tell us. Fruit contains important trace elements including iron, zinc and copper. Many are chock-a-block with carbohydrates and vitamin C. It is said to defy diabetes, head off heart disease and even keep cancer in check.

The World Health Organisation is so sold on it, it reckons we should be eating at least 600 g of fruit and veg a day. The reality though, is that South Africa's poor cannot afford to. The country is rightly famous for its Outspan oranges, gorgeous table grapes and other orchard exotics. But much of these are grown for export or the well-heeled and for many of our countrymen remain like those delicious peaches at the top of the tree – beyond reach.

But what if more people, particularly the two-fifths of South Africans living on communal lands in rural areas, were encouraged to grow indigenous fruit? After all, the country is blessed with a bounty of indigenous fruit – more than 35 species – and many are tasty or nutritious. Marula (***Sclerocarya birrea***), for example, has an appealingly tart flavour (which famously finds its way into a top-selling liqueur brand) and, according to the literature, contains up to four times more minerals and vitamin C than commercial oranges.

The fruit of the baobab tree (***Adansonia digitata***) is said to be even better for you, offering nearly 10 times as much vitamin C as supermarket oranges. Only, good luck finding any at your local Spar.

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Perhaps best of all, indigenous fruit trees are adapted to local conditions and bring wider, ecological benefits. They resist pests and diseases and survive without irrigation. This makes indigenous fruit well suited to subsistence farmers eking out a living from the frequently parched and degraded soils of our country's former homelands.

It's this drought resistance and a widely held perception they are more frugal water users than exotics that has fuelled fresh interest in propagating and ultimately growing indigenous fruit commercially. Much of South Africa is semi-arid and water is increasingly scarce. Meanwhile, the spectre of climate change looms. We face a growing likelihood of more frequent droughts, higher temperatures and water losses to evaporation. Alternative crops to support our economically important agricultural sector and to feed the less fortunate must be found.

All of which brings us to a Water Research Commission study published in August, titled ***Water use and yield of selected indigenous fruit tree species in South Africa*** (**WRC Report No. 2720/1/22**).

So, do indigenous fruit trees use less water than the exotics in commercial orchards?

The study, completed over five years, found that some certainly do. However, when water was plentiful some trees set aside their slow-sipping ways and turned to drinking like so many lapsed drunks falling off the wagon. The report also cautioned against generalising. Species and conditions vary significantly, and yield must be considered too. While indigenous trees may use less water than exotics, this should be measured against the quantity of fruit produced for a given quantity of water.

The authors – Zanele Ntshidi, Sebinasi Dzikiti, Nompumelelo Mobe, Nontuthuko Ntuli, Rosemary du Preez, Noluthando Nkosi, Lindokuhle Buthelezi, Lumko Ncapai, Leopold Wilkens and Mark Gush – made the point that the production and consumption of indigenous crops have long been declining as farmers switched to higher-yielding and more valuable exotics. Part of the reason for this, they said, was a dearth of research and information on indigenous species and the authors hoped their findings would support the development of indigneous fruit trees as a crop.

"Our goal at this point was really not necessarily to end up with a fully-developed commercial crop, but rather to provide baseline information to other researchers they can use down the line in transferring from wild unmanaged trees to a fruit crop," said Dzikiti, addressing a workshop on Mainstreaming Indigenous Fruit Trees and Food Crops, hosted by the WRC in August 2022. The report aimed to quantify water use by selected species and to understand how these responded to variables, including soil conditions and climate so recommendations could be made on species suited to specific areas.

With limited time and money, the authors – representing the Council for Scientific and Industrial Research (CSIR); the University of Zululand's Botany Department; the National Port Authority, Richards Bay; the Agricultural Research Council (ARC) Institute for Tropical and Subtropical Crops; Stellenbosch University's Horticultural Science Department; and the UK's Royal Horticultural Society – were anxious to narrow the field of study, so at the outset roped in other experts for guidance.

Twenty-six participants gathered at the University of Zululand to talk about indigenous fruit trees. They wanted to agree on species that produced an abundance of fruit with some commercial

Photo supplied

A marula orchard at the Agricultural. Research Council's Institute for Tropical and Subtropical Crops in Nelspruit. Marula trees observed in Mpumalanga during the study appeared "much happier" and considerably larger than those in KwaZulu-Natal and experienced less water stress.

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Photo supplied

Members of the research team observing leaf growth during the study.

value. The trees needed to be easy to grow and drought and disease tolerant. On the checklist too were ease of harvesting, transportation and storage. Over the course of a day in October 2017, the workshop came up with 10 species. The participants then whittled down the list to five.

In order of priority, these were:

- ***Sclerocarya birrea*** (marula);
- ***Strychnos spinosa*** (monkey orange);
- ***Vangueria infausta*** (wild meddler);
- ***Dovyalis caffra*** (Kei apple); and
- ***Syzygium cordatum*** (water-berry).

Dzikiti remarked in August that the list looked a "little controversial" because it excluded "obvious" species, including baobab. "Part of the reason for this was because most of the participants at the stakeholder meeting were from the nursery side of things and had strong opinions on species that can easily be propagated in the nursery situation."

The team gathered data on the different species at Bonamanzi Game Reserve, near Hluhluwe in KwaZulu-Natal; and ARC in Nelspruit and near Hazyview, in Mpumalanga. But for the purposes of this article we will limit ourselves mainly to the work done on marula and monkey orange at Bonamanzi and marula at Hazyview.

Data collection and logging was largely automated, with instruments set up to measure the micro-climate and soil-water content changes as well as sap flow and leaf gas (water and carbon-dioxide) exchange during photosynthesis. In Bonamanzi, fruit was counted while unripe (to beat monkeys and other wildlife to the punch) on a cross-section of branches to estimate yield.

Dendrometers were wired up to record fruit and trunk growth. This was so growth curves could be mapped to see how seasonal and cyclical changes as well as water availability, weather and other variables affected growth. Data was gathered over two years because the team suspected alternate bearing. This is when trees overproduce in one year and underproduce in the next. Recordings from January 2018 to December 2019 let the team average out dips and rises in production.

At Bonamanzi, the research team measured the transpiration of marula and monkey orange trees. Transpiration is when leaves release vapour through pores (known as stomata) during photosynthesis. It accounts for most water-use in mature trees. The heat ratio method was used to measure the sap flow of whole trees, which is numerically equal to transpiration. The method involved sticking sets of temperature probes into individual stems. A central probe delivered a pulse of heat which the other probes in the set detected. The heat acted as a tracer for the flow of sap – water, essentially, on its way to the leaves. The different probe sets were wired to data loggers to record flow in litres an hour.

The leaf area index (the degree to which a tree's canopy shades the ground) was measured. And a leaf porometer was used to detect how much gas and vapour the stomata allowed to pass. These and other plant, soil and micro-climate data provided values which were plugged into the well-known Penman-Monteith equation. In their findings published in the ***South African Journal of Botany***, the authors said they were able to demonstrate that using the equation, transpiration could be accurately modelled for marula and monkey oranges, despite differences in the species.

Summarising a few of their findings, Dzikiti said the monkey orange trees at Bonamanzi consumed much more water than nearby marulas despite being much smaller. "At the peak, the marula consumed just above 15 ℓ per day per tree versus 35 ℓ per tree per day of the ***Strychnos*** (monkey-orange)." He noted that marula tended to have a long dormant, leafless period when it did not transpire; with monkey orange this period was short. "So… if you are in an area where water is a limiting factor… [marula] has water-saving benefits."

On the other hand, the authors suggested monkey orange trees, with its fine, dense roots were better at scavenging water and nutrients – and so more drought-resistant – than marula trees, which have deeper tap roots, but few feeder roots. Climate was found to be the biggest factor in monkey orange transpiration. But with marula, the response of its stomata when water was available, emerged as the "strong driver".

What about yield? The Bonamanzi marula fruit were not only relatively small in size, but the average yield of 4.3 kg a tree compared poorly with the same species in Mpumalanga, where the trees produced on average 44.9 kg in season one and 24.6 kg in season two. The authors pointed out the Bonamanzi trees were smaller and grew in leached, sandy, "extremely nutrient poor" soils, with a low soil-water content of just over 8%.

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Photo supplied

Monkey orange trees in Bonamanzi during their brief leafless period. By contrast marula tended to have a long dormant, leafless period when it did not transpire

Photo supplied

Marulas were instrumented in Bonamanzi to determine their water use.

In contrast, the much bigger Mpumalanga trees appeared "much happier", including those growing in "probably one of the oldest marula orchards in the country" and experiencing less water stress, said Dzikiti. Mpumalanga marula canopies were considerably bigger too, with one particularly large specimen, growing in clayey-loam soils in Hazyview, exceeding 100 ℓ/tree/day.

The authors said the data suggested indigenous fruit trees can use large quantities of water when they can get it. "However, the yield can also be large. For instance, this specific marula tree produced 82 kg of fruit in the 2019/20 season – almost double the yield of a high-performing apple tree."

They noted all the marula trees in the study appeared to be affected by soil-water deficits. The Bonamanzi monkey orange trees produced an average of 15.2 kg. "This suggests you cannot generalise the water use of one species to another," said Dzikiti.

How productive were the trees as water users? The study recorded average yields in Bonamanzi of 2.0 kg of marulas for every cubic metre of transpiration and 2.5 kg/m^3 for monkey orange. "These water productivity values are quite low compared to those of exotic irrigated commercial deciduous fruit under management," the authors said, citing studies which reported water productivity values of 8 to 18 kg/m^3 in Western Cape apple orchards.

This was consistent with the general correlation between transpiration and yield. "Therefore, it is possible the water productivity of the indigenous fruit tree crops could be improved with supplemental irrigation, for high value species like, for example, marula."

They suggested monkey orange, with its greater resilience to drought, might be a productive option for agroforestry where soils are poor or rainfall low. Dzikiti said it was clear that water use varied with conditions and "no one-size fits-all" recommendations could be made.

Further research was needed, "targeting specific species for further development of species into crops". This would include studying how water use efficiency might be improved through tree management. And work would be needed to shorten the time taken to get from a tree's planting to it bearing fruit. Information was lacking on diseases, pollinators and the adaptability of indigenous species to different climates, soils and water availability.

"There are also questions that should be answered on the post-harvest side of things, for instance, the optimal handling techniques of the fruit. How do you store it?" And new indigenous fruit products were needed to add value. "From where we are, we are still a long way to commercialising," said Dzikiti, but he was encouraged by a recent call for tenders from the Industrial Development Corporation for a study to assist in the development of marula orchards and products such as refined marula oil.

To download the report, ***Water use and yield of selected indigenous fruit tree species in South Africa*** (**WRC Report No. 2720/1/22**), Visit: https://bit.ly/3TgscOu

Photo supplied

Researchers study data from a monkey orange tree in Bonamanzi during the 2018/19 growing season.

ON-SITE SANITATION

More than a decade of sludge management research behind new guide

A new report and guideline published by the Water Research Commission (WRC) on deep row entrenchment of sludge is the culmination of more than a decade of research on the topic. Article by Sue Matthews.

All images supplied

In 2008, a research team from Partners in Development and the University of KwaZulu-Natal embarked on a WRC-funded study on deep row entrenchment (DRE) of pit latrine and wastewater sludges. The technique, pioneered in the United States in the 1970s, entails disposing of sludge by burying it in a trench under at least 300 mm of soil, which prevents odours and reduces attraction of disease vectors such as rats, flies and mosquitoes. Forestry or fruit trees, or even other crops like sugarcane and maize, can be planted on or between the trenches to take advantage of the sludge's high nutrient levels.

This initial project, published as **WRC Report No. 1829/1/12** in 2012, included trials at a number of different study sites, one of which was a two-hectare area of gently sloping ground in a Sappi timber plantation near Howick. In November 2009 the site was pegged out into 30 blocks measuring 20 m x 20 m and separated by a 10 m buffer zone. In all but six of these blocks, which served as controls, six trenches of 20 m length, 0.6 m width and 1.5 m depth were dug 3 m apart. Four different treatments were applied to the blocks with trenches, amounting to some 360 m^3 of waste activated sludge from the Howick Wastewater Treatment Works (WWTW) being entrenched in total. Eucalyptus trees were then planted across the entire site and their growth monitored over 52 months to May 2014, a follow-up project (published as **WRC Report No. 2097/1/14**) having allowed the research to continue. During that period,

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the plots with sludge showed a 50% increase in timber volume compared to those without.

Growth measurements were taken once again in September 2018, and the trees were harvested at the end of that year. In early 2019, new trees were planted on the site, although no additional sludge was entrenched. Monitoring then resumed twice a year between March 2020 and February 2022 as part of a WRC-funded Partners in Development project that not only researched the long-term impacts of sludge entrenchment (published as **WRC Report No. 2899/1/22**), but also resulted in the compilation of ***Guidelines for deep row entrenchment of faecal sludge and secondary wastewater sludge*** (**WRC Report no. TT 880/22**).

The results of this research proved that the trees were still benefiting from the sludge over a decade after its entrenchment. When the first crop was harvested in 2018, the volume of trees planted in blocks with sludge was 15 – 30% higher than those without. In the first two years after planting, the effect had been even more apparent, with as much as 77% higher tree volume. The project team suggest two possible reasons for the reduced impact over time – the roots probably grew beyond the shallow sludge layer after two years, but nutrients in the sludge could also just be more important early in the growth cycle.

With the second crop planted in 2019, blocks with the most sludge had 29% higher tree volume after 2.5 years than those with no sludge. The project team predict that the overall increase in timber volume will be approximately 10% by the time the crop is harvested, should the growth boost follow a similar trajectory to that of the first crop.

Of course, the monitoring wasn't limited to tree growth, because there are naturally concerns that sludge entrenchment could pollute the environment. In the initial project, groundwater monitoring was conducted with a variety of instruments, but the most useful measurements were from piezometers installed on drainage lines below the site, as well as two boreholes drilled further downslope. The samples were only analysed for the nutrients nitrate and phosphorus, and although there seemed to be a slight increase in nitrate concentration during the 18 months after entrenchment, this difference was no longer evident by the 2013/14 rain season.

Soil samples taken at the site in February 2013 were analysed for 10 different properties, and this revealed that the sludge itself still had elevated phosphorus, zinc, calcium, magnesium – and to a lesser extent potassium – levels. However, levels in the surrounding soil in and alongside the trenches were not significantly different from background levels just beyond the study site. And the fact that there was no significant difference in nitrogen content between the sludge, surrounding soil and background soil suggests that any nitrogen not taken up by the trees had been returned to the atmosphere through the process of denitrification.

For the recently completed project, a more comprehensive set of soil samples was collected and analysed for 24 different properties. The same two boreholes were used to collect groundwater samples for nitrate and orthophosphate analyses, and in May 2020 river-health specialists from GroundTruth carried out a survey on the stream flowing past the downslope end of the study site. Water samples were taken for nitrogen (nitrate, nitrite and ammonia) and phosphorus (orthophosphate and total phosphate) analyses, benthic diatoms were collected, and ***in situ*** water quality measurements were made with a multiparameter water meter.

The results revealed that the entrenched sludge has had a positive effect on soil health in the long term. The carbon in the sludge stimulated microbial activity and raised the soil's organic content, which can in turn improve structural aspects such as water-holding capacity. As anticipated from the previous project's findings, there was no evidence of nutrient contamination of groundwater or the stream after all these years.

Faecal pollution, which is typically assessed in freshwater systems through ***E. coli*** counts, was not investigated in this project. However, the previous projects had evaluated the health risk associated with pathogens in the sludge by analysing soil samples for helminth ova – the eggs of parasitic worms. While bacteria and viruses from human guts die off quite quickly once outside the body, the ova of the common round worm, ***Ascaris lumbricoides***, are particularly hardy, and are therefore used as an indicator of sludge safety. Samples analysed from both the plantation study site and another of the project sites where pit latrine sludge had been buried showed that most ova die off within two to three years, and survival beyond four years has not been observed. What's more, the ova are much larger than soil particles and will remain where they are buried if the ground is not subsequently dug up.

In producing the DRE Guidelines, the project team drew not

Google Earth

The sludge treatment blocks, clearly visible in satellite imagery from 2010, supported a mature crop of trees by 2018.

The layout of the 30 treatment blocks at the study site. Six trenches oriented downslope were dug in each of the 20 m x 20 m blocks.

The buried sludge can still be differentiated from the surrounding soil after more than a decade, and has a clustering of roots that can be attributed to elevated nutrient levels.

only upon their own research and experience on the topic, but also on findings from the early trials in the United States and more recent studies internationally. The recommendations are also in line with South Africa's national ***Guidelines for the utilisation and disposal of wastewater sludge***, published by the WRC for government in 2006–2009. Those guidelines introduced a sludge classification system based on three parameters – microbiological quality (faecal coliforms and helminth ova), stability (relating to the degradable organic matter content) and pollutant content (metals and elements).

The DRE Guidelines focus on entrenchment of sludge from both WWTW and pit latrines, and detail the various aspects to consider for commercial, decentralised and household entrenchment. Commercial entrenchment would typically involve a partnership between a municipal WWTW and a forestry or sugarcane company, and both an environmental impact assessment and a water use licence application process would need to be followed. Decentralised entrenchment refers to small tracts of land, particularly in rural areas, where sludge could be used to grow trees or other non-edible crops, rather than transporting it long distances for beneficial use or disposal. As its name implies, household entrenchment is the on-site burial of sludge from pit latrines.

The final chapter provides an introductory overview to the DRE Guideline Toolbox, an MS Excel workbook developed within the project to help users decide whether deep row entrenchment is a suitable option for dealing with the sludge under consideration.

"Sludge disposal by burial will not be appropriate everywhere," note the project team in the research report. "The relevance of sludge disposal as well as the nature of sludge disposal will rely on a variety of factors, such as available land, potential for reuse, soil and geology type, volume of sludge requiring disposal, etc."

They point out that even in the forestry industry, there may not be many opportunities for sludge entrenchment. Private timber companies have stringent safety and environmental policies, and the survival of helminth ova for the first two years implies that workers would need to wear appropriate personal protective equipment, such as masks and gloves, while weeding the young crop. And nowadays the harvested timber is not only used for poles, paper and board.

"The private forestry industry is moving further in the direction of high-value uses such as clothing and pharmaceuticals. These companies are therefore extremely reluctant to risk possible contamination of their timber, whether the risk is real or only perceived," note the project team.

They add that the findings from the forestry plantation site, where soils have a relatively high clay content, are not necessarily applicable to other areas with different soils or crops. This presents opportunities for further small-scale studies, and some other aspects should ideally be investigated too, such as the fate of carbon in the soil and the potential of using sludge to rehabilitate surface mines. They also suggest that a model be developed to allow a detailed cost-benefit analysis of options for disposing of WWTW sludge, incorporating the main approaches currently used by municipalities.

Indeed, municipalities around the country are exploring ways of reducing the enormous costs associated with sludge disposal. An industry brief produced by GreenCape in 2021 reports that the City of Cape Town (CCT) spends some R60 million per year to dispose of the dewatered primary and waste activated sludge its various WWTW generate at a daily rate of about 200 dry tonnes. This expense and some regulatory changes restricting liquid and organic waste disposal at landfills has put the CCT on a path towards anaerobically digesting its WWTW sludges in two biosolids beneficiation facilities (BBFs) that will be established over the next 15 years. The BBFs will produce digestate cake that is nutrient rich, odour free and so low in contaminants that it will be safe for unrestricted use.

Currently, the CCT's WWTW sludge production makes up 74% of the total for the Western Cape, according to the Sewage Sludge Status Quo Report 2020/21, published by the provincial government's waste directorate. Analysis of feedback from 107 WWTW, following an 80% response rate to a questionnaire sent to all municipalities within the province, indicated that most WWTW dispose of their sewage sludge by land farming (22%) or to general (20%) or hazardous landfills (10%), while 22% stockpile sludge and 11% make it available for composting, agricultural or irrigation use.

Similar trends can be expected in other provinces, but a year ago the City of Tshwane won the inaugural Green Economy

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Change Champions Competition for its beneficiation of sewage sludge. The competition, organised by GreenCape in partnership with the Friedrich Naumann Foundation, aimed to highlight municipalities applying innovative and sustainable green technologies in contributing to improved service delivery. In 2010, the City of Tshwane awarded a tender to Agriman for a 15-year period to convert sludge to useful fertilizers. The process starts with mechanical dewatering, followed by solar drying, composting and stabilisation. The product is then granulated and disinfected, and subjected to more drying, screening and coating before being blended and bagged in a range of fertilizers and other prescription blends for agricultural use.

The WRC has been promoting the concept of a circular economy for municipal WWTW sludge and faecal sludge from pit latrines for some time. In a recent working paper on the WRC's new Sanitation Transformation Initiative (SaNiTi) research strategy, Sudhir Pillay and Jay Bhagwan note that the WRC began funding innovation development within the faecal sludge management supply chain as far back as the early 2000s. Later, it commissioned a study to optimise the Latrine Dehydration Pasteurisation (LaDePa) technology, which processes faecal sludge into pellets that can be used as a soil conditioner, fertiliser or fuel. It has also funded projects on using faecal sludge to make biochar briquettes and to raise black soldier fly larvae that can be harvested as a protein-rich poultry or fish feed. Research has been initiated on market demand for these and other products that can be derived from sanitation waste.

Furthermore, in light of South Africa's electricity supply challenges, the WRC has funded a review of technologies for energy recovery from wastewater sludge (**WRC Report No. TT 752/18**) and more recently a case study on the role of such technologies in transitioning to a circular economy (**WRC Report No. TT 883/22**).

Clearly, DRE is just one possible method for the productive disposal of sludge. This highlights the need for a detailed cost-benefit analysis of sludge disposal options. Given the expense of transporting sludge, there needs to be a method of determining the distance at which entrenchment becomes less financially feasible than alternatives.

"The economic case for DRE is most compelling where there is enough space to dispose of the sludge on the same site that it is originally produced, such as a site with a VIP toilet. Simply dig a trench, transfer the pit sludge to the trench, cover it up and then plant some trees along the trench to benefit from the nutrients and carbon-enriched soil," says David Still, director of Partners in Development. "There is a widespread belief that this practice will 'contaminate the groundwater', but there is no evidence to support that belief, which is based on a misunderstanding of the way buried sludge and soil interact, and also a misunderstanding of the characteristics of faecal sludge."

To download, *Guidelines for deep row entrenchment of faecal sludge and secondary wastewater sludge* (**WRC Report No. TT 880/22**), visit: https://bit.ly/3EQafSI

To download, *Long-term impacts of entrenchment of pit latrine and wastewater sludge* (**WRC Report no. 2899/1/22**), visit: https://bit.ly/3Tt8ChD

Lani van Vuuren

One of the greatest challenges of VIP latrine management is how to safely dispose of the sludge when pits are full. Deep row entrenchment could be a viable management option.

INTEGRATED WATER RESOURCE MANAGEMENT

Cooperative governance in water resource management – Drawing lessons from the Breede River catchment

Globally, there is recognition of increasing complexity in the governance and management of water resources. The complexity is attributed to various factors, including climate change, pollution, institutional fragmentation, and urbanisation. Communities of water practitioners and scientists point to cooperative governance as key to tackling existing and anticipated complexities in the sector. So writes Margo Paterson, Jessica Wilson and Amanda Gcanga.

This consensus is reflected in leading international water governance thinking, such as Integrated Water Resources Management (IWRM). South Africa's National Water Act (NWA) of 1998 is based on IWRM, which recognises the need for integrated management of all aspects of water resources and it provides the foundations upon which participatory water management institutions are established. The NWA provides a legal framework for sustainable water resource management and places a great emphasis on the need for water actors to work cooperatively and enable stakeholder participation.

But what is cooperative governance? It is described as a process where actors from different parts of civil society and government work together in a coordinated manner to respond to a mutual issue. Cooperative water governance is made up of two principles: collaboration and adaptive management. These principles are essential to embrace because current and future water challenges cannot be solved by a single actor. Reported benefits of a collaborative culture in the water sector include improved environmental decision-making, enhanced trust between water stakeholders, sharing of information, pooling of resources, and effective conflict management. Adaptive management, on the other hand, enables a feedback cycle of learning by doing. This is particularly important when tension arises among stakeholders dealing with uncharted water challenges. Ultimately, the feedback cycle of learning-by-doing has proven to enhance joint gains while limiting transition costs.

In South Africa, decentralisation of water management to lower levels, such as catchment management agencies (CMAs), is

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acknowledged among the water community of practitioners and scientists as a good step towards enabling water stakeholders to participate and collaborate more effectively in water resources management. It fosters greater inclusion of local water actors, improves stakeholder relationships, enhances coordination, enables local learning platforms for stakeholder engagement, and improves decision-making on water resources management.

By including stakeholders in decision-making, the coordination of resource management can be improved. The need for cooperative governance at catchment scale is increasingly important due to uncertainty in megatrends, such as climate change and urbanisation, that have major impacts on water sources. There is currently a lack of guidance on how to practically enable cooperative governance that allows existing and future CMAs to work closely with key water actors.

The Breede Partnering Solution (BPS) is a partnership between the Breede-Gouritz Catchment Management Agency (BGCMA) and the Western Cape Government, as represented by the Department of Environmental Affairs and Development Planning (DEA&DP) (see more about the BPS: https://arcg.is/5umvb). The BPS was used to test adaptive and collaborative water management practices in order to develop a framework that can support cooperative governance between CMAs and Provincial governments.

The BPS was established in July 2017, with the recognition that an integrated water resource management approach on the Breede River would deliver greater impact than the two institutions working alone. The purpose of the partnership is to improve planning and implementation of water resources management in the Breede River Catchment. The two institutions identified nine areas of mutual interest and prioritised three areas in which they agreed to explore working together. The three areas being water quality monitoring, natural asset management around the removal of alien species and rehabilitation of nature, and communications.

The Western Cape Economic Development Partnership (EDP) acted as the facilitating intermediary partner. To formalise this relationship, the BGCMA and DEA&DP agreed on a Memorandum of Understanding (MoU) which was finalised in August 2017. The MoU was first put into action in October 2017 when the EDP facilitated a Partnering Design Engagement with the strategic leadership of DEA&DP and the BGCMA.

Joint development of a common partnering agenda between the BGCMA and DEA&DP.

Since the formalisation of the partnership, the two institutions have progressed toward joint annual planning and reporting for water quality monitoring. There is also sharing of monitoring data and increased capacity. Overall, this level of collaboration has minimised duplication of efforts, improved management of water quality monitoring and improved relationships between the two institutions. Similar strides have been achieved in natural asset management.

Drawing from the case study, the Water Research Commission (WRC) and the EDP, in collaboration with Stellenbosch University's Centre for Sustainable Transitions conducted a study titled ***Practical approaches for enabling collaborative and adaptive water management for catchment management agencies*** (**WRC project no. C2020/2021-00276**). The main aim was to distil and develop a guiding framework for collaborative and adaptive management that enables key water institutions, such as CMAs, to improve water governance.

The BPS provided an opportunity to learn and fill in some of the gaps in how CMAs can embrace collaborative and adaptive management practices to improve water resources management. This is becoming more pertinent in the context of the increasing complexity in managing water resources. By learning from the BPS, this study delivered the following outcomes:

- Collaborative practices required to build a partnership between a CMA and a provincial government.
- Adaptive practices required by a CMA and a provincial government to maintain collaboration and improve water resources management.
- A partnering framework for a CMA and provincial government which is supported by collaborative and adaptive practices.

The framework is an adapted version of EDP's partnering framework. It rests on six partnering stages which were identified and confirmed through the research, and which are shown in Figure 1. It draws on the BPS experiences and provides insights into how a relationship between a CMA and provincial government could be established and maintained. These stages are supported by specific adaptive and collaborative practices, which provide practical guidance for CMAs and their partners to strengthen cooperative governance and implement IWRM. The first five stages – build the foundations, analyse the system, sustainability of the partnership, design and planning, enabling implementation – are generally sequential in time with overlaps and iterations between them. The sixth stage – reflecting, learning and adapting – cuts across, and is relevant to all the other stages.

Before embarking on an analysis of the system, potential partners should take time to agree on the need and objectives for collaboration and ensure that all the stakeholders see the value of collaboration and their involvement. The 'Build the Foundations' stage requires building relationships based on a deep understanding. It is critical to not only have an idea of what people want and need but to understanding historical contexts of people and their connection to a landscape. If the foundations are not built in the beginning, trust building will be tricky further along the partnership.

The importance of clarifying the context in which the work is

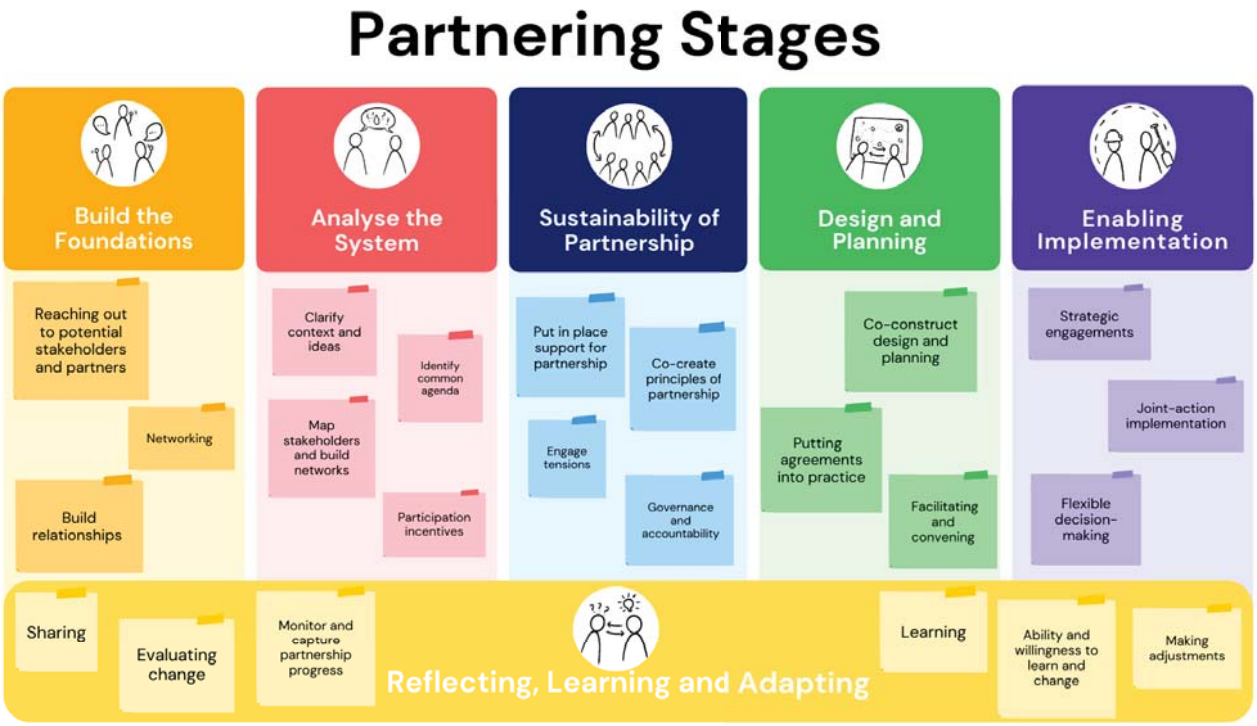

Figure 1. The partnering stages.

being done is highlighted in the 'Analyse the System' stage. This is important to identify the underlying problem, what the conditions are that are creating the problem, and whether working together cooperatively will address the problem.

During this stage of the BPS, the BGCMA, the DEA&DP and the EDP engaged in a conversation to discuss the benefits of a partnering approach to integrated water resource management in the Breede Catchment area. The BGCMA, DEA&DP and the EDP aimed to gauge a better understanding of the system (i.e., the Breede Catchment area) and explored the potential for the BGCMA and the DEA&DP to collaborate on mutual areas of interest, even though both the BGCMA and the DEA&DP have separate mandates. It was discussed that these joint-action planning sessions would be carried out through a series of engagements facilitated by the EDP.

The third stage 'Sustainability of the Partnership' focuses on what the underlying conditions are that will support the longevity of the relationship. It's about co-creating the principles for working together and putting in place governance and accountability structures. It is important to identify the roles and responsibilities of the different actors, and then recognise the different skills of the different parties and delegate roles accordingly. Additionally, the co-creation of principles for working together is critical.

Throughout this stage, trust building takes place. The BPS signed a Memorandum of Understanding (MoU) to build an institutional partnering solution, based on the understanding that an integrated environmental and water resource management approach in the Breede River catchment would deliver greater impact than the two institutions working alone. Additionally, the BPS cocreated principles for working together.

The results indicate that the fourth stage 'Design and Planning' focuses on a collaborative development of a set of solutions to be implemented by an incremental, problem-driven, and iterative approach that promotes experimentation, innovation and learning. Impact-oriented work is prioritised during this stage and focus areas are identified. Designing and planning entails putting in place short-to-medium-term plans and keeping the plan simple and straightforward. During this stage, the BPS created a common agenda, which helped them hone in on their mutual interests and how to work together to achieve it. The common agenda outlined key aspects of the partnering process that were agreed upon.

The 'Enabling Implementation' stage entails the practical delivery of the work outlined by the common agenda. It is about joint-action delivery. The study found that enabling implementation requires engagements to take place. This stage involves managing ongoing engagements for strategic planning around joint actions, execution of actions, as well as reviewing previously identified, and next, joint actions. It's about coordinating and convening strategic engagements, joint-action implementation and tension management.

During this stage, the BPS held a Partnering Design Engagement with the strategic leadership of DEA&DP and the BGCMA to begin putting the signed MoU into action. This engagement focused on prioritising the previously identified areas of mutual interest to allow for agreed joint actions over the next three to six months. The BPS set up quarterly engagements facilitated by the EDP to enable implementation, with the specific goal of strengthening collaboration.

The final stage 'Reflection, Learning and Adaptation' is considered the most important stage in the partnership.

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Reflection, learning and adaptation creates well-functioning partnerships, without which they won't achieve their goals. For sustainable and resilient water management, it is critical to reflect on what has been undertaken, new understandings of the water system, adjustments made, challenges, outcomes, and lessons learnt. This process creates opportunities for partners to adjust as necessary and builds adaptive capacity. Reflection and learning are on-going processes conducted as agreed by actors. After each engagement, the BPS reflected on what they had undertaken the previous quarter, ascertained the outcomes thus far, and subsequently adapted and changed the process where necessary. Additionally, the BGCMA and DEA&DP reflected and shared with each other what is working and what is not working in their respective workplaces. This helped to build a better understanding of how these institutions work, how better to strengthen the collaboration, and adapt partnering targets in order to make necessary adjustments.

These findings, drawn from a critical examination of the BPS, contribute to the emerging discussion on water governance in South Africa and how cooperative governance approaches operationalized through a partnering framework can overcome challenges induced by fragmented water actors and megatrend influences. The findings highlight the importance of CMAs working closely with other actors in a Water Management Area (WMA) to enable cooperative governance, namely through collaborative and adaptive management practices.

The research confirmed the critical need for cooperative governance to support IWRM and found that partnership is one of the ways to operationalise cooperative governance. By actively working together, water institutions are better equipped to navigate complex systems and societal issues. Understanding the different partnering stages helps to strategically guide the use of collaborative and adaptive management practices that are required for effective cooperative governance at catchment level.

Key advantages of partnering include processes and structures that promote trust, data sharing, alignment of purpose, clarification of overlapping mandates, joint actions, monitoring, evaluation, and learning. Partnering requires attention to both structural and practice systems or approaches. It is both about strengthening a culture of willingness and cooperation, and about putting in place necessary structures. There are many benefits to partnering at catchment level, including, but not limited to, resource efficiency, better and/ or shared use of shrinking budgets which favour collaboration, reducing political risk, and supporting each other across institutions.

The catalytic and holding role of an independent intermediary in facilitating a partnership towards cooperative governance has been highlighted through this research. This role facilitates trust building, reflection, and integrating learning, amongst other things.

Water is essential to all life on earth and in a drought-prone country, such as South Africa, we have to make use of the structures we have and optimise them. International and local water policy highlight the importance for cooperative governance between CMAs and other water institutions. Now, more than ever, water security is becoming a global challenge. Managing a complex resource such as water is challenging, yet it poses many inspiring, intriguing and ambitious avenues for research. Addressing the rising complexity and unprecedented challenges facing the water sector requires the commitment of everyone. By actively working together, water institutions are better equipped to navigate complex systems and societal issues. Cooperating enables sustained impact by building trust in the system.

Jason Mingo

The Breede River.

WEF NEXUS

Second winter school on water-energy-nexus successfully concluded

Professionals and emerging scientists in the agriculture, energy and water sectors representing SADC, the US, Italy and the Netherlands gathered at the University of Pretoria for the second water-energy-food (WEF) nexus winter school, held from 8 – 12 August. Mpho Kapari, Luxon Nhamo, and Samkelisiwe Nhlophe-Ginindza reports.

The idea for a WEF nexus winter school first arose in 2020, but plans were scuppered by Covid-19 and the resultant lockdown restrictions. Attended by more than 80 participants, the first winter school was held virtually in 2021. The subsequent relaxation of Covid-19 restrictions allowed the water utilisation in agriculture business unit from the Water Research Commission (WRC) to host the second winter school physically, in collaboration with its strategic partners, the Centre for Transformative Agriculture and Food Systems (CTAFS) of the University of KwaZulu-Natal (UKZN), IHE Delft Institute for Water Education, WaterNet and Global Water Partnership Southern Africa (GWPSA). Other partners include the One CGIAR Nexus Gains Initiative, Jones and Wagener Engineering Associates and the WEF Nexus in Africa Initiative.

Several presenters, mentors, participants (students and working professionals), and assistants attended the winter school. The school offered delegates the opportunity of mentorship, engagement and sharing knowledge on the WEF nexus. The WEF nexus refers to the inter-linkages between water security, energy security and food security and how the actions in any one particular area can have effects in one or both of the other areas. The goal is to drive the holistic comprehension and recognition of this interconnection in order to create and maintain the balance between the three.

As such, the WEF nexus winter school has now formed an integral part of the WEF-Nexus capacity-building development programme. The school is seen as an introductory and foundational course for the comprehension of WEF-nexus concepts and tools. Its objective is to showcase tools for the assessment of trade-offs and synergies in the water, energy, and food sectors. This was introduced on the first day of school where the significance of the nexus was emphasised while referring to the ***Limits to Growth*** warning regarding the fact that the earth's carrying capacity will eventually be exceeded. It was a hands-on experience for all the participants, focusing on indicators and applications in real-world contexts and countries.

All the participants were divided into five groups, and each was given a country to focus on and to later provide feedback to the rest of the class. This sparked great engagement in the room, the conversation was mainly focused on the reasons why various countries' WEF-Nexus was weaker than others.

The second day was spent with participants tasked to develop a conceptual map based on the case study of their choice. In this case, each participant was expected to relate the WEF-nexus and United Nations Sustainable Development Goals (SDGs) with case studies. The third day was spent on field visits to WRC-funded projects by the Agricultural Research Council (ARC) in Roodeplaat and Silverton. Among others, principal researcher, Dr Nadia Araya, provided a demonstration and presentation of hydroponics to the attendees. The delegates were also treated to a demonstration of the production of biogas as a source of energy.

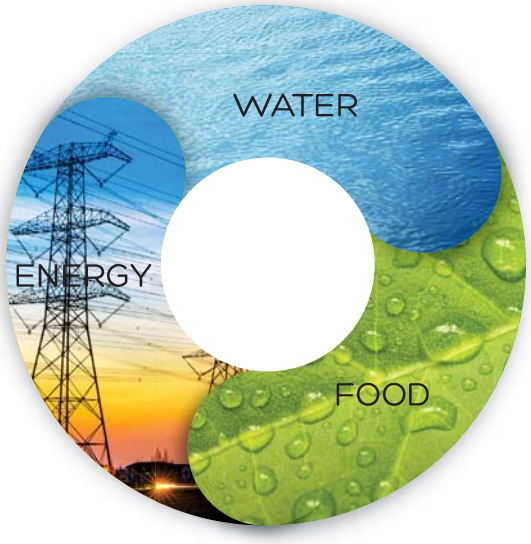

Figure 1: A schematic representation of the Water-Enegry-Food nexus.

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Sifiso Mazibuko.

From left: Dr Luxon Nhamo (WRC), Prof Stanley Liphadzi (WRC), Prof Tafadzwanashe Mabhaudhi (UKZN), Dr Jennifer Molwantwa (WRC), and Prof Sylvester Mpandeli (WRC) at the launch of the book, Water Energy Food Nexus Narratives and Resource Securities. A Global South Perspective.

The week also included the launch of the book, ***Water Energy Food Nexus Narratives and Resource Securities. A Global South Perspective***. The book, available from Elsevier (https://doi.org/10.1016/C2020-0-03951-4) provides a synthesis on the WEF-nexus, focusing primarily on the global south. By presenting concepts, analytical tools, and case studies, the book serves as a practical resource for researchers, policymakers, and practitioners in sustainability and functional roles across all three sectors The WRC takes pride in spearheading WEF-nexus research, having support research in this realm since 2012. Since then, the focal point has been to integrate SDGs, human and livelihood impacts, and WEF-nexus drivers with the concept itself. As such, during the exercises in the masterclass, each participant was advised to include these in their conceptual models. Also, research findings have guided policy and decision-making to develop coherent strategies needed for transformative resource management and development. This culminated in a mini-summit on the final day, moderated by GWP-SA, where participants presented their country's case studies and policy recommendations. This closes the learning circle of WEF-Nexus concepts, tools, discourse, and their applications to inform policy and investment plans. As it stands, WRC mandate is beginning to move from theory to practice and it seems the winter school is just the beginning.

What is the water-energy-food nexus?

The water-energy-food (WEF) nexus is part of a movement towards more integrative thinking around water resource management. In essence it 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. Nexus thinking is based on a systems approach and often uses the socio-ecological system as a primary point of reference. The WEF nexus is argued to be valuable for understanding complex systems, and for decision-making to achieve macro-scale sustainable development. However, the ultimate measure of success for achieving sustainable development is measured at a different scale, namely, the improved livelihoods and wellbeing of individuals and households.

Source. www.acdi.uct.ac.za

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CLIMATE CHANGE

Comprehensive climate resilience programme takes off in Limpopo

South Africa is extremely vulnerable to the impacts of climate change, and the country's already scarce water resources are expected to be particularly affected. A new programme being implemented in the Giyani Municipal Area, in Limpopo, is demonstrating climate adaptive responses and solutions with communities in the area in support of a water secure future.

All images supplied

The Giyani Local Scale Climate Resilience Programme is funded by the Government of Flanders and the Water Research Commission (WRC), with partners Tsogang Water and Sanitation, the Association for Water and Rural Development (AWARD), and the University of the Western Cape (UWC). The programme aims to, among others, create an enabling environment whereby local authorities, institutions, communities, tribal authorities and market players are mobilised to improve climate resilience and water utilisation.

The project team is working with local authorities and communities to test new methods and innovations to supplement water supply, enhance food security and ultimately, improve livelihoods. "Our ultimate objective is to ensure sustainable and secure water resources so as to improve the livelihoods of the communities living in the rural area while creating opportunities for job creation and emerging farmers," reports WRC Programme Manager, Virginia Molose. The ambition is to positively impact the lives and socio-economic opportunities of an estimated 5 000 beneficiaries from 2022 until 2025.

Molose explains that an earlier study, undertaken by the UWC, revealed the area's particular vulnerability to the impacts of climate change. Dwindling water supplies and present challenges to electricity-dependent water-supply systems amid loadshedding also threaten Giyani's water security. This motivated the launch of the programme in Giyani.

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Sustainable water supply is a considerable challenge in the Giyani district.

The project team is engaging the local municipality, Greater Giyani, on local economic development initiatives while the Mopani District Municipality, which is the water services authority, is being engaged on the water services component of the programme. "The need for water is extremely apparent in Giyani. Both municipalities have been receptive to the programme and see the value in the proof of concept of alternative water supply and energy models to improve water security in the area for both domestic and productive purposes," notes Molose.

Particular objectives of the Giyani programme

The project has set a number of key objectives, as described below.

Objective 1: To strengthen the enabling environment in key communities in Giyani and to improve water utilisation for environmental, social and economic activities

The programme is working towards effecting change in the way water resources are leveraged towards social, environmental and economic objectives. This requires capacitated and engaged stakeholders and effective monitoring, coordination and oversight of all the moving parts. The enabling environment envisaged for the programme aims to:

- establish and improve the rights and capabilities of all key beneficiaries and stakeholders
- ensure that a sustainable balance is achieved between the social, economic and environmental needs for water to act as an enabler

Among others, design and rollout of learning events and establishment of local and national learning networks will be key to sustaining the outcomes of this objectives. Prioritised capacity build and knowledge transfer will include:

- An in-house Local Authority component established with the local and district authority to focus on alternative water solutions and the process, regulatory and maintenance implications of these alternative operating models whereby communities are empowered to manage water infrastructure and utilisation
- Knowledge transfer workshops to assist various beneficiaries and stakeholders to engage, collaborate and share lessons learnt. It is envisaged that the workshops will culminate in learning documents and will recommend and guide implementation, policy, social, policy and regulatory activities.

A water sample being taken from the area of Nhlambeto where the community is abstracting water from the sand river.

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Agriculture is the main economic activity in the Giyani area.

Objective 2: Implementation and scale-up of multiple use water systems, services and alternative energy options

Multiple use water scheme (MUS) are low-cost, equitable water-supply systems that are expected to diversify the water mix for communities in Giyani for both livelihood needs and high-value agricultural production. This will benefit households, subsistence farmers and smallholder farmers. Having piloted the MUS model in other parts of Limpopo province, whereby the participatory model was developed and tested, this scale-up demonstration will bring in solar energy options for the treatment and pumping of water, diversifying water resources (through, for example, groundwater and sand banks) and move the implementation into a space whereby key outcomes linked to environmental protection, livelihoods and economic activity can be achieved.

The programme has already revealed some interesting insights, such as the indigenous practices being applied by local communities. This includes rotation ploughing methods, and the planting of drought resistant crops as well as the abstraction of water sand rivers. These local initiatives might be replicable elsewhere.

Objective 3: Support to local economic development priorities and alignment with the development of a post-project sustainable strategy

This programme aims to achieve socio-economic and growth-linked benefits to Giyani beneficiaries ensuring that the resilience demonstrated is extended beyond the programme's life. One way in which the project team aims to achieve this is through social franchising. This will involve the training and developing of a number of local businesses and franchisees to support implementation of, for example, MUS solutions in the Giyani area.

The programme has not been without difficulties. Molose reports that institutional hindrances and models of service delivery in rural areas remain a challenge, with authorities expressing some reluctance to institutionalise alternative water supply options. This while communities' patience and trust in municipalities is at an all-time low. It is hoped that through the participation of municipalities and communities in the programme this situation might be improved. Particularly the municipalities' willingness to commit to a process of co-learning is to be commended.

"The WRC cannot tire in its quest to offer innovative solutions and alternatives as part of government's goal of providing sustainable services to all communities in South Africa," notes Molose. It is hoped that programmes such as these can go a long way in reigniting the potential of rural communities such as those located in Giyani.

Co-learning and knowledge sharing is a central part of the programme.

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DEEPLY ROOTED IN SOUTH AFRICA WATER SOCIETY

www.wrc.org.za

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

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

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

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THE POWER OF KNOWLEDGE TO THE PEOPLE