THE WATER WHEEL

MARCH/APRIL 2024 Volume 23 No 2

WATER QUALITY

New research takes a step towards real-time testing for chemicals of concern

UNDERUTILISED CROPS

Diversifying the agrifood system by mainstreaming underutilised crops

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WATER RESEARCH COMMISSION

THE WATER RESEARCH COMMISSION (WRC) AND PARTNERS

ARE CONVENING A REGIONAL SUMMIT ON ACCELERATING PROGRESS TOWARDS ACHIEVING THE SDGS THROUGH BROADENING THE WATER-ENERGY-FOOD (WEF+) NEXUS

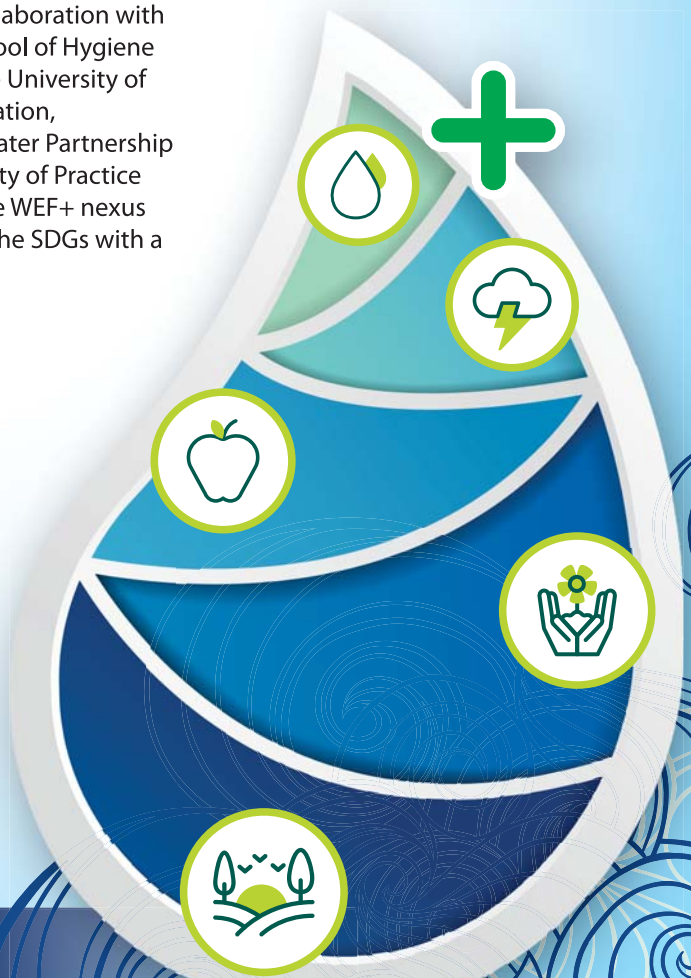
Theme: Accelerating progress towards sustainability through the WEF Nexus

Date: 19-20 August 2024 | Venue: CSIR, Pretoria

Global challenges such as advancing climate change, rapid population growth, overexploitation of natural resources, and rapid urbanisation exert additional pressure on the rising demand for freshwater, energy, and food, with severe implications for people and the planet. Understanding trade-offs and synergies across water, energy, food, environment, and health is important for sustainable and equitable development under climate change.

The water-energy-food (WEF) nexus approach aims to unite different interests in resource use, manage conflicts, and simultaneously respect the planet's ecological carrying capacity limits. In the broadened context, the WEF+ nexus acknowledges that water, energy, and food security are inextricably linked with each other and environmental and human health/wellbeing. Adopting a WEF Nexus approach is a fundamental shift from pure sectoral approaches to solutions that embrace a cross-sectoral, coherent, and integrated perspective. It challenges existing global, regional, and national structures, policies, and procedures.

Against this background, the Water Research Commission (WRC), in collaboration with the Centre on Climate Change and Planetary Health of the London School of Hygiene and Tropical Medicine, IHE-Delft, the Institute for Natural Resources, the University of KwaZulu-Natal, Nexus Gains, WaterNet, Department of Water and Sanitation, Department of Agriculture, Land Reform and Agriculture and Global Water Partnership Southern Africa, under the auspices of the Global WEF Nexus Community of Practice (CoP), is convening a WEF+ Nexus Regional Summit to deliberate on the WEF+ nexus and its operationalisation for accelerating progress towards achieving the SDGs with a focus on southern Africa.



The summit will address the following questions:

- What challenges and opportunities are related to achieving the SDGs?
- How can operationalising the WEF Nexus assist with accelerating SDGs' implementation?
- What capacity is needed to enhance the operationalisation of the WEF nexus?
- What collaboration, coordination, and partnerships are needed to strengthen the science-policy-practice interface?
- How to share knowledge and best practices on integrated and transformative approaches for accelerating progress towards achieving SDGs?

Regional policymakers, sector experts, researchers/academia (including postgraduates and early career researchers), and civil society actors are invited to attend.

For more information, contact Prof Sylvester Mpandeli, email: sylvesterm@wrc.org.za or click here

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Contents

Researchers are coming up with new ways to monitor the presence of emerging contaminants in our drinking water. Read the article on page 12.

NEWS

Partnership to review water and sanitation service delivery

A nationally coordinated task team comprising the departments of water and sanitation (DWS) and cooperative governance and traditional affairs (COGTA), as well as the South African Local Government Association (SALGA) is being set up to review service delivery mechanisms for water and sanitation services.

The aim of the task team, announced at the water service authority (WSA) summit hosted by DWS earlier this year, is to address the decline of water and sanitation services as outlined in the latest Blue Drop, Green Drop and No Drop reports published last year. The task team will focus on the 105 municipalities that are in the critical and poor performing categories in terms of the Blue and Green Drop reports.

The Drop reports indicated a general decline in performance of municipalities. The Blue Drop report found that the percentage of water-supply systems with poor or bad microbiological water quality compliance increased from 5% in 2014 to 46% in 2023. In turn, the Green Drop report found that the percentage of municipal wastewater systems in a critical state increased from 30% in 2013 to 39% in 2022.

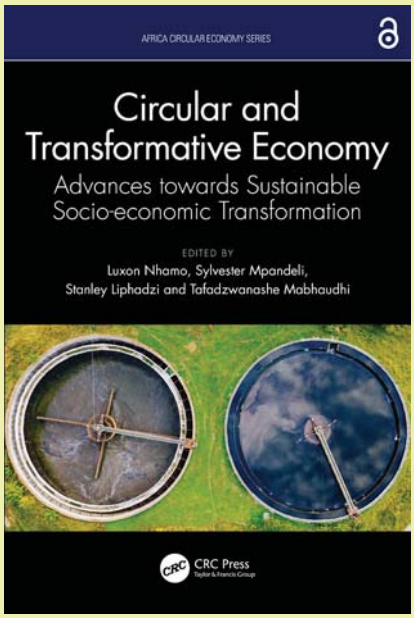
This indicates that there are limitations on the extent to which problems can be solved through support from the national government – which includes R20-billion a year in water and sanitation infrastructure grants; technical and engineering support and assistance; capacity building and training; and financial management advice and support – and that more fundamental reforms are required.

For example, routine maintenance and operations must be funded by revenue from the sale of water by municipalities to customers, and municipal councils must take the required decisions to prioritise budgets for this.

Other key decisions taken at the summit include that all WSAs were to develop action plans to address their Drop results and submit to DWS by the end of February; that training institutions should prioritise the training of uncertified process controllers and that all WSAs must issue advisory notices without fail when their drinking water fails to meet microbiological water standards.

Back to Top

New book on circular and transformative economy



A new open access publication, Circular and Transformative Economy – Advances towards Sustainable Socio-economic Transformation, is now available online. The book has been edited by Dr Luxon Nhamo, Prof Sylvester Mpandeli and Prof Stanley Liphadzi of the Water Research Commission along with Prof Tafadzwanashe Mabhaudi of the University of KwaZulu-Natal.

The main aim of the book is to illustrate circular models for sustainable resource management. It highlights the benefits of transformative approaches in integrating, simplifying, and facilitating understanding of complex systems and transforming systems towards greater sustainability while achieving multiple social, economic and environmental outcomes. It provides pathways towards strategic policy decisions on socio-economic transformation supported by case studies.

Among others, the book explores a transitional path to the circular economy, explored from the point of view of waste and technology; explains transformational change towards sustainable socio-ecological interactions; reviews provision of pathways towards sustainability through scenario development; and provides an assessment of progress towards the United Nations Sustainable Development Goals. The book is aimed at researchers and professionals in water and environmental engineering, circular economy, sustainability and environmental studies.

• The book, available from Taylor & Francis, can be downloaded here, https://bit.ly/3VoLfKl

New policy to improve basic services on privately-owned land

The Minister of Water and Sanitation, Senzo Mchunu, has launched a new policy aimed at improving the delivery of water and sanitation services on privately-owned land.

The Water and Sanitation Services on Privately Owned Land Policy was propelled by a court case in 2019, which sought to enforce the provision of basic services to farm dwellers and others who reside on privately-owned land in different parts of the country. The policy, which was subject to a nationwide consultative process, was approved by Cabinet on 29 November.

"The purpose of the policy is to outline government's intentions regarding water and sanitation services provision to residents living on privately-owned land. It establishes a framework for enhancing water and sanitation services provision in such areas, with specific strategies to be developed at provincial district and local municipal level," noted Mchunu.
"We have put measures in place to ensure the effective and successful implementation of this policy, working collaboratively with other sister departments, civil society organisations and all spheres of government."

Research council opens up access to research data

The Human Sciences Research Council (HSRC) has made datasets from its research available for free download.

Every year, HSRC scientists collect large volumes of data, often through in-person or digital surveys, interviews or observation. This data is interpreted to understand various societal issues. After publishing the findings in academic journals, the datasets from this work are curated, stored and shared from the HSRC's Research Data Service.

The qualitative and quantitative datasets are now available for further scientific research and educational purposes, and to build further bodies of knowledge. The datasets emanate from HSRC studies such as the South African Social Attitudes Survey, the National Research and Experimental Development Survey, and others.

According to the HSRC, the data is of good quality, and most datasets are longitudinal and repeated cross-sectional to allow for trend analysis.

The datasets can be accessed here, http://datacuration.hsrc.ac.za

Back to Top

GLOBAL

Researchers warn of increase in water scarcity due to future pollution

A newly published study, led by researchers from Wageningen University & Research and published in ***Nature Communications***, has found three billion people may face water scarcity in 2050 due to pollution.

The researchers conducted a global assessment of future clean-water scarcity for 2050 by adding the water pollution aspect to the classic water quantity-induced scarcity assessments. Water scarcity generally refers to the condition wherein the water availability cannot meet the demand of nature and society. Water availability is affected by factors such as climate change, urbanisation, agricultural activities, increasing water demand and pollution.

The researchers included the impact of nitrogen pollution on traditional water quantity assessments by integrating land-system, hydrological and water quality models to the potential prognosis of over 10 000 river basins around the world. They found that nitrogen pollution impacts water scarcity in 2 000 sub-basins worldwide, with projected scenarios increasing to 3 061 sub-basins by 2050.

The study focused on future water scarcity based on nitrogen pollution in rivers under climate and socio-economic scenarios, including land-use change, irrigation and dam constructions and how these directly affect the hydrological cycle by altering the timing and magnitude of water discharge.

According to the researchers, current and future water scarcity becomes a substantially more severe issue globally when considering the impact of pollution. "The number of sub-basins facing severe scarcity may even triple in 2050 when not only water quantity is considered. Many sub-basins in South China, Central Europe, North America and Africa become water scarcity hotspots. This also implies more than a doubling of the global area and population affected by severe water scarcity, meaning that up to 40 million km^2 of extra global drainage area, including highly biodiverse aquatic ecosystems and an additional 3 billion people are facing water scarcity challenges due to nitrogen pollution.

To access the original article, view https://www.nature.com/articles/s41467-024-44947-3

System could make seawater drinkable

Researchers have achieved a major breakthrough in redox flow desalination, an emerging electrochemical technique that can turn seawater into drinking water and also store affordable renewable energy.

In a paper published in ***Cell Reports Physical Science***, the researchers increased the redox flow desalination (RFD) system's salt removal rate by about 20% while lowering its energy demand by optimising fluid flow rates.

RFD offers multiple benefits. These systems provide a scalable and flexible approach to energy storage, enabling the efficient utilisation of intermittent renewable energy sources such as solar and wind. RFD also promises an entirely new solution to the global water crisis.

"By seamlessly integrating energy storage and desalination, our vision is to create a sustainable and efficiency solution that not only meetings the growing demand for freshwater but also champions environmental conservation and renewable energy integration," noted André Taylor, professor of chemical and biomolecular engineering at New York University Tandon School of Engineering.

RFD can both reduce reliance on conventional power grids and foster the transition toward a carbon-neutral and eco-friendly water desalination process. In addition, the integration of redox flow batteries with desalination technologies enhances system efficiency and reliability. The inherent ability of redox flow batteries to store excess energy during periods of abundance and discharge it during peak demand aligns seamlessly with the fluctuating energy requirements of desalination processes.

To access the original article, view https://www.sciencedirect.com/science/article/pii/S2666386423006069?via%3Dihub

Back to Top

First-ever global estimation of the impact of disasters on agriculture

A new FAO flagship report, ***The impact of disasters on agriculture and food security***, brings the first-ever global estimation of the impact of disasters on agricultural production focused on crops and livestock.

It also notes that the figure may be higher if systematic losses in the fisheries and aquaculture and forestry subsectors were available. The report stresses the need for urgently improving data and information on the impact of disasters on all subsectors of agriculture to create data systems that can serve as the foundation upon which effective action can be built and informed.

"Agriculture is one of the most highly exposed and vulnerable sectors in the context of disaster risk, given its profound dependence on natural resources and climate conditions. Recurrent disasters have the potential to erode gains in food security and undermine the sustainability of agrifood systems," said FAO DG Qu Dongyu in the foreword to the report. "Leveraging FAO's technical expertise, this publication showcases opportunities to proactively address risks in agrifood systems while demonstrating ways to mainstream disaster risk management into agricultural practices and policies."

The report reveals that over the last three decades, disasters inflicted the highest relative losses on lower and lower middle-income countries, up to 15% of their total agricultural GDP. Global losses mask significant variability across regions. Asia experienced by far the largest share of the total economic losses. Africa, Europe and the Americas also displayed a similar order of magnitude. However, losses in Asia only accounted for 4% of the agricultural added value, while in Africa they corresponded to nearly 8%. The variability was even higher across subregions.

To access the report, view https://www.fao.org/documents/card/en/c/cc7900en

International funder sets aside US$900-m for urgent environmental action

The Global Environment Facility's Council has allocated US$916 million for international action on biodiversity, climate change, nature renewal, and pollution control, and advanced five Integrated Programmes designed to tackle complex challenges in their entirety.

The meeting, which took place in February, approved funding for 45 projects and programmes, including four blended finance initiatives involving the private sector. The support will directly help more than 12 million people.

The work programme – the second-largest in the GEF's history – includes US$530 million for integrated programmes for the ocean, food systems, transportation infrastructure, wildlife conservation and critical forest biomes that have been designed to break down silos and advance holistic action across sectors and borders. "To achieve impact that lasts, we need to work in an integrated and inclusive way," noted Carlos Manuel Rodríguez, GEF CEO and Chair. "The GEF is moving quickly and efficiently to target donor contributions to urgent needs. We also recognisee that financing alone cannot reverse environmental degradation for the long term. This work program therefore stands out not only for its size but also for its focus on a whole-of-society approach to phasing out harmful practices."

Back to Top

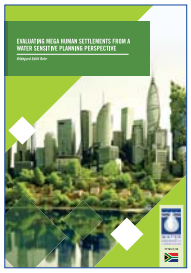
NEW WRC REPORTS

Supporting social learning and knowledge management within the ecological infrastructure for water security project

This project formed part of the greater Ecological Infrastructure for Water Security (EI4WS) project, which is funded by the Global Environment Facility, implemented by the Development Bank of Southern Africa and executed by the South African National Biodiversity Institute, in partnership with the WRC and other implementing partners. The core contribution of the project has been the articulation of a strategy-as-practice for social learning, knowledge management and mediation (SLKMM) to support the work of Component 3 in the EI4WS project. The strategy set out the conceptual framing, strategic interventions and implementation plan to enable robust knowledge management and social learning necessary for the change sought by the wider EI4WS project.

WRC report no. 2988/1/23

Web link: https://bit.ly/4carZq9



Evaluating MEGA human settlements from a water sensitive planning perspective

If not planned properly, MEGA Human Settlements are likely to result in satellite cities relying on costly overstretch infrastructure networks, high levels of unsustainable resource consumption, spatial fragmentation, and dislocation causing increased strain on the surrounding ecological infrastructure. Thus, there is a need to inform and facilitate the Gauteng Department of Human Settlements, private developers and professional practitioners in the planning and development of water sensitive MEGA Human Settlements. This requires a critical evaluation of existing land development and design practice which informs decision-making and guides the project from feasibility to implementation. This study opted to design a comprehensive Self-evaluation Water Sensitive Compliance/Criteria Toolkit which allows decision-makers to score the planning and development processes of MEGA Human Settlements against water sensitive outcomes.

WRC report no. TT 923/1/23 and TT 923/2/23

Web link: https://bit.ly/4cgrNpe (main report) and https://bit.ly/3VjYzzN (guideline and toolkit)

Participatory course to activate ecological infrastructure for water security learning networks

The Ecological Infrastructure for Water Security Project (EI4WS) is funded by the Global Environment Facility (GEF), implemented by the Development Bank of Southern Africa (DBSA), and executed by the South African National Biodiversity Institute (SANBI), in partnership with the Department of Forestry, Fisheries and the Environment (DFFE), Department of Water and Sanitation (DWS), Water Research Commission (WRC), and other implementing partners. This project focuses on improving water security by integrating biodiversity and ecosystem services into planning, finance, and development in the water sector. As part of this project, Prime Africa was contracted to develop a participatory course to activate water pricing learning networks. This training course aims to strengthen learning networks in the water value chain. This is done through a platform that enables decision makers to have robust engagement with stakeholders across the value chain.

WRC report no. 3095/1/23

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

Scoping study towards developing a WEF framework for decentralised sanitation in rural and peri-urban communities in Limpopo

Research and development in the Water-Energy-Food (WEF) nexus touches on numerous interrelated problems that are still experienced in low-income communities in South Africa. Much research has been done on technical solutions for decentralised sanitation, and a variety of technologies are available to manage sanitation on-site and to use the waste productively for food production or energy generation. However, similar to many technology-driven development projects in many parts of the world, user acceptance of decentralised sanitation solutions remains an unsolved problem. At all levels, the problem is a complex combination of socio-cultural and institutional issues and the lack of facilities and inadequate guidelines. Technical concepts imported from one region to another without considering the socio-cultural context have too often caused failure. Education of and demonstrations to ensure the sustainable use of the given technology seldom succeed. A key prerequisite for end-user acceptance in micro-contexts is that the new technology must become part of the daily practices of the end-users. End-users should not only be consulted, but must be enabled to become active co-developers of the solutions. The overarching goal of this study was to conduct a scoping assessment to prepare for a long-term programme with the vision to find or design and upscale a decentralised sanitation practice in a WEF framework (DSP-WEF) that is functionally integrated into the context by participating farmers and experts, and are approved by all stakeholder

WRC report no. 3112/1/23

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

Entrepreneurial development for establishing small farming businesses and employment by youth in rain-fed crop farming

This study examined the challenges and opportunities in pursuing entrepreneurial development pathways in rainfed agriculture, linking youth to profitable food value chains and exploring avenues for establishing small farming businesses. The study further reviewed and evaluated appropriate entrepreneurial development paths for establishing small-scale rain-fed crop farming businesses in the food value chain by the youth for attaining improved rural livelihoods in the selected study areas. It is expected that the outcomes will inform policy on the priority intervention areas in this sector. The study was published as two reports, the first describes research undertaken

Back to Top

in KwaZulu-Natal while the second describes work undertaken in the Free State.

WRC report no 2789/1/23 and WRC 2789/2/23
Web link 1: https://bit.ly/3PorKOq
Web link 2: https://bit.ly/3VkExVY

The establishment of a knowledge hub for contaminants of emerging concern in South African water resources

The present water quality guidelines only cover known contaminants; however, water professionals are already discovering novel pollutants in our water bodies that were previously at levels below detection limits. Categorized as 'emerging' contaminants these substances could have an adverse effect on the environment and human health. Examples include nanomaterials, flame retardants, microplastics, agricultural waste, microbial pollutants, heavy metals, and personal care products. We may significantly improve research efforts by allowing for research collaborations between scientists in the same discipline by collecting research data. This would help uncover knowledge gaps and reduce the likelihood of duplication of research efforts. The creation of an interactive knowledge hub with databases for comprehensive information on growing pollutants of concern in South African surface water sources was the project's primary goal. Additionally, it sought to develop a platform for citizen science that would have fact sheets and brief videos that were supported by scientific evidence. The application developed can be found at https://www.ceckh.agric.za.

WRC report no. 3105/1/23 (Volume 1) and 3105/2/23 (Volume 2)
Web Links: https://bit.ly/49UjD4s (Volume 1) and https://bit.ly/49UCsVb (Volume 2)

Comparative functional metagenome analysis of the Jukskei River system impacted by the urbanisation phenomenon

Urban rivers represent a unique ecosystem in which pollution occurs regularly, leading to significantly altered chemical and biological characteristics of the surface water. However, the impact of urbanisation on the diversity and structure of the river microbial community has not been well documented. The universal problem is the environmental pollution and most important pollutants are the heavy metals in aquatic network because of their toxicity and accumulation. The effects produced by environmental stressors on microbial diversity can be multifaceted, leading to significant changes in community composition and diversity, high spatiotemporal variability, and alteration of community functionality. The aim of this study was to make a comprehensive description of the taxonomic and functional profile of the microbial community, using PICRUSt in the Jukskei River impacted by the urbanisation phenomena with the potential of expressing enzymes that are of industrial relevance.

WRC report no. 3110/1/23
Web Link: https://bit.ly/49VT3Ia

Africa's Living Rivers Programme – Eco-social assessments of aquatic ecosystems

Three decades ago, South Africa began to support an ecosystem approach to water management, long before the term had been coined or the country's law required it. The approach has matured enormously, with several major advances and important consolidation activities funded by the Water Research Commission. Basin-wide modelling of the ecological and social implications of planned water-resource planning and management across Africa and Asia has provided massive, basin-specific DRIFT-Water databases. A much smaller but growing set of data describes the drivers of land-use change and the ecological and social responders (DRIFT-Land). The progress made is mirrored in advances in South Africa's Estuarine Method for calculating Environmental Flows, which has its own array of databases. These databases contain knowledge needed to improve our understating and management of river and estuarine ecosystems. This project was a first step in collating that knowledge into formats that are more readily accessible to managers and decision-makers in the form of generic sets of indicators, response curves and their links driving ecosystem functioning and hence response to human interventions.

WRC report no. TT 934/1/23 (Volume 1) and TT 934/2/23 (Volume 2)
Web Links: https://bit.ly/4cvgDgC (Volume 1) and https://bit.ly/43jnUfh (Volume 2)

Economic management of conjunctive use of irrigation water and root-accessible water tables

In South Africa, irrigated agriculture contributes significantly to the nation's field crop and horticultural production while exerting immense pressure on the country's water resources. Irrigated agriculture consumes approximately 64% of the available surface water in a country where water scarcity is prevalent. Integrated bio-economic models that include enough detail to provide decision support to improve conjunctive use management of surface water and root-accessible water tables do not exist in South Africa, which hampers the conjunctive management of surface water and root-accessible water tables. The project's general objective was to develop and apply a bio-economic model to improve the conjunctive use and management of surface and shallow groundwater economically.

WRC report no. 3118/1/23
Web Link: https://bit.ly/43lAjiB

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

Back to Top

RESEARCH AT A GLANCE

The Water Research Observatory: Unlocking the power of water data

The water-focused cloud platform for data storage, sharing and analytics is gathering steam. And artificial intelligence is showing practical value in helping us predict streamflow when measured data becomes unavailable, pinpoint groundwater depletion using satellites that monitor changes in the earth's gravity, and enable the more precise spatial application of seed and fertiliser in a field based on crop response and yield potential. The Water Research Observatory is open for business, writes Michael van der Laan.

Data is the new oil, they say, and every day new pipelines are being built for data to flow into lakes and buckets that are stored in the cloud. Water quality challenges are soaring in South Africa, signalling a need for technological leaps to address these issues. In 2021, the Water Research Commission(WRC) began funding the development of the Water Research Observatory (WRO), a valuable resource for scientists, engineers, and water enthusiasts alike. It serves as a centralised platform for discovering and sharing water-related data and information, fostering collaboration, and driving innovation in the field.

This centralised and secure platform for water data asset storage, analytics and visualisation is expected to have major benefits for research in the form of increasing research efficiency, while advancing the ability for new projects to build on previous research. Enabling data processing, analytics and modelling in the cloud means that institutions no longer need powerful hardware and expensive software to achieve high-quality research, effectively levelling the playing field between all teaching and research institutions across South Africa.

The flexibility of the Google Cloud Platform and other similar

Back to Top

platforms allows extremely high levels of data acquisition and interoperability. Although beyond the scope of the project, data from citizen science and social media can now be ingested and utilised in ways that promote the equitable and sustainable use of water in South Africa.

The WRO provides a comprehensive and growing collection of water-related data from various sources. By visiting the WRO website (www.waterresearchobservatory.org), users can access a wide range of datasets directly or through links when hosted by others, including hydrological data, water quality information, and more. The user-friendly interface allows for easy navigation and searching, ensuring that you find the data you need quickly and efficiently. To date, the most popular data have been climate datasets as well as pre-formatted South African land cover and soil maps for hydrological modelling. Recently, layers have also been developed for areas where catchments are shared with neighbouring countries.

Are you conducting research or collecting valuable water-related data? The WRO welcomes contributions from researchers, institutions, and individuals passionate about water conservation. By uploading your data to the WRO, you can make a meaningful impact on the scientific community and contribute to our collective knowledge and management of water resources. Metadata, or 'data about the data', are captured according to SANS and ISO standards, and a user manual can assist users to capture this crucial information effortlessly. Uploaded datasets will be given a unique URL, which is more commonly becoming a requirement when publishing research.

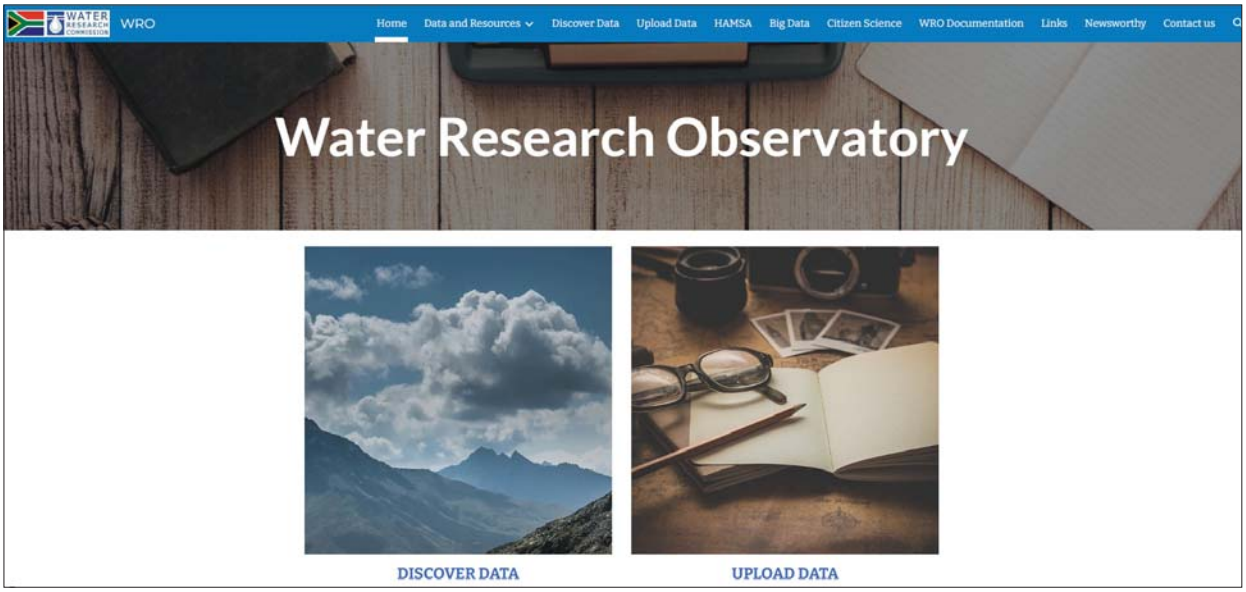
The WRO platform circumvents the issues of hosting and sharing very large files and models. High levels of security and privacy ensure data integrity. The sharing of metadata with similar platforms is also promoted to ensure the data are FAIR – Findable, Accessible, Interoperable, and Reusable. Visit the WRO Upload Data page (https://www.waterresearchobservatory.org/upload-data) to learn more about the process of uploading data.

The WRO is more than just a repository of data; it is a community of researchers and enthusiasts working together to address pressing water-related challenges. As part of the development of the WRO, the ground-breaking potential of artificial intelligence applications, especially machine learning, have been demonstrated. A newly developed WRO model for predicting streamflow with high levels of accuracy can be applied, for example, to patch datasets with missing data due to weir malfunctioning.

Amazing opportunities to pinpoint groundwater depletion from space using satellites that detect changes in the earth's gravitational field, and rainfall and temperature are also being developed and refined for South Africa. And finally, machine learning models that can optimise seed and fertiliser input application even at very high resolutions in the field based on thousands, of measurements in mini experiments from previous seasons is becoming possible. The models from these studies and others can then be modified and used according to other's specific needs and run in the cloud without the need for high end computers. This can all break down collaboration barriers and previous inequities like never before.

The WRO is an invaluable resource for anyone interested in water research, conservation, or management. Whether you are a seasoned researcher or an enthusiastic citizen scientist, the WRO provides a platform for discovery, collaboration, and innovation. And a call to action: If you have valuable data and information that society can benefit from, please upload it to the WRO.

Ongoing work will be to ensure the the platform remains secure as its use and value increases, that a data quality control system is implemented, and that new technology is harnessed in such a way that it remains financially viable over the long term as data volumes and processing and application requirements grow.



Landing page of the WRO website.

Back to Top

WATER QUALITY

New research takes a step towards real-time testing for chemicals of concern

Over 350 000 chemicals and mixtures are registered for commercial use across the globe today. They are used to make a broad range of products that we use in our everyday lives, including pesticides, pharmaceuticals, personal care products, flame retardants, surfactants and various forms of plastic. Traces of these end up in our water, which, as a result, contains a complex cocktail of chemical contaminants and their transformation products. Article by Petro Kotzé.

Though mostly present in low concentrations, the potential negative effects of these potentially hazardous contaminants on both people and the environment are a growing concern. It is now generally accepted that even at low levels, cytotoxic, genotoxic, and carcinogenic substances could damage cells and organisms, with a range of potential impacts including various forms of cancers.

However, micropollutants – generally considered to be chemicals that can pose a risk to lifeforms at microgram per litre or lower concentrations – are not yet commonly monitored in the environment internationally, and existing water quality regulations, including in South Africa, do not currently cover them.

The problem, says Chris Swartz of Chris Swartz Water Utilization Engineers, is that these chemicals mostly occur at very low concentrations, and to test for each of them individually is not only difficult but rarely practically possible. And, he adds, the tests are very expensive. Plus, Swartz points out that by the time you have taken a sample, taken it to the lab for chemical analysis, and received the results, that volume of water already passed through the system, and has done the potential damage.

The challenge is something that South African researchers have been grappling with for some time. And there might be an answer. If we had something that measured the water quality online, in contrast to spot testing and chemical analysis, Swartz says, we could see in real-time on a digital meter what the values

Back to Top

are. The first steps towards this aim are now firmly in place. With funding from the Water Research Commission, a group of researchers from the Stellenbosch University Water Institute (SUWI), under the leadership of Swartz in this research project, have developed a framework for future water quality monitoring that takes the mentioned modern-day challenges in mind.

Over and above using real-time sensors, the monitoring develops towards engineered, effect-based biosensors combined with advanced data analysis. Effect-based methods (EBM), also referred to as bioanalytical tools or bioassays, is a different approach to monitoring compared to targeted chemical analyses. Instead of characterising chemicals by their structures, the process aims to characterise them by their potential adverse effects, or key health risks, on whole organisms.

Once developed, it will be the first of its kind for the country and at the forefront of water quality monitoring globally. And, it will be able to detect the presence of contaminants of emerging concern (CECs) that are potentially harmful to human and environmental health at a fraction of the cost of analytical chemistry methods.

The foundation for the work was laid by an earlier project, also led by Swartz.

What lurks in our water?

Among other outputs, this work (**WRC Project No. K5/2369**) resulted in a list of 20 emerging contaminants of concern in reclaimed potable water in southern Africa. The list, Swartz says, contains the most important chemicals that they think should be addressed locally, as a starting point. This list can, in future, be used by the Department of Water and Sanitation to draw up guidelines for water quality for water reuse systems, something that we do not currently have in South Africa (the country relies on World Health Organization and other international guidelines and norms).

The multi-disciplinary work was conducted by researchers from Chris Swartz Water Utilisation Engineers, the CSIR, the University of the Western Cape, Chalmers University of Technology and private consultancy Innovative Research for Water Solutions (INREWASOL). Fieldwork included testing water samples before and after potable water treatment works in large urban areas, including the City of Cape Town.

The list of chemicals includes pharmaceuticals prescribed in the largest volumes in South Africa, country-specific high-risk priority pesticides, and chemicals common to South Africa (like antiretroviral drugs). It also includes chemicals representing each of the groups of CECs. The chemicals on the list are persistent, not removed by conventional water treatment processes and hold the potential for human exposure. Importantly, Swartz says, those included on the list can all currently be detected in water resources.

He says they realised that it is necessary to be able to test for the cumulative effect of this cocktail of chemicals in the water. Swartz explains: "The ideal is to have something in the line, pipe or tank that indicates the presence of CEC, without necessarily telling you what they are. If you can see that there is a loading of unwanted chemicals coming into your system, you can start a more detailed monitoring program to find out what it is that you're working with. Something like this could act as an early warning system."

The study, completed in 2018, recommended that, instead of the traditional chemical testing, a battery of bioassays must rather be employed in a monitoring programme where the reuse of wastewater takes place either intentionally or by accident.

Effect-based monitoring

The use of effect-based methods (EBMs) for water quality screening or monitoring is not new, says Dr Christoff Truter, a researcher at SUWI. The approach has gained a lot of traction

South Africa's water quality regulations do not currently cover micropollutants.

According to South Africa's most recent Blue Drop Audit Report, the quality of the country's drinkable water is getting worse. Nearly half (46%) of all water supply systems do not comply with microbiological standards. These water supply systems pose acute human health risks because drinking water is contaminated by sewage. The report also found that more than two-thirds (67.6%) of all wastewater treatment works are close to failure.

in recent years thanks to research initiatives such as the EU-funded SOLUTIONS and the efforts of the Global Water Research Coalition, amongst others showing the advantages of EBMs. "It entails using certain key pathways that represent the risks that several chemicals can pose providing an indication of risks, but more importantly presence and therefore compromised water quality."

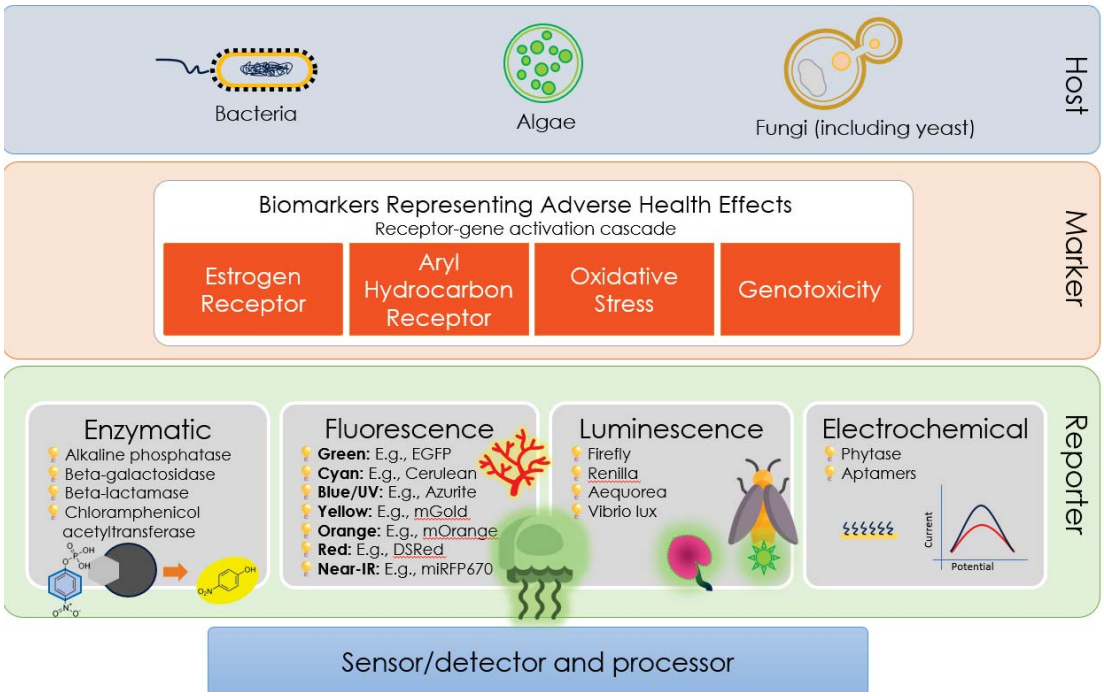
Towards this purpose, researchers are continuously looking for surrogate parameters for the CECs, Swartz explains. The classic example is estrogenicity, says Truter, who did his PhD in zoology and focused on the use of biological assays to screen South African water bodies for the risk of endocrine disruption. There are more than 300 chemicals that are known to be estrogenic based on the US EPA Endocrine Disruptor Screening Program, he says. These chemicals can bind to a human estrogen receptor, or those of other vertebrates including aquatic species, potentially inducing a cascade of effects. One of the best-characterised estrogenic effects is male fish that becomes feminised, he explains. If estrogenicity is picked up in water, it can be interpreted as an indication that some of the estrogenic chemicals are present.

Another good example of an indicator is sucralose, a component found in artificial sweeteners, Swartz says. Since it is man-made, once you pick up sucralose in a river, you know that there has been some human discharge, like sewage or urine into that source. And, it means there are going to be a lot of other potential pharmaceutical products and hormones present too.

This also applies to pathogens (disease-causing microorganisms) with ***E. coli*** being a good example of a widely used indicator. The pathogen is an indicator that there's sewage present in the water, Swartz says. Another is caffeine, which is also included on the list of 20 chemicals identified in the earlier-mentioned project. Caffeine is an indicator of the presence of a certain group of chemicals possibly in the water, Swartz says.

This knowledge of indicator compounds or pathogens can be applied to identify and develop biosensors functioning as EBMs. A yeast cell, for example, can be engineered to sense estrogenicity, and be applied as part of a digital interface to form a biosensor. The yeast cell can be seen to represent human exposure, Truter explains. When such cells are exposed to a water sample potentially containing thousands of chemicals, and it shows a measurable response, it will indicate that there's a risk, he says.

"Engineered microbes can predict whether a particular chemical or mixture of chemicals within a water sample, or other matrix, would actually trigger a biological effect in a human or other vertebrates such as fish or amphibians." In comparison to expensive, individual chemical analysis, Truter says "these effect-based methods are geared to screen samples containing complex mixtures of chemicals." The purpose of EBMs is to show the presence of chemicals, which indicate risk, and more broadly also overall water quality.



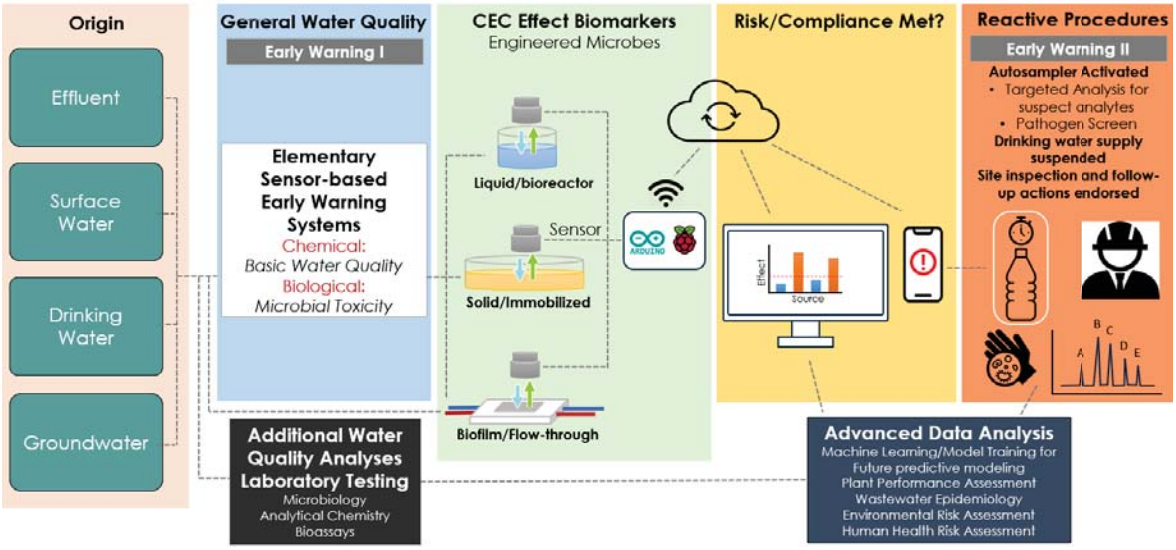
Application of engineered microbes for effect-based monitoring of water quality as part of digital sensor devices. The biomarkers included are based on the testing framework proposed by the Global Water Research Coalition (GWRC) for drinking water and effluents.

Back to Top

The use of engineered microbes representing important biomarkers, was key to the framework for future water quality monitoring suggested by the researchers. The project's final report (**WRC Report No. 3103/1/23**) was just published in November 2023.

A framework for future water quality monitoring

The illustration below suggests a largely automated system for water quality testing.



Framework for future water quality monitoring utilizing real-time sensors, engineered microbe effect-based methods, and IoT devices.

The first step of the system involves the testing of the water source with commercially available sensors that can measure basic water quality parameters like ph, electrical conductivity and total dissolved solids, as well as microbial toxicity. The information is relayed to a software platform that can interpret the data to assess the degree of risk, serving as an early warning step.

The next testing step involves engineered microbes that will act as CEC effect biosensors. This is the tricky one, Truter says, though he adds that synthetic biology is "an exciting space in science" that is evolving fast. "You can, for example, literally put a human gene inside a yeast cell or a bacterial cell with relatively little effort."

In the suggested framework there are three potential ways in which the bioengineered cells can be exposed to the water body. The first one is in a liquid bioreactor format, which is yeast, bacterial or algal cells in a liquid form. The next option is in a solid form, like an agar plate. We have our hopes on the third option, the biofilm format, Truter says. In the illustrated framework, in a very simplified way, this includes a food source (the red line) to feed the biofilm, and the water source being monitored (blue line), running in a continuous flow over the engineered microbes.

The engineered microbes representing key adverse effects (like DNA damage) will be coupled to sensors that detect if something activates the reporters, which can be, for example, in the form of a colour change.

The data from the biosensors and the physical sensors is then interpreted with the help of machine learning to allow risk prediction in real-time. Wastewater treatment works operators or catchment management agencies can then simply receive an interpreted message that flags a problem as it occurs, with an indication of the necessary action to take.

The future of water quality testing

The project's final report points out that although real-time effect-based biosensors are not currently available, such technology may likely be the future of water quality monitoring. They state that increased investment and research efforts are still needed for the development of effect-based biosensor devices representing key health risks. These technologies will enable remote deployment and routine testing at a fraction of the cost of analytical chemistry methods. The research team recommends that future research efforts should include the development of digital devices harnessing the advantages of engineered microbes for effect-based monitoring. Such devices can form part of chemical pollution surveillance programmes to monitor surface water, groundwater, effluents, recycled water and drinking water.

The biosensor development research is exciting because it's still an open canvas, Truter says, in reference particularly to the fields of synthetic biology integrated with data science.

The work will continue in the currently EU-funded MAR2PROTECT project (https://mar2protect.eu/).

However, Swartz adds that there should also be a start towards regulation of these chemicals and their compounds or, making sure that they don't land in the water in the first place.

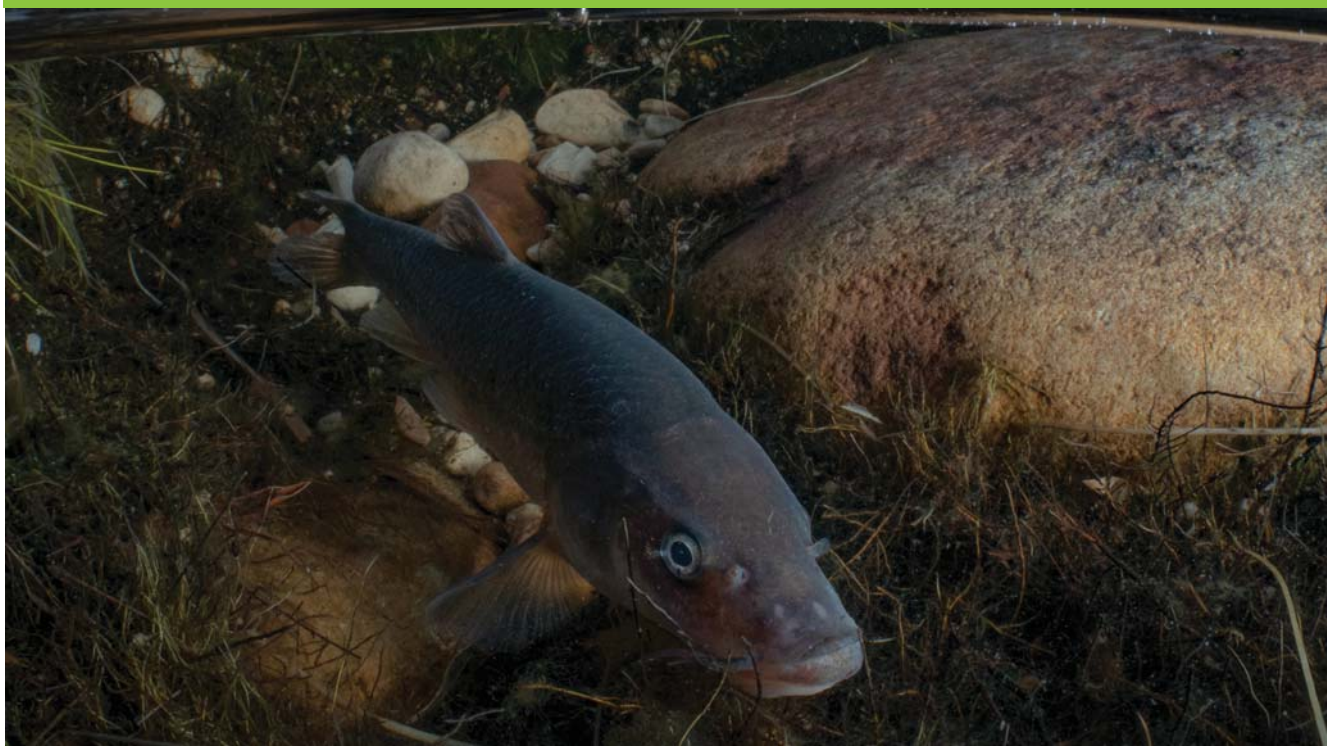
To download the report, ***Real-time sensing as alert system for substances of concern*** (**WRC report no. 3103/1/23**), visit: https://bit.ly/3TBbfkm

Back to Top

FRESHWATER FISH

FBIS – helping to collate quality data for the preservation of SA's freshwater biodiversity

The Freshwater Biodiversity Information System (FBIS) is proving its worth in supporting data-driven decision-making for managing rivers, wetlands and protected areas. Article by Sue Matthews.



Jeremy Shelton

When the recipients of the annual 'Science Oscars' were announced in July last year, it probably came as no surprise to anyone in the freshwater research and management field that the Cape Town-based Freshwater Research Centre (FRC), together with technical partner Kartoza, won the Data for Research Award for their groundbreaking Freshwater Biodiversity Information System, better known as FBIS. This open-access, online platform for hosting, visualising and sharing freshwater biodiversity data was developed in consultation with a wide range of end users, who have seen how FBIS facilitates their own work.

Executive Director of the FRC, Dr Helen Dallas, already had a good idea of what was required at the project's inception in mid-2016 because of her experience in developing the BioBase during the 1990s and the Rivers Database in the 2000s. These databases were primarily focused on invertebrates, the latter having been the repository for SASS data from the national River Health Programme – since replaced by the River Eco-status Monitoring Programme (REMP) – but they had not been maintained and were no longer readily accessible. With fish specialist Dr Jeremy Shelton on the FRC staff, the intention was always to include fish too, but the project nevertheless began with a needs analysis and then a stakeholder workshop involving representatives from academia, key parastatal organisations and environmental consultancies.

"It was very much designing backwards, finding out what the

Back to Top

end users wanted and then designing a system that's visual, appealing and easy to use," says Dallas. "And, of course, it was teaming up with Kartoza that made our vision a reality."

Collating data to populate FBIS was a mammoth task. Dallas, Shelton and other senior FRC staff drew upon their personal contacts to solicit contributions, while a team of postgrads, interns and junior staff trawled though scientific papers, reports and theses, finding data that could then be checked and verified by specialists. The BioBase and Rivers Database were pulled in, as was any relevant data in GBIF – the Global Biodiversity Information Facility – where organisations such as the South African Institute of Aquatic Biodiversity (SAIAB) and the Albany Museum make data available once it has been used in publications.

By July 2020 – the end of the first project phase supported by a grant from JRS Biodiversity Foundation – data for freshwater invertebrates, fish and algae were accessible on FBIS through user-friendly maps and dashboards. But another JRS grant for a second phase, which ends in April 2024, allowed FBIS to be expanded to include anurans (frogs and toads), wetland plants, algae and invertebrates, as well as water temperature and other physico-chemical data. Today there are some 734 000 occurrence records of approximately 10 000 taxa, and data continues to trickle in as users upload their data.

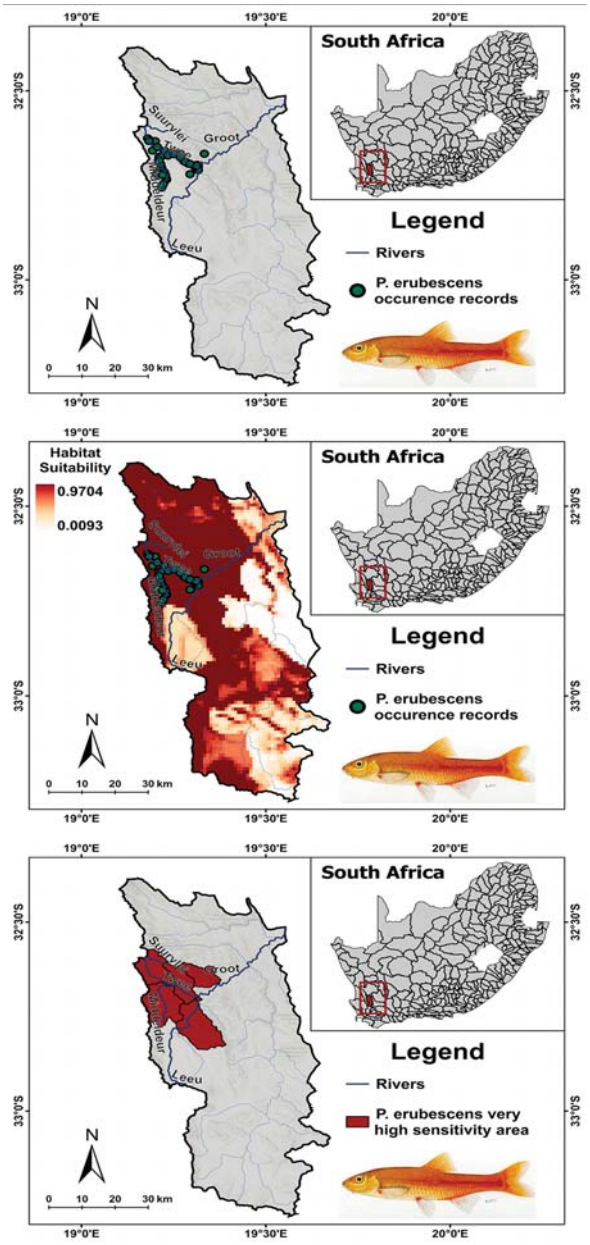
"We also bring in available citizen science data by pulling down any research-grade i-Naturalist data that's been published to GBIF," says Dallas. "Observations submitted to i-Naturalist are classed as research-grade data once identifications have been confirmed by three subject specialists. Likewise, citizen science data in the Virtual Museum's FrogMAP and OdonataMAP are verified before being pulled into FBIS. With the lack of resources for doing monitoring in this country, it's fantastic that citizen scientists can bolster data collection!"

The Virtual Museum, originally developed by the Animal Demography Unit at the University of Cape Town (UCT), is now hosted by UCT's FitzPatrick Institute of African Ornithology. Dallas points out that it's largely thanks to citizen scientists photographing dragonflies with their cellphones that FBIS currently has almost 100 000 adult odonate records of 191 taxa at more than 12 000 sites countrywide.

"During the second phase, apart from developing the new modules and a mobile app for use in the field, we set out to embed FBIS in key decision workflows," says Dallas. "So FBIS is now becoming the accepted freshwater resource for data that will feed into the National Biodiversity Assessment, the IUCN red listings, the REMP and so on. It has already been really valuable in developing freshwater fish sensitivity layers for the EIA screening tool."

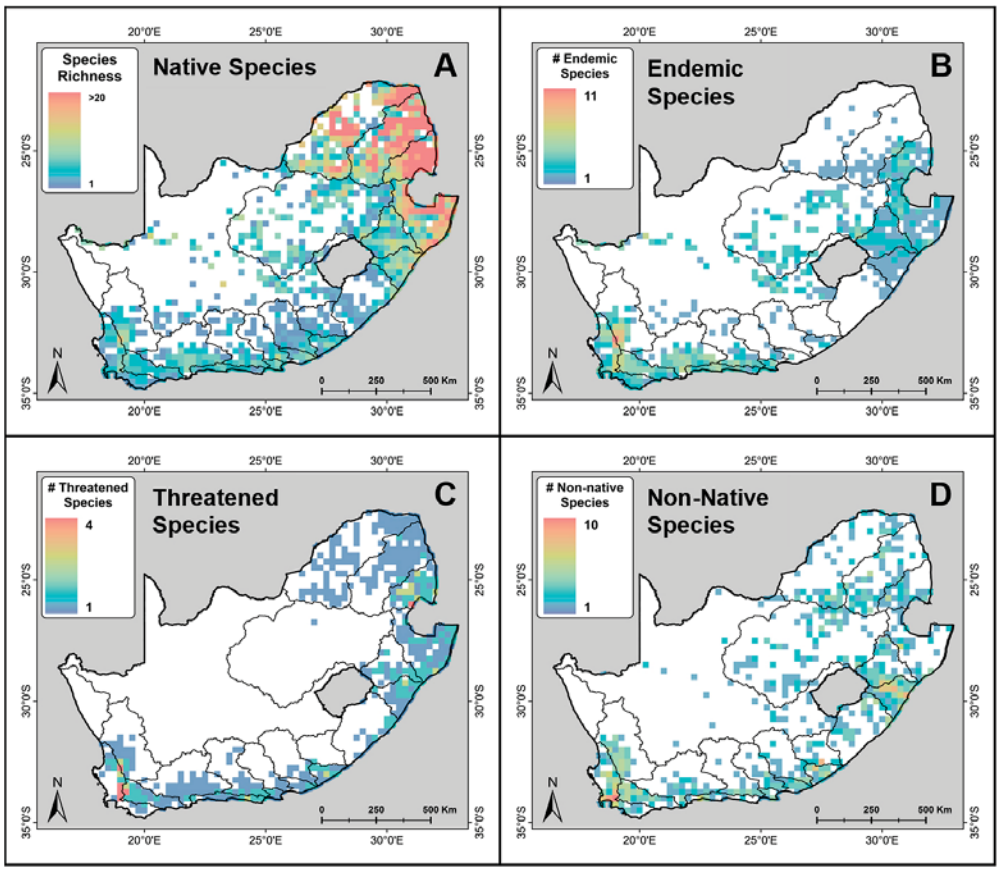
She explains that environmental impact assessments typically identify areas of concern using model outputs or expert knowledge, but the fish sensitivity layers in the Department of Forestry, Fisheries and the Environment's national web-based environmental screening tool rely on hard data that has been verified by experts. The tool allows landowners, developers and their environmental consultants to screen sites for any environmental sensitivity before applying for environmental authorisation in terms of the EIA regulations.

A PhD student co-supervised by Dallas and Shelton, Mohammed Kajee, did a lot of the grunt work behind the development of the fish sensitivity layers and is the lead author of an open-access paper describing the process in the journal ***Frontiers in Environmental Science***, but it was very much a collaborative effort involving several stakeholder organisations. Essentially, occurrence records in FBIS were extracted for 34 threatened



The output from the DFFE screening tool for the critically endangered Twee River redfin, Pseudobarbus erubescens, showing occurrence records (top), the species distribution model (middle) and the very high sensitivity area located in tertiary catchment E21 (bottom).

Kajee et al. 2023, 8, 571.



Species richness per QS grid cell for all native, regionally endemic, threatened and non-native species within South Africa's primary catchment areas.

freshwater fishes, representing 27 formally described species that have been classified as vulnerable, endangered or critically endangered according to the IUCN Red List, plus seven genetically distinct lineages that had as yet not been formally described and had only been assessed nationally for SANBI's Red List of South African species.

Taxon specialists around the country then verified these records, with erroneous ones removed and missing data sets added. The final 'cleaned' data set of 6 660 records was used to generate updated distribution maps that were checked again before the sensitivity layers were developed. The very high sensitivity layer applies to the six critically endangered fish taxa, reflecting all pre-2002 and post-2002 occurrence records, while the high sensitivity layer represents post-2002 occurrence records of taxa assessed as vulnerable or endangered. For both layers, the occurrences were intersected with the sub-quaternary catchment layer from the National Freshwater Ecosystem Priority Areas (NFEPA) project to create polygons indicating the presence of a threatened fish in that catchment.

The medium sensitivity layer also represents vulnerable and endangered taxa, but in this case the records were combined with a suite of environmental and hydrological variables to develop species distribution models used to predict geographic ranges. This layer covers a total catchment area of 251 264 km^2 and spans almost 50 000 km of river – vastly more than the 5 992 km^2 area and 1 024 km river span of the very high sensitivity layer.

The authors note that the screening tool should help prevent further destruction of critical freshwater habitats, which would support the conservation of threatened freshwater fishes, particularly where they occur outside formal protected areas.

In a subsequent paper published in the MDPI journal ***Fishes*** in November 2023, Kajee and co-authors investigated the extent to which threatened freshwater fishes fall outside such formal protected areas. After downloading 57 485 records for freshwater fishes from FBIS and undertaking a data-cleaning exercise, they were left with a final data set made up of 50 927 records for native fishes and 4 288 records for non-native fish, covering the 184-year period from 1839 to 2023. The 129 species represented in the data set comprised 105 (81%) native and 24 (19%) non-native species. Species richness maps were then produced at a quarter-degree square (QDS) spatial scale for all native, non-native and threatened species.

"Areas of relatively high density of occurrences (>100 records per QDS grid cell) were in the northeast (Limpopo, Olifants, Komati, Mfolozi, Tugela and Mkomazi Primary Catchments) and southwest (Olifants/Doring, Berg, Breede and Gourits Primary Catchments) of South Africa," report the authors. "Conversely, large areas with no records were observed within the central (Orange and Vaal Primary Catchments) and western (Buffels Primary Catchment) parts of the country. On a finer scale, there were noticeable gaps in data in the northern part of the Olifants Doring, Gourits, Mzimvubu and Limpopo Primary Catchments, respectively."

Back to Top

Native species richness followed a similar pattern, while endemic species richness was highest in the Western Cape (Olifants/Doring, Berg and Bree Primary Catchments) and along the south coast of the Eastern Cape (Swartkops, Kromme and Gamtoos Primary Catchments). Worryingly, the same Western Cape catchments contained the highest concentration of both threatened species and non-native species.

What's more, of the 5 740 records of threatened species countrywide, only 1 060 were from a formally protected area, although a further 2 216 fell within a conservation area such as a biosphere reserve, conservancy or botanical garden. More than a third of the records for non-native species were located within these protected and conservation areas.

The authors point out some limitations of the methodology and important caveats, but note that the patterns of species richness, endemism and threatened species broadly agree with previously published descriptions of South Africa's freshwater fish diversity.

"It is thus recommended that all QDS grid cells identified as having high levels of species richness, endemism and threatened species be prioritised for resampling and monitoring, to better inform the conservation interventions required in these catchments. Focusing effort and resources in this targeted manner could provide the most efficient use of the limited national, provincial and scientific resources available in the country."

They add that their findings lend further evidence to the growing body of research that considers South Africa's protected area network to provide inadequate protection for sensitive freshwater species. Fortunately, the Fish Sanctuaries, Fish Support Areas and Upstream Management Areas identified in the NFEPA layers, as well as the freshwater sensitivity layers in the DFFE screening tool, may provide some additional protection.

Clearly, FBIS is very useful in such studies, and there has been considerable interest in the system from beyond South Africa's borders, with instances of FBIS already set up in Rwanda and Botswana, and work under way on a more advanced version to replace Europe's Freshwater Information Platform (FIP) data portal. A system is also being developed for SANParks to include freshwater, marine and terrestrial biodiversity within its national parks and marine protected areas, and the FRC is seeking funds in partnership with NGOs such as WWF, African Parks, Wild Bird Trust and The Nature Conservancy to develop an Africa-wide freshwater biodiversity platform.

The FRC and Kartoza team have therefore implemented a multi-tenant model to ensure the longevity of FBIS and other information systems beyond the JRS-funded project. By sharing costs, the resilience of all platforms will be increased.

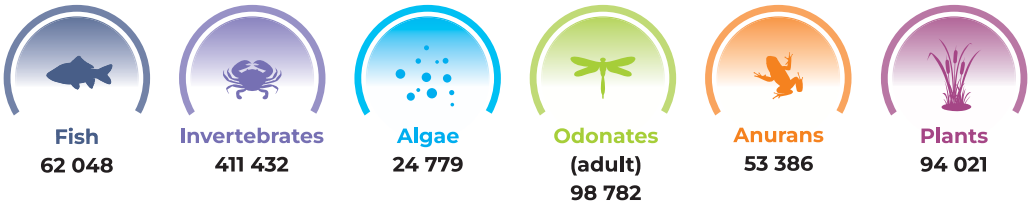
"In the multi-tenant model, there'd be one cloud host with one database, but every tenant would have their own entry point," explains Dallas. "The South African FBIS would look much the same, but any improvement made in one instance would get rolled out to all of them. Each tenant would contribute to hosting and support, but if any instance has a gap in funding, it will be able to piggyback off the projects that do have funds and will just keep ticking over."

"So by spreading the funding requirements across countries and organisations in and out South Africa, we're hoping that it will be a sustainable solution, allowing the FRC and Kartoza to continue providing technical support," she says. "Truth be told, we've become very attached to FBIS and we're super proud of it. From inception six years ago to where it is now, it's been really exciting stuff!"

The Freshwater Biodiversity Information System (FBIS) can be accessed at https://freshwaterbiodiversity.org/

A short video, The Life of a Data Point, produced to raise awareness about the importance of sharing data and to encourage researchers and postgraduate students to upload their data to FBIS, can be viewed on the Freshwater Research Centre's YouTube channel.

The number of records on the FBIS system



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Back to Top

WATER QUALITY AND ECOSYSTEMS

New water quality guidelines published for aquatic ecosystems

After 28 years, South Africa has a new set of water quality guidelines for its aquatic ecosystems, thanks to a project funded by the Water Research Commission. The revised guidelines are software-based and can facilitate rapid decision-making in the management of the country's water resources.

In the 1990s the then Department of Water Affairs and Forestry led a project to develop procedures and to derive a set of water quality criteria for safeguarding freshwater ecosystems in South Africa. The resultant first edition of the Water Quality Guidelines for Aquatic Ecosystems, published in 1996, was part of an ongoing effort to improve the decision support tools required for the management of the country's water resources.

The 1996 water quality guidelines are widely used in South Africa, however, they have been criticised for four fundamental reasons. Firstly, they have been criticised for not being explicitly risk-based and not taking an explicit risk approach in their development and implementation. An important implementation outcome of not being risk-based is what has been referred to as over- or under-protection. In this regard, the current guidelines are being used as trigger value, above which an action, usually a corrective one, needs to be taken, and below which all is assumed to be fine.

Back to Top

Secondly, the 1996 guidelines were developed prior to the promulgation of the National Water Act in 1998. This means that they are not aligned to important strategies, initiatives and approaches for balancing the protection and use of South Africa's water resources as envisaged in the act and in the national water resource strategies. Critical among these are the classification system, the ecological Reserve, the resource quality objectives (RQOs) as well as source directed control measures such as licensing and the waste discharge charge system.

The 1996 guidelines, for example, have a single target generic water quality value, which is not helpful given that the current approach accords water resources different levels of protection, e.g. Class I, II, III and ecological categories A to D, with descriptive and quantitative RQOs. From a spatial perspective, such a single target value is also not helpful because it does not take into account spatial variability within the country. In addition, the old guidelines do not reflect existing water quality monitoring networks that support water resource management decision-making.

Since the 1996 guidelines were published, much research has been undertaken locally and internationally in the field of water quality, with new and emerging pollutants of concern being identified. Thus, the need was identified to update the guidelines to reflect the latest scientific developments and knowledge in the field. The 1996 guidelines finally been criticised for not supporting rapid decision-making processes and not being easily updatable.

How the revised guidelines addressed these limitations

The revised guidelines follow a multi-tier approach. Tier 1 refers to generic guidelines similar to the 1996 guidelines, but with reference to the ecological categories A to F. This implies that guideline values are developed for each ecological category. Tier 1 guidelines are developed for 23 inorganic salts, 42 organic compounds and 26 pharmaceuticals.

Tier 2 guidelines are derived at ecoregion level II to account for spatial variability and factors such as climate, physiography, geology and soils as well as altitude. In addition, the guidelines at Tier 2 are developed for both physico-chemistry and biological response, thus accounting for the community-based effect of the ecosystem on water quality change. The physical-chemical variables were mainly driven by available data within the current Department of Water and Sanitation water quality monitoring networks. As such, some ecoregion level II were data-rich, while others were data-poor This highlights the urgent need to invest in water quality data collection and monitoring.

Tier 3 assessment is triggered when risk is suspected based on the results of Tier 1 and 2. Tier 3 provides a means for a site-specific water quality risk assessment by collecting detailed site-specific information. A key feature of Tier 3 assessments is that they are event or scenario based. The reasoning this approach is that improving water quality implies a focus on the event or scenario driving water quality change rather than on the symptoms. For Tier 3 assessment, risk is conceptualised as a measure of the likelihood (probability) of an event / scenario / issue occurring and its adverse effects or consequences as well as the associated uncertainty.

The guidelines are implemented within a software-based decision support system (DSS) flexible enough to allow for rapid decision-making regarding the risk posed by pollutants of concern. The DSS interface allows for easy navigation and takes DWS capacity and capability into account. As the guidelines are software-based, they are easily updatable, and support educational and research purposes.

The 2024 guidelines have been aligned with the current approach to water resource management in many ways. First, the need for different protection levels, aligned to ecological categories, is recognised and implemented. Second, the guidelines recognise the importance of spatial variability and site-specificity in water quality decision-making. Third, risk associated with events, scenarios or other risk-triggering activities such as development projects can be assessed using the DSS. The DSS can also support decision-making in different contexts, e.g. water quality licensing, impact assessment, monitoring progress towards the resource quality objectives, etc.

Recommendations for policy and implementation

The project made the following recommendations for policy and implementation of the guidelines:

Capacity building – As the revised guidelines have been developed using a different approach and within a new DSS, there is a need for capacity building across various sectors of society. Such capacity building would facilitate the use of the guidelines in different contexts and by different sector stakeholders.

Invest in water quality monitoring and data – While much effort has gone into water quality monitoring in the country, the study suggests that additional investment is needed in water quality data collection, including establishing additional monitoring networks and building capacity within DWS, its agencies as well as other institutions responsible for data collection at catchment scale.

Risk-based decision-making – Risk is an important element in water resource decision-making. With the developed DSS, water resource managers and practitioners can assess acceptable levels of risk given protection level and other resources. It is thus important that policies within the sector should place a premium on risk-informed decision-making in ways that ensure balanced use and protection of water resources, and capacity should be strengthened in this regard.

The DSS can be downloaded here, https://bit.ly/4afBvq0

Back to Top

UNDERUTILISED CROPS

Diversifying the agrifood system by mainstreaming underutilised crops

The increasing demand for food, including inequities in household food and nutrition security, is exerting pressure on the agrifood system, which is already threatened by climate change, environmental degradation and declining agrobiodiversity. Mainstreaming neglected and underutilised crop species could help communities overcome these challenges. So writes Tafadzwanashe Mabhaudhi, Sithabile Hlahla, Moloko Mojapelo, Cliff Dlamini, Baitsi Podisi, Luxon Nhamo, Sylvester Mpandeli, Tshilidzi Madzivhandila and Rob Slotow.

Diversifying the agrifood system and supply chains with neglected and underutilised crop species can increase agricultural income, promote agrobiodiversity, and supply diverse and nutritious food to tackle malnutrition, hidden hunger and food insecurity under climate change. Mainstreaming these crops will promote food and livelihood security and empower vulnerable communities, economically and sustainably, making the agrifood system more inclusive and socially just.

In South Africa, food production is dominated by monocrop agricultural systems which lack agrobiodiversity. The monocrop system is centred around a few major cash crops, such as maize, wheat, sugarcane, potatoes, apples and onions, while excluding neglected crops such as sorghum, taro, sweet potato, amaranth and Bambara groundnut. While this model of agriculture has been valuable in assuring national food and nutrition security and surplus for export, it has yet to be successful at the household level. There is rising household food and nutrition insecurity and widening insecurities as people cannot afford healthy diets.

Key challenges to the adoption and mainstreaming of neglected and underutilised crops

Neglected and underutilised crops have informal seed systems, also called local, traditional or farmer seed systems, as the farmers access seeds directly from their harvest and disseminate

Back to Top

it through exchange and barter among friends, neighbours, relatives and local markets. The seeds are often of variable quality as they are often landraces and may be heterogeneous (modified through informal breeding and use). In addition, the seed systems of these crops are not regulated by government policies and regulations.

There is a need to recognise and develop a greater understanding of the operation of the informal markets through which neglected and underutilised crops are currently sold and to deploy research for development to scale exemplar crops and support strategies that maximise profitability for farmers selling their produce. Bottlenecks to achieving this are the need to robust and comparable empirical information concerning informal markets and workable models for maximising the value of these crops and scaling them. This, in turn, is a function of an approach to understanding the economy, which regards the informal economy as a deviation from the norm rather than being complementary to formal markets.

There needs to be more policy that recognises the use of neglected and underutilised crops as part of a strategy for sustainable food systems and climate change adaptation, especially in marginalised communities. This acts as a disincentive to developing distribution channels and adopting the post-harvest handling techniques necessary to limit losses and widen the distribution of these crops.

The policies governing the food system reflect a favourable environment for big businesses and have made it conducive for a few players to dominate the food system. Many policymakers favour the commercial agenda because its actors have shown that it is productive, improving national food security, reducing unemployment, and contributing to the national gross domestic product (GDP). However, the profit-environmental harm and inequitable distribution, which results in household food and nutrition insecurity.

The potential of neglected and underutilised crops under climate change

Climate change will affect crop yields and quality, food supply, and ultimately cause an increase in food prices, highlighting the importance of supporting traditional crops and farming systems. A change in the observed climate will affect the growth of crops through multiple mechanisms, including changing phenology, heat stress, water stress, waterlogging, and increases or reductions in pests and diseases.

Several neglected and underutilised crops (e.g. Bambara groundnut, cowpeas, amaranth, millets, and wild mustard) are nutrient dense. Their ability to adapt to harsh conditions suggests that they can be deployed to champion climate change adaptation. This can improve food systems' resilience to climate shocks while transforming healthier, more equitable, and inclusive diets.

Furthermore, there will be environmental co-benefits, as neglected and underutilised crops are typically adapted to marginal environmental: they require less landscape modification, are more tolerant to stresses (e.g. drought, heat, salinity), and need fewer external inputs (e.g. fertiliser, water pesticides). Hence, diversifying the food system by incentivising such crop production and consumption can be pivotal in adequately addressing food insecurity, micronutrient deficiencies, vulnerability to climate change, and environmental degradation.

Benefits of including neglected and underutilised crops in the climate change agenda

Millions of people in the global South rely on neglected and underutilised crops as a primary food source. Research has shown that these crops are highly nutritious, containing several micro- and macro-nutrients that are essential for health, more so than some of common major crops. For example, several traditional cereals, legumes, and vegetable crop species contain high proportions of vitamins, calcium, iron, potassium, magnesium and zinc, and some neglected and underutilised fruits and vegetables contain more vitamin C and pro-vitamin A than major crop species and their staple counterparts such as maize.

Certain neglected and underutilised crops have been reported to have certain health protection and medicinal properties and can have protective effects against major chronic diseases. For example, finger millet has a low glycaemic index (GI) and can be digested slowly, making it popular among diabetic patients.

Neglected and underutilised crops are important for conserving agricultural biodiversity and agroecosystems, critical for the long-term sustainability of food and agricultural production. In addition, adopting these crops could contribute towards reducing greenhouse gas (GHG) emissions. Research shows that worldwide adoption of a more plant-based diet could reduce food-related GHG emissions by up to 70% by 2050.

Crops such as sorghum have been found to be suited for drought and heat-stress-prone areas such as KwaZulu-Natal, Eastern Cape and Limpopo provinces, where most agricultural and rural households reside.

Back to Top

The demand for agriculture that supports a healthier diet, which is less dependent on monocultural systems and external inputs and is better suited to marginal and semi-arid environments, has revived interest in diverse traditional systems.

Neglected and underutilised crops can also reduce the contribution of environmental contaminants by agriculture, which can tolerate pests and diseases, grow in low-quality soils and require lower levels of inputs such as pesticides fertilisers.

Climate-socio-economic co-benefits of neglected and underutilised crops

Neglected and underutilised crops can provide and improve income for people experiencing poverty, especially women and youth, who generate income from agricultural activities, creating job opportunities through agro-processing and value-adding, particularly in rural areas. The crops require low inputs such as pesticides and fertilisers, reducing farmers' inputs costs.

They are also resistant to pests and diseases and tolerant to environmental extremes and less favourable weather conditions, unlike major crops, meaning the farmers' income sources will not be disrupted. Within communities, neglected and underutilised crops can offer cross-cutting solutions to multiple constraints. For instance, sorghum, millet, Bambara groundnut, lentils, and cowpeas are recommended food choices under nutritional and water-limited conditions.

In this regard, they can benefit low-income producers and consumers of food who are limited in their capacity to adapt to increasing climatic risks. Therefore, the promotion and inclusion (i.e. mainstreaming) of these crops could contribute towards addressing Sustainable Development Goals related to social and economic issues.

The suitability of neglected and underutilised crops to harsh environments

Changes in rainfall and temperature due to climate change will affect land suitability. Several neglected and underutilised crops are drought and heat-stress-tolerant, making them ideal for de-risking cropping systems in drought-prone areas. However, owing to their status, current crop suitability maps do not include them as part of the crop choices. Knowing these crops' spatial and temporal suitability is important for fitting them into marginal production areas and cropping systems under climate change.

It has been found that approximately 70% of South Africa's

In South Africa, food production is dominated by monocrop agricultural systems which lack agrobiodiversity.

land is categorised as unsuitable for rain-fed crop production due to poor rainfall distribution and soils with low fertility. Yet, neglected and underutilised crops, such as sorghum, taro, amaranth, and cowpea, are naturally suitable in marginal areas. However, there were variations in the magnitude of suitability for each of the crops investigated. For example, sorghum and cowpea were suited for drought and heat-stress-prone areas such as KwaZulu-Natal, Eastern Cape and Limpopo provinces, where most agricultural and rural households reside.

These crop species are well adapted to high climate risk and can be produced under water-limited and extremely hot (33–38°°C) conditions. Amaranth is highly suitable across most cropping lands in South Africa, and this is because the crop has a short growing period and low water requirement. The suitability of taro in KwaZulu-Natal and Mpumalanga provinces is consistent with the observed length of the growing period. Specifically, taro takes up to 300 days to mature and has a high water use (651–1 701 mm). In this regard, the areas suitable for taro production in South Africa have been found to be low and mostly confined to subtropical areas receiving high rainfall. The crop's mild drought tolerance and adaptation to waterlogging suggests it may be more suited to high rainfall areas that experience mid-season dry spells and are prone to flash flooding.

Therefore, neglected and underutilised crops can be introduced as part of sustainable intensification approaches for climate change adaption, as they could use land unsuitable for growing cash crops. This option offers a complementary crop rather than a substitution production scenario. However, the information on suitability needs to be complemented with information on "better bet" agronomic management to realise the full potential of the crops in question.

Cowpea, sorghum, and amaranths are highly suitable in areas which receive more than 500 mm per season and most of these areas are highly urbanised (i.e. Gauteng province). Therefore, the land value near urban areas might affect the opportunity cost of promoting NUS near urban areas. Peri-urban farmers prefer high-valued horticultural crops and dairy production with higher market demands.

Promoting neglected and underutilised crops within marginal

Back to Top

production areas can create new and sustainable economic pathways and improve the availability and access to nutrient-dense foods. The importance of smallholder farmers to sustainable food systems and their participation in local food systems must be emphasised. Moreover, there is a need to create an enabling environment for all participating stakeholders.

This can be achieved if there is a harmonisation of existing policies that speak to land, environment, agriculture and health, and new land-use policies are co-designed based on evidence. Policies such as the National Environmental Management: Biodiversity Act of 2004, National Food and Nutrition Security Policy and Draft Policy on Preservation and Development of Agricultural Land Bill 2015 could foster the co-development of NUS technologies and aid in addressing challenges in the land, environment, agriculture and health domains.

The potential of neglected and underutilised crops to contribute to diverse socio-economical goals

The demand for agriculture that supports a healthier diet, which is less dependent on monocultural systems and external inputs and is better suited to marginal and semi-arid environments, has revived interest in diverse traditional systems. Neglected and underutilised crops can offer new opportunities to address malnutrition and food insecurity, exacerbated by the rapidly increasing global population, the reduction in arable land, and the changing climate.

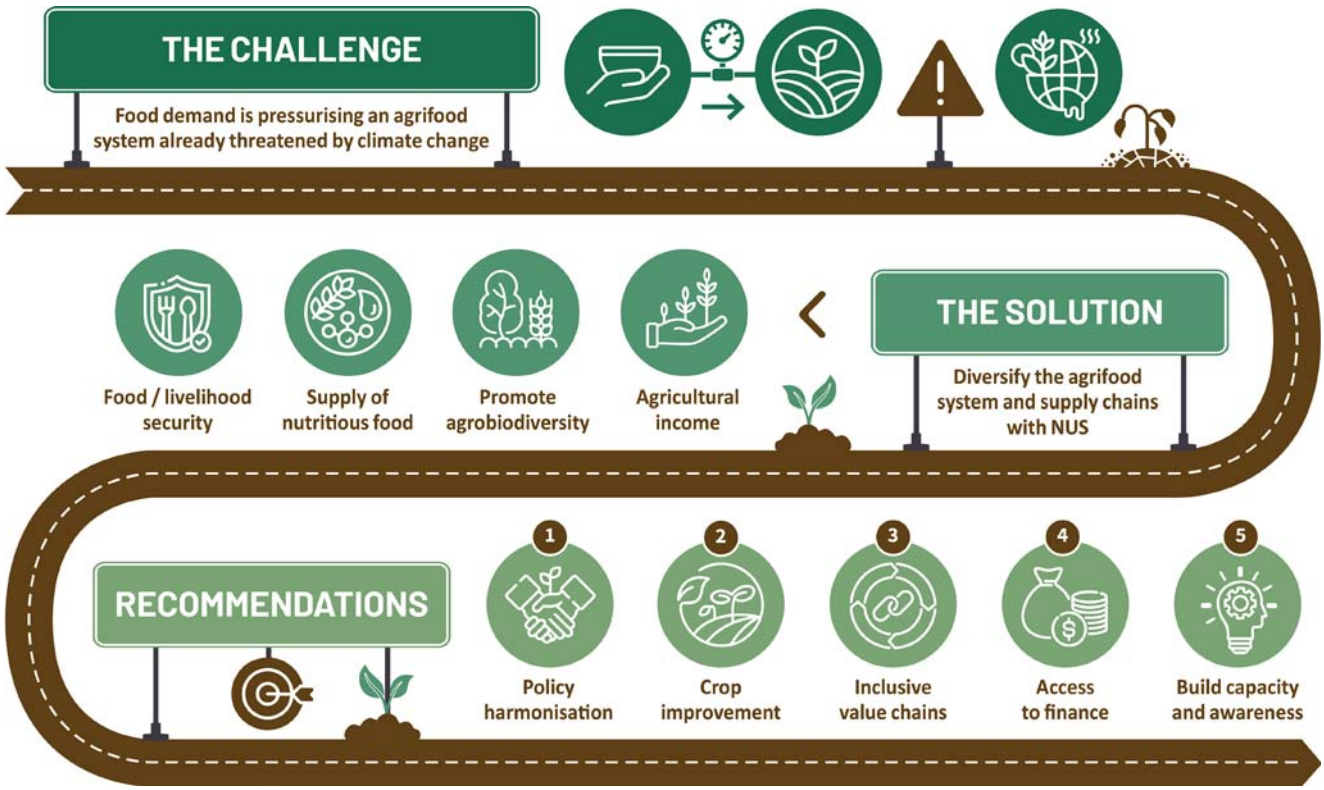
In this regard, they offer opportunities to co-evolve, hence transform socio-ecological landscapes, in response to changing socio-economic and bio-physical factors and the need for healthier diets. Including these crops as part of transformative adaptation allows for adapting to the climatic, ecological, and natural limits in which resource-poor farmers, in particular, reside. Therefore, neglected and underutilised crops can offer opportunities for 'fitting to' or 'fitting with' the socio-ecological environment while sustaining the natural products or processes needed for sustainable food systems.

What is needed

The current South African food system is centred around a few cash crops and needs to fully recognise the value of neglected and underutilised crops. Diversification of the food system and supply chain with these crops can increase farmers' food supply and agricultural income, promote agrobiodiversity (crop diversity), and tackle malnutrition, hidden hunger, and food insecurity in the face of climate change and environmental challenges.

Crop diversification can also increase the South African food basket and reduce reliance on food imports. Therefore, creating a value chain for these crops is imperative. The value chain must be promoted from production, post-harvest and processing, and consumer marketing. Creating an enabling environment for promoting neglected and underutilised crop production, marketing, and consumption will require governments to acknowledge their potential while ensuring broader stakeholder participation from inception. This will promote integrating indigenous and expert knowledge into the process and contribute to gaining stakeholder commitment and developing the necessary capacities and structures for holistically integrating these crops into the food system.

Mainstreaming neglected and underutilised crop species

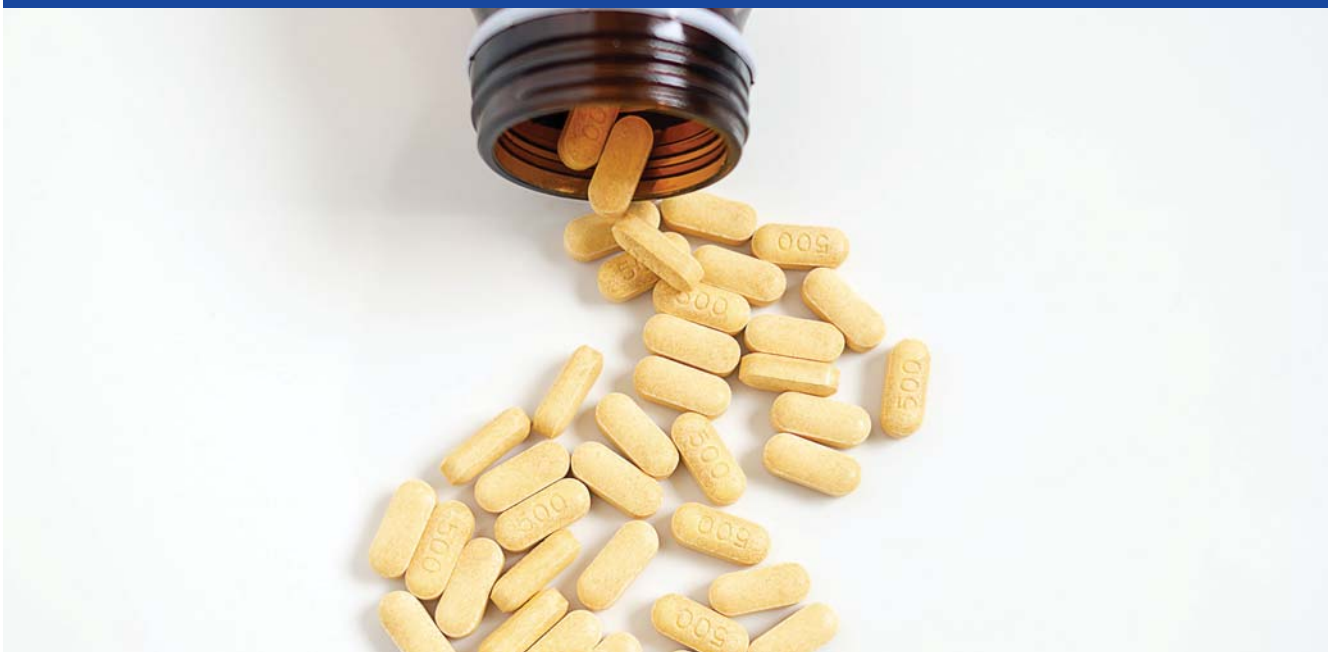


Back to Top

WATER AND HEALTH

Safe disposal of unwanted pharmaceuticals a must

Most pharmaceutical consumers are unfamiliar with the proper disposal measures for unwanted and expired medication. This results in the occurrence of these drugs in the environment, causing a serious danger to both human health and ecosystems. The aim of this article is to inform the public of the correct disposal methods for pharmaceuticals, thereby assisting in curbing their uncontrolled release into the environment and downstream negative implications on animals and humans. Article courtesy of the Agricultural Research Council (ARC).



Pharmaceuticals are chemicals that are used to diagnose, treat or prevent illnesses. It is worth emphasising that life would have been extremely difficult without the availability of these drugs. However, the majority of pharmaceutical users are unfamiliar with the proper disposal measures for unwanted medication.

As a result, medicines belonging to diverse therapeutic groups have been discovered in environmental matrices. The presence of these chemicals in the environment is a serious and complex issue that has received considerable attention because pharmaceutical pollution poses distinct risks to human health and ecosystems, including the near extinction of species, the feminization of fish, and the spread of antibiotic resistance.

Commonly used ineffective pharmaceutical disposal techniques and negative impacts

Most unwanted liquid medications are washed down the sink or flushed down the toilet, whereby they enter water systems and may also end up in drinking water, leading to the unintentional intake of certain drugs. Solid tablets and capsules, on the other hand, are usually thrown away in the trash, eventually ending up in landfills where they could leak into the environment as leachate. Since they are hazardous to pets and wild animals, unused and expired pharmaceuticals should not be placed in rubbish bins, discarded on open ground or flushed down toilets.

Improper approaches to disposing of unwanted medications, such as trash bins, toilets and the land surface, may lead to

Back to Top

the contamination of groundwater by leaking into the soil. Their spread can also be a potential source of pharmaceutical pollution. Furthermore, surface runoff channels these drugs into rivers where they can endanger aquatic species. In areas where there is an inadequate supply of freshwater, people often make use of river water to irrigate food crops as well as to drink, which may increase human exposure to incorrectly disposed medications.

Sources of unwanted pharmaceuticals

Unused and expired pharmaceuticals are frequently the result of patients failing to comply with instructions for the use of particular medications and so not taking or completing the recommended courses. Excessive prescribing by medical practitioners may also increase the amount of unwanted drugs. According to the World Health Organization (WHO), more than half of all medications are dispensed incorrectly, resulting in wasteful storage and environmental concerns. Moreover, some of these drugs are available in retail stores, allowing people to overstock them for future usage, leading to unwanted pharmaceuticals being stored in households. Since many nations still lack standardized medication disposal protocols, there is a great deal of confusion regarding the 'proper' way to dispose of pharmaceuticals.

When to dispose of unwanted pharmaceuticals

Pharmaceutical users should get rid of their current medication if the doctor updates their prescription while they still have some remaining, or when they are feeling healthy and the doctor has advised them to stop taking the medication. When over-the-counter medications are no longer required or have reached their expiration dates, they should be thrown away.

This is because having unwanted drugs in the home raises the danger of taking the wrong medication. It can also lead to the unintentional poisoning of children. It has been reported elsewhere that 70 000 children are admitted to hospitals each year as a result of medication errors, which is fuelled by the storage of drugs that are no longer needed. Therefore, it is crucial not to store unwanted medications because they put children's lives in danger.

Effective pharmaceutical disposal techniques

Returning medications that are no longer needed or have expired to the nearest medical store (pharmacy) is the most effective and environmentally friendly approach to getting rid of them. Healthcare professionals are obligated to accept unwanted drugs from patients and standardised procedures are in place for them to dispose of such medications. In the absence of a nearby medical store, they may be disposed of at home, provided that certain precautions are taken prior to their disposal. This involves taking the drugs out of their original containers and mixing them with unwanted substances such as used tea or coffee grounds, then putting the mixture into a sealable bag or disposable container with a lid.

The discarded medication thereby becomes unappealing to children or pets and less recognisable to people who may intentionally go through the trash seeking drugs. Because medicinal containers are recyclable, the information on them must be scratched out. In this way, your medical privacy is protected and no one can refill the medication. The sealed drug mixture containers and empty drug containers can then be thrown into the trash bin.

How properly disposing of drugs safeguards human health and the environment

Proper disposal of pharmaceutical waste contributes significantly to the reduction of the spread of these chemicals in the environment, thereby reducing the exposure risks to aquatic organisms and human health. It has been documented that some aquatic species have developed reproductive abnormalities due of their exposure to pharmaceuticals. Hence, proper disposal may lessen the extinction risks of such species. Although there are other sources of pharmaceutical waste in the environment besides incorrect disposal, the potential risks to aquatic and other organisms, including antimicrobial resistance in human health, may be lessened through proper disposal.

Addressing the problems related to inappropriate disposal procedures is necessary if we are to lessen the negative effects of pharmaceuticals on the environment. The healthcare industry is ideally positioned to aid in stopping the improper disposal of medications. Healthcare professionals can advise patients on how to get rid of unused/expired drugs and discourage them from overstocking for future use since the items may end up passing their expiration dates. Indeed, pharmaceutical consumers should pay special attention to the expiration dates before purchasing any medications so as to avoid storing drugs that will soon expire. The establishment of awareness campaigns spearheaded by healthcare workers, along with other measures as illustrated in Figure 4, could greatly reduce the amount of pharmaceutical waste in the environment.

CEC Knowledge Hub

The ARC, in collaboration with Tshwane University of Technology, North-West University and the University of South Africa (UNISA), initiated a project funded by the Water Research Commission to establish the Contaminants of Emerging Concern (CEC) Knowledge Hub. This takes the form of an online portal comprising information relating to newly detected aquatic pollutants such as pharmaceuticals.

The CEC Knowledge Hub was established to guide the public and scientists in pre-empting any aquatic catastrophe relating to CECs by identifying the problem and taking relevant, informed steps to prevent the situation from escalating beyond control. It clearly demonstrates the widespread occurrence of pharmaceuticals in several waterways, highlighting the dire need for proper disposal methods.

The CEC Knowledge Hub can be accessed at https://www.ceckh.agric.za/

Questions related to proper measures for disposing of unwanted medications and mitigative actions that can reduce pharmaceutical waste in the environment can be submitted by e-mail to the authors:

- Mr Ronewa Netshithothole at 14585790@mylife.unisa.ac.za
- Dr Tarryn Lee Botha at TarrynB@uj.ac.za
- Dr Ashira Roopnarain at RoopnarainA@arc.agric.za

Back to Top

WETLAND

Raising awareness of the existence, importance, and need for conservation of South African wetlands

Wetlands are distinct ecosystems comprising land that is transitional between terrestrial and aquatic systems, and vegetation cover that is typically adapted to flooded or saturated soils. There are numerous beneficial ecosystem services provided by wetlands to humans and animals, which include: protection and improvement of water quality and quantity; supply of food to humans and nutrients to plants; carbon sequestration; storage of flood water in wet periods and maintenance of surface water flow in dry periods; erosion control during heavy rainfall events; maintenance of ecosystems productivity; provision of habitat for threatened and endangered plant and animal species; recreational and educational opportunities, as well as creation of sustainable products and livelihoods, by providing a range of resources for people, including wetland plants harvested for manufacturing crafts and grazing for animals in the winter months. So writes Nadia Araya, Alanna Rebelo, Althea Grundling, Piet-Louis Grundling, Jason le Roux, Nwabisa Masekwana, Lerato Maboa and Kwazi Zuma.

Wetlands in South Africa's landscape today make up only 2.2% of the country's area, yet wetland ecosystem types are mostly under-represented in the National Wetland Map. The National Biodiversity Assessment 2018 confirmed that wetlands are the most threatened South African ecosystems, with only 15% of the extent in a near-natural ecological condition; 18% moderately modified and 67% heavily to severely/critically modified; while 62% of wetland ecosystem types are critically endangered. Furthermore, about 73% of inland wetlands are threatened and unprotected.

A study by Skowno et al. in 2021 reported that 83% of wetlands are critically endangered in South Africa. This is particularly true for peatlands, which contain a high amount of organic matter in their soils due to being inundated permanently for most of the year. The permanently saturated conditions of a peatland do not permit oxygen to break down the organic matter, which allows peat to accumulate over time. South African peatlands are very old (from 3 000 years to 45 000 years old). This, coupled with their slow accumulation rates (on average 1 mm per year), means that peatlands are not easily replaceable. The copious water supply in peatlands and the ease of draining of peat make peatlands highly attractive for agriculture. This is especially relevant in drier landscapes with low agricultural potential soils such as in Maputaland, northern KwaZulu-Natal, where peatlands are over-exploited.

The Colbyn Valley Wetland, located in the heart of Pretoria, Gauteng, is among the few ultimate urban wetland survivors in South Africa.

Tamsyn Sherwill

Colbyn Valley Nature Reserve, located in the heart of Pretoria, Gauteng

The Colbyn Valley Wetland covers an area of about 15 ha and is formed by backflooding of the Hartbeesspruit River where it flows through a quarzitic ridge, along with the contribution of groundwater. This led to the formation of a peatland. The intensive use of this peatland for agricultural activities in the past, including construction of drainage ditches and irrigation trenches, have drained parts of the wetland. In addition, the ZASM railway line of the 1890s was built across the reserve,

Back to Top

which was later aggravated by building the Koedoespoort line that divided the wetland into two parts, causing compaction of the soil and altering the drainage conditions.

The Vyeboom Wetland located in the Fynbos Biome, Western Cape, is an example of a threatened palmiet peatland ecosystem in South Africa. This wetland is situated upstream of the Theewaterskloof Dam, near Cape Town. The dam covers an area of 25 ha and is the main contributor to Cape Town's water supply. At present, only 4% of the Vyeboom Wetland's total land surface area is degraded, while the remaining area is expected to degrade over a period of 50 years, following spatial changes over time.

The Riviersonderend River feeds the Vyeboom Wetland, and it has the highest runoff of all the tributaries that feed the Theewaterskloof Dam catchment, causing it to backflood. This, in turn, floods the Vyeboom Wetland during wet winter months, while the water recedes to the main channels in drier summer months. Flooding of the Vyeboom Wetland by the Theewaterskloof Dam appears to be the principal cause for advancing headcut erosion within this wetland. The Vyeboom Wetland is also impacted by irrigation activities upstream and alongside the wetland.

Cape Winelands Biosphere Reserve

Vyeboom Wetland, located above the Theewaterskloof Dam near Cape Town, Western Cape.

To raise awareness of the existence, importance, and need for conservation of South African peatlands, on 1 February 2024 the Agricultural Research Council (ARC) held the premiere of a short film titled 'The Plight of South Africa's Peculiar Peatlands', to celebrate World Wetlands Day 2024. The film was funded by the Embassy of the Federal Republic of Germany and formed part of a project titled: 'Biodiversity-Climate Nexus for Wetland Management'. The premiere took place at the ARC-Central Office in Pretoria and was attended by various organisations that support peatland research. The peatland film was subsequently disseminated across several media platforms, including YouTube, LinkedIn, Facebook, Instagram and WhatsApp, and received more than 3 300 views in just 17 days after its release. To watch the film, go to [The Plight of South Africa's Peculiar Peatlands)]

World Wetlands Day 2024 celebrations continued with two wetland awareness events held at the Mhangele Wetland, Morelata Kloof, on 2 February (attended by 60 children) and the Colbyn Valley Nature Reserve on 3 February 2024 (attended by more than 160 children). A third event took place on 10 February 2024 at Cluny Farm, Midrand, where the peatland film was shown to 67 people, including 15 environmental organisation representatives and 23 people from Diepsloot.

ARC-CO

Participants who attended the peatland film premiere and networking event on 1 February 2024 at ARC-Central Office, Pretoria.

These events were centered around the participation of children from various schools in Pretoria. Several activities were conducted by the ARC, Department of Forestry, Fisheries and the Environment (DFFE) and Department of Water and Sanitation (DWS) to raise awareness about the importance of wetlands and the need for their protection, conservation and preservation.

Acknowledgements: Special gratitude goes to the Department of Forestry, Fisheries and the Environment for support and to the Water Research Commission for funding peatland research projects, the Embassy of the Federal Republic of Germany for funding the peatland film, the Agricultural Research Council for implementing the research, and other partners who provided meaningful contributions to peatland research and awareness by distributing the peatland film.

ARC-NRE

World Wetlands Day 2024 celebrations by the ARC staff and students.

ARC-NRE

World Wetlands Day 2024 event at the Mhangele Wetland, Morelata Kloof. A wetland model (left) and ecosystem wildlife diversity (right) were explained to children from three primary schools: Glenstantia Primary, Eastside Primary and Laerskool Constantiapark.

ARC-NRE

World Wetlands Day 2024 event at the Colbyn Valley Wetland. Children participating in a quiz about wetland management (left) and identifying wetland plant species (right).

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Back to Top

THE WATER WHEEL

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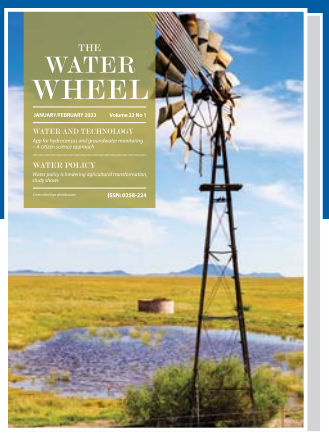

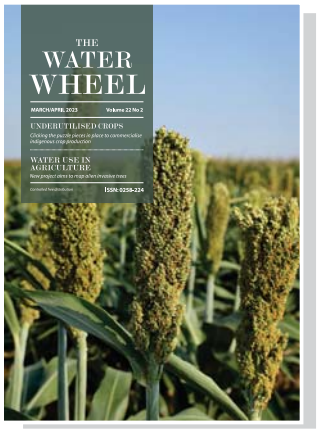

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WATER RESEARCH COMMISSION

The Water Wheel

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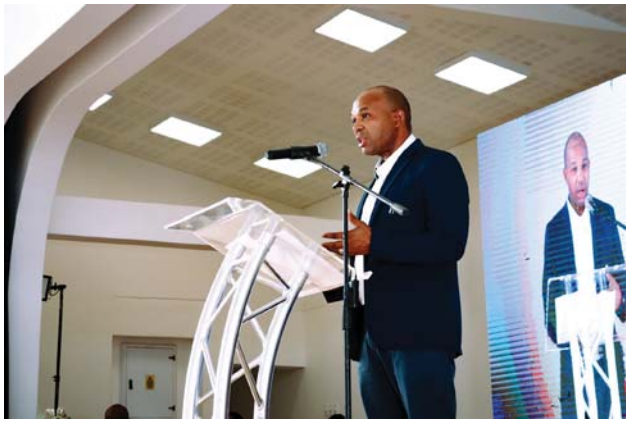
WRC EXTENDS FURTHER HAND OF PARTNERSHIP AND SUPPORT TO NORTHERN CAPE



WRC Deputy Chair Dr Harrison Pienaar addressed delegates at the event.

WRC CEO, Dr Jennifer Molwantwa, addresses delegates at the event.

The Water Research Commission, in partnership with the Department of Water and Sanitation (DWS), the South African Local Government Association (SALGA), Sol Plaatje University (SPU) and Frances Baard District Municipality, hosted a roadshow in the Northern Cape on 12-13 March 2024. The event formed part National Water Week, themed 'Accelerating Change', and sought to strengthen provincial water and sanitation resilience to climate change through research, development and innovation. This latest engagement comes after a strategic decision of the WRC in 2023 towards a stakeholder-centric approach that boosts innovation-driven developments to enhance climate resilience and adaptation within the water and sanitation sector in South Africa. The Northern Cape was selected as the first province of focus, and several engagements were held with, among others, SALGA, Sol Plaatje University, the Office of the Premier and district and local municipalities during the course of the year to assess the specific needs of the province. The event was used as a platform to announce the strategic interventions that the WRC is supporting in the Northern Cape to accelerate change in water, services, research and development. Particular highlights include the signing of a memorandum of understanding (MoU) with SPU to launch an Arid Water Centre. This strategic partnership will see collaboration between the university, the WRC and its research partners towards RDI programmes, projects and activities to address key water sector needs and challenges in the Northern Cape province. Various other partnerships with organisations such as SALGA and the Department of Cooperative Governance and Traditional Affairs (COGTA), among others, are also aimed support and coordinate initiatives to address the Northern Cape's water and sanitation challenges.

Various WRC-supported innovators showcased their water and sanitation technologies at the event.

Back to Top

DEEPLY ROOTED IN SOUTH AFRICA WATER SOCIETY

www.wrc.org.za

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

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

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

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THE POWER OF KNOWLEDGE TO THE PEOPLE