THE WATER WHEEL

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WATER CRISIS

Gauteng: Multipronged solution required to keep SA's economic heart beating

AQUACULTURE

Buna boon: online platform to boost aquaculture

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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

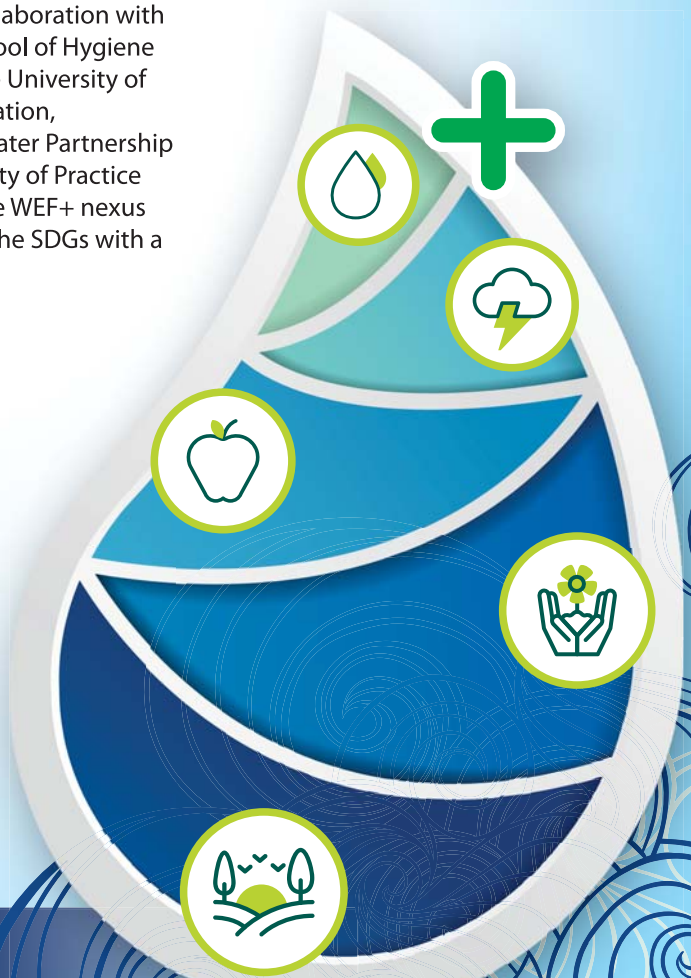
Theme: Accelerating progress towards sustainability through the WEF Nexus

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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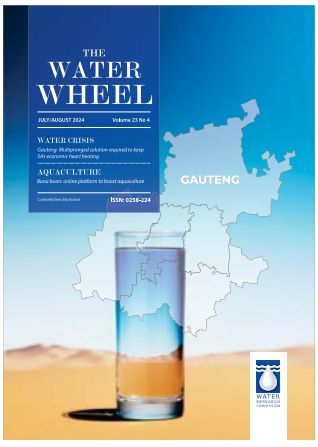

Gauteng is facing a cluster of water challenges that can only be solved through a multi-pronged approach. See article on page 10.

NEWS

New catchment management agencies to boost water governance

The Department of Water and Sanitation has launched four new catchment management agencies (CMAs) to enhance decentralised decision-making around water resources.

The CMAs are aimed at ensuring participative management, good governance and integrated planning around the country's water resources. "A CMA manages all the water resources in a water management area at the catchment level. This means that the CMA is responsible for the protection, use, development, conservation, management and control of all the water resources in that particular water management area," said the department in a statement. "This responsibility requires all speres of government, water users and communities in the water management area to participate with CMAs as partners."

The four new CMAs are the Pongola-Umzimkhulu, Vaal-Orange, Limpopo-Olifants and Mzimvubu-Tsitsikamma. For two of the CMAs board members have already been appointed, while board members are being finalised for the other two.

Former Minister of Water and Sanitation, Senzo Mchunu, said at the launch: "Water resource management is more than just a technical challenge; it is a societal imperative. Our water resources are the lifeblood of our nation, underpinning our health, our economy, and our environment. Effective management of these resources is essential for the sustainable development and prosperity of South Africa."

Hub for testing water and sanitation innovations in Africa launched

The Africa Water and Sanitation Association (AWSA) together with the Water Research Commission (WRC) launched a hub for the testing of innovations in the field of water and sanitation in Africa at the recent 10th World Water Forum, held in Bali, Indonesia.

While Africa faces the same water security challenges as the rest of the world, it also faces unique local problems. This includes water availability in the driest regions of the continent, ecosystem destruction and biodiversity loss due to land-based activities, inadequate and poor sanitation services, access to infrastructure, pollution, and public health.

Technological changes can offer a positive change towards improving people's lives.

The Innovation Testing Hub has been conceptualised using lessons learned from various innovation acceleration programmes around the world and in Africa, including South Africa, such as WADER (Water Technologies Demonstration Programme), SASTEP (South African Sanitation Technology Enterprise Programme), Imagine H2O, Watershare, US Innovation Networks andBlue Tech; as well as by the various suppliers of equipment on the African market.

The centre will provide a space for technology developers from around the world to test their innovations in agreed countries and locations to inhabit the test platforms. These sites could also be used by researchers and academics in the context of training and research, including in the overall framework of the African Water and Sanitation Academy.

The main objective of the hub will be to match innovative technologies to current and emerging local challenges. The key components of the hub are: provide knowledge sharing and collaboration sessions to discuss countries' national programmes to understand the problems and their objectives; stimulating interest from private sector industrialists to develop solutions that allow the development of enterprises; and communicating brokering and promoting jointly with partners to drive adoption and commercialisation of new innovations and technologies.

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Public-private partnership strives towards water security in Polokwane

In a demonstration of the impact achieved through public-private partnerships, the Polokwane Water Partnership unveiled the successful completion of Phase 3 of its ambitious project to address water scarcity challenges in the region. The partnership brings together South African Breweries (SAB), Anglo American, the Strategic Water Partners Network (SWPN) and the City of Polokwane Municipality.

The Phase 3 report builds upon the work of the previous phases, which identified substantial inefficiencies and water losses within the Polokwane water-supply system. This latest phase focused on financial, legal and regulatory recommendations for priority interventions to drive water conservation, demand management, and long-term financial sustainability.

Alyssa Jooste, Africa Water Stewardship and Smart Agriculture Sustainability Manager at SAB and SPWN Co-Chair, hailed the partnership's progress, stating, "We are ecstatic about witnessing the tangible impacts of our collective effort in Polokwane. By proactively addressing water losses and improving efficiency, we are not only safeguarding this vital resource but we are also contributing to the region's long-term economic growth and resilience."

The Phase 3 report outlines a comprehensive roadmap for further improvements, including visible leakage repair, bulk meter replacement and installation, implementation of pressure management strategies, enhanced metering and monitoring of top consumers, and the establishment of flow, pressure and level monitoring systems.

UFS scientist granted full membership by world's largest interdisciplinary scientific honour society

Prof Paul Oberholster, Dean of the Faculty of Natural and Agricultural Sciences at the University of the Free State and researcher in environmental management has been nominated for full membership in Sigma Xi, the Scientific Research Honor Society.

Sigma Xi is an international, multidisciplinary community of science, technology, engineering and mathematical professionals dedicated to research excellence, promoting public engagement with science and fostering the next generation of researchers. Prof Oberholster, who is rated among the top 5% in the world in the scientific category of engineering/technology, ecological engineering, and environmental engineering, receives the award in recognition of his scholarly achievements and contributions to the advancement of knowledge in his field.

Prof Oberholster is one of the few limnologists in South Africa who studies inland water systems to develop strategies for water resource management and nature-based treatment solutions. He believes in the importance of science serving society. His research directly contributes to the management, protection and rehabilitation of one of the country's most important resources.

WATER DIARY

World water
11-15 August
The International Water Association (IWA) World Water Congress will be held in Toronto, Canada under the theme 'Shaping our water future'.
Visit: https://worldwatercongress.org/

Engineering
9-13 September
The 10th UNESCO Africa Engineering Week will take place in Luanda, Angola. *Visit: https://www.aewconference.com/*

Hydrology
2-4 October
The South African Hydrological Society is hosting its second hydrology conference at Protea Breakwater Lodge, Cape Town. The theme of the conference is 'The future of hydrology and water security'.
Visit: https://southafricanhydrologicalsociety.org.za/sahs-conference-2024/

Wetlands
7-11 October
The 2024 National Wetlands Indaba will be held in the Eastern Cape.
Visit: https://nationalwetlandsindaba.org/#:~:text=Welcome%20to%20the%20National%20Wetlands,venue%20still%20to%20be%20decided.

Large dams
6-8 November
The Annual South African National Committee on Large Dams (SANCOLD) Conference will be held in Gauteng.
Visit: https://sancold.org.za/sancold-annual-conference-2024/

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GLOBAL

Scientists discover long lost branch of the Nile River

Some 31 pyramids in Egypt, including the Giza pyramid complex, may originally have been built along a 64-km-long branch of the Nile River which has long since been buried beneath farmland and desert.

The findings, published in the journal, ***Communications Earth & Environment***, could explain why these pyramids are concentrated in what is now a narrow, inhospitable desert strip. The Egyptian pyramid fields between Giza and Lisht, built over a nearly 1 000-year period starting approximately 4 700 years ago, now sit on the edge of the inhospitable Western Desert, part of the Sahara. Sedimentary evidence suggests that the Nile used to have a much higher discharge, with the river splitting into several branches in places. Researchers have previously speculated that one of these branches may have flown by the pyramid fields, but this has not been confirmed.

Eman Ghoneim and colleagues studied satellite imagery to find the possible location of a former river branch running along the foothills of the Western Desert Plateau, very near to the pyramid fields. They then used geophysical surveys and sediment cores to confirm the presence of river sediments and former channels beneath the modern land surface, indicating the presence of a former branch, which they propose naming ***Ahramat*** (meaning pyramids in Arabic).

The authors suggest that an increased build-up of windblown sand, linked to a major drought which began approximately 4 200 years ago, could be one of the reasons for the branch's migration east and eventual silting up. The discovery may explain why these pyramid fields were concentrated along this particular strip of desert near the ancient Egyptian capital of Memphis, as they would have been easily accessible via the river branch at the time they were built. Additionally, the authors found that many of the pyramids had causeways that ended at the proposed riverbanks of the Ahramat branch, which they suggest is evidence the river was used for transporting construction materials.

Source: Nature. To view the original article, Visit: https://www.nature.com/articles/s43247-024-01379-7

New study confirms forever chemicals are absorbed through human skin

A study of 17 commonly used synthetic 'forever chemicals' have shown that these toxic substances can readily be absorbed through human skin.

New research, published in ***Environment International*** in June proves for the first time that a wide range of perfluoroalkyl substances (PFAS) – chemicals which do not break down in nature – can permeate the skin barrier and reach the body's bloodstream. PFAS are widely used in industries and consumer products from school uniforms to personal care products because of their water and stain repellent properties. While some substances have been banned from government regulation, others are still widely used and their toxic effects have not yet been fully investigated.

PFAS are already known to enter the body through other routes, for example, being breathed in or ingested via food or drinking water, and they are known to cause adverse health effects such as a lowered immune response to vaccination, impaired liver function and decreased birth weight. The new study is the most comprehensive assessment yet undertaken of the absorption of PFAS into human skin and confirms that most of them can enter the body via this route.

Lead author of the study, Dr Oddný Ragnarsdóttir, carried out the research while studying for her PhD at the University of Birmingham. She explained: "The ability of these chemicals to be absorbed through skin has previously been dismissed because the molecules are ionised. The electrical charge that gives them the ability to repel water and stains was thought to also make them incapable of crossing the skin membrane. Our research shows that this theory does not always hold true and that, in fact, uptake through the skin could be a significant source of exposure to these harmful chemicals."

To view the original article, Visit: https://www.sciencedirect.com/science/article/pii/S0160412024003581?via%3Dihub

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Half of world's lakes are less resilient to disturbance than they used to be

Nearly half of the world's large lakes have lost resilience, or the ability to bounce back after an abrupt disturbance, in recent decades, according to the first global assessment of long-term changes in lake resilience.

Lakes in eastern North America and northern Europe have been hit the hardest, and dense populations and pollution are largely to blame, the study suggests. However, wealthier regions had healthier lakes, suggesting costly conservation efforts may pay off.

Both people and climate can gradually shift lakes away from their natural, healthy state. Warmer temperatures can increase evaporation, decreased precipitation can lower lake levels, and persistent pollution can chip away at the lake ecosystem's health. When sudden disturbances hit, such as heat waves, droughts or floods, a 'resilient' lake can recover; a vulnerable one may not be able to return to its previous state.

Assessing a lake's resilience, which takes into account its structure and ecosystem functions, is crucial for scientists predicting how it will respond to climate- and human-induced changes. But long-term trends of changes in lake resilience at a global scale—and why they happen—remain unknown. The new study, published in ***Geophysical Research Letters,*** fills in this knowledge gap.

"Tracking lake resilience is crucial because it allows us to detect early warning signs of ecosystem degradation," said Ke Zhang, an environmental scientist at the State Key Laboratory of Lake Science and Environment at the Chinese Academy of Sciences who led the study. "It enables us to do timely interventions and prevent the irreversible catastrophic collapse of lake ecosystems, which can have severe socioecological consequences."

Zhang and colleagues looked at comprehensive lake health and resilience and a mix of climate and human factors for 1 049 of the world's largest and most important lakes, looking for changes from 2000 to 2018. A suite of statistical tests allowed the scientists to look for 'flickers' and longer-term changes in a lake's colour, indicating changes in its health. If at least two of the statistical tests agreed, the researchers marked the lake as experiencing a change in resilience. The researchers analysed lake area, depth and satellite-derived colour in the context of each catchment's temperature, precipitation, population density, and per capita gross domestic product (GDP).

Nearly half of the studied lakes worldwide significantly lost resilience over the study period, the researchers found. Most were between 30- and 60-degrees N, but the authors note that many of the world's lakes are in the higher latitudes of the northern hemisphere, with more growing there under climate change.

To view the original study, visit: https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2024GL109298

Negotiations advance towards global intergovernmental science-policy panel on chemicals, waste

Governments gathered in Geneva have advanced in the process to establish a science-policy panel on chemicals, waste and pollution prevention, agreeing to continue negotiations to further develop the proposal for this body, akin to the IPCC on climate change and the IPBES on biodiversity.

Negotiations were held in June during the third session of an ad hoc open-ended working group that was mandated by the United Nations (UN) Environment Assembly in 2022. Discussions will continue at a date to be defined, preceding the intergovernmental meeting expected to establish the panel.

The new panel will support governments and other stakeholders by providing science-based advice to review problems and issues of concern and co-create solutions with governments and other stakeholders for the sound management of chemicals and waste to prevent pollution. Pollution is estimated to be responsible for 9 million deaths a year globally as a result of challenges such as lead exposure, air pollution, antimicrobial resistance, and mismanagement of solid waste.

"A new science-policy panel is a critical step to securing a pollution-free world," said Sheila Aggarwal-Khan, Director of the UN Environment Programme Industry and Economy Division. "A new panel will be able to work with governments, companies, farmers and many others on how we can better manage chemicals, reduce waste and prevent pollution. We look forward to working with countries to deliver this and tackle our waste and pollution crisis."

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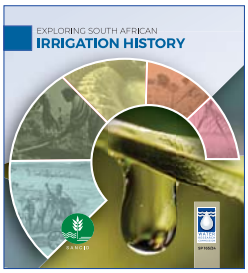
NEW WRC REPORTS



Exploring South African irrigation history

South Africa cannot boast an ancient irrigation history such as Syria, Egypt, Iran and Turkey, yet irrigated agriculture forms an important part of the country's agricultural sector. The combination of influences varying from traditional African to European, combined with the country's unique agricultural challenges makes for an interesting history. The South African National Committee on Irrigation & Drainage (SANCID) with support from the Water Research Commission, created a platform to provide an account of South Africa's irrigation history, including the history of its own origin, some years ago. It was seen as especially pertinent to include the history of irrigation among smallholder farming communities which has hitherto been much neglected. The result is a detailed chronicle of how the irrigation sector developed in South Africa from initial private initiatives to the cooperative flood diversion schemes of the nineteenth century and the large, sophisticated public storage schemes which took shape after unionisation in the early 1900s. The book ends with a glimpse of the current and future challenges faced by both commercial and smallholder irrigation farmers in the country. The book will also be available in hard copy from end July. Pre-orders can be made by emailing laniv@wrc.org.za. Hard copies and courier are available at no cost.

WRC report no. SP 165/24
Link: https://bit.ly/466IPUI

Position paper: Next generation water loss tracking, compliance, management, and performance solutions

The National Development Plan 2030 states that reducing growth in water demand is just as important as increasing its supply. South African water service providers and authorities are under increasing pressure to address the growing concern of water losses from drinking water distribution networks. As information and communication technology platforms and tools improve, several smart and modern solutions are being developed which offer better integration of water loss management together with daily operations and maintenance management. There is a move toward next generation cloud-based water loss tracking platforms that will help water agencies and its customers to track water use effectively by lowering the non-revenue water and be compliant with legislations.

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

Meeting each other halfway: Institutionalising community participation in integrated development plans and water services development plans in South Africa

South Africa's Integrated Development Plan (IDP) and Water Services Development Plan (WSDP) processes provide a legally binding framework, or so-called 'long route to accountability', in which citizens can hold their elected political representatives accountable. This includes municipalities' prioritisation and allocation of available internal and external financial, technical and institutional resources for service delivery, and the appointment of internal or external service providers to that end. On the ground, communities interact directly with these service providers in a short route to accountability. However, when it comes to participation for improved water services, communities in low-income rural and urban areas seem inactive. Instead, they protest on the streets. The project examined the stumbling blocks in the implementation of this long route to accountability or in other institutional issues that seem to ignore ordinary community members in under-resourced settings. This evidence is the basis for recommendations to revive the IDP and active participation in the water sector. In addition to the main report, the project team created a user-friendly Guidelines.

WRC report no. 3130/1/24
Link: https://bit.ly/3zDNwsc
Link to Guidelines: https://bit.ly/4bwhqMz

Development of a resilient water-energy-agriculture strategy plan for the City of Cape Town, through predictive simulations

The water supply for Cape Town is a complex system that is intertwined with other resource systems (notably food production and energy supply). Multiple sectors all compete for the water required to maintain and expand their operations. This leads to a difficult scenario for the City of Cape Town to plan for future water security, especially in the face of an expanding population due to in-country immigration into the Western Cape. The water-energy-food (WEF) nexus framing enables a conceptual understanding of interconnected and complex resource systems, yet quantitative descriptions of city scale WEF nexus scenarios, especially forward-looking ones that incorporate potential changes in climate, are not often encountered in academic literature. This project therefore set out to achieve two main goals: to develop a WEF nexus description for the City of Cape Town that enables future planning, and to train researchers that are able to set up and operate the required tools and models, and to make conclusions and recommendations that are implementable for a governing city administrator.

WRC report no. 3134/1/24
Link: https://bit.ly/4clj92c

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The effects of Pliocene-pleistocene climatic changes on evolution of river systems in Southern Africa: Focus on the Zambezi and Orange River drainage basins

Steep gorges incised by rivers and related fluvial terraces are common geomorphologic features on the margins of orogenic plateaus, such as the Great Escarpment of Southern Africa. Such features are often used to infer the timing and amplitude of surface uplift. However, climatic changes, such as intensified precipitation and increased amplitudes of glacial-interglacial climatic fluctuations, could also potentially enhance fluvial incision. In this study, International Ocean Discovery Program drilling cores surrounding the Southern African continent were utilised to capture significant river evolution events, through the establishment of sedimentary accumulation rates and provenance variation records since the Pliocene. Furthermore, provenance and geomorphological studies were performed to extend the state of knowledge on the drainage areas of the Zambezi and the Orange Rivers (and their tributaries) to aid the interpretation of the marine records.

WRC report no. 3123/1/24
Link: https://bit.ly/4cqpRu4

Dynamic system water balance model (DYWABM) enhancements: Climate change and water quality risks using Steve Tshwete Local Municipality as a case study area

A linear approach to solving water-related problems leads to transfer of risks and costs from one user/sector/place to another which is not in line with principles of sustainable development and equitable access to water resources. A dynamic system water balance model (DyWaBM) developed on the Kgetlengrivier Local Municipality in the North West Province of South Africa was applied on a more complex water supply system in the Steve Tshwete Local Municipality in the Mpumalanga Province to enhance its capabilities on water quality and climate change risks. It works with operational time scales, testing interventions that can affect water security on a day-to-day basis. On this study the basic water system configuration for the municipality was developed using baseline data which included land use, water resources, bulk water supply and wastewater infrastructure.

WRC report no. 3144/1/24
Link: https://bit.ly/4csIsFG

Investigating and accounting for non-stationary data in design rainfall and flood estimation: case study in KwaZulu-Natal, South Africa

The reported increase in the occurrence of extreme rainfalls leading to catastrophic flood events has raised the questions of whether changes in the magnitude and frequency of observed extreme rainfall events are already evident in South Africa, what the drivers of these changes are, and what the potential impacts on design rainfall estimation and consequently on flood risk assessment could be for in South Africa. Accurate estimations of design floods are required to limit the risk to loss of life and failure of, or over expenditure on, hydraulic structures. The needs to develop methods to account for non-stationary data, and to update design rainfall estimation methods to include possible trends in extreme rainfall events in a changing environment, have been identified as high priority research areas. The damage and loss of life caused by 2022 flooding across KwaZulu-Natal, and the realisation of possible increased rainfall variability in the future, highlight the fact that Design Flood Estimation (DFE) techniques currently used in South Africa are outdated and need revision.

WRC report no. 3147/1/24
Link: https://bit.ly/3VLufNb

Policy brief: Legal impediments to providing services to informal settlements on private land

Since 2000, the national government has embarked on a series of initiatives to reform water supply and sanitation policies. However, despite the progress made by local government, there are still over 3 million South African households that experience substandard sanitation services. The WRC funded a study to understand the challenges and constraints associated with providing sanitation in urban areas and present policy recommendations to address these challenges.

Link: https://bit.ly/4eOjqT8

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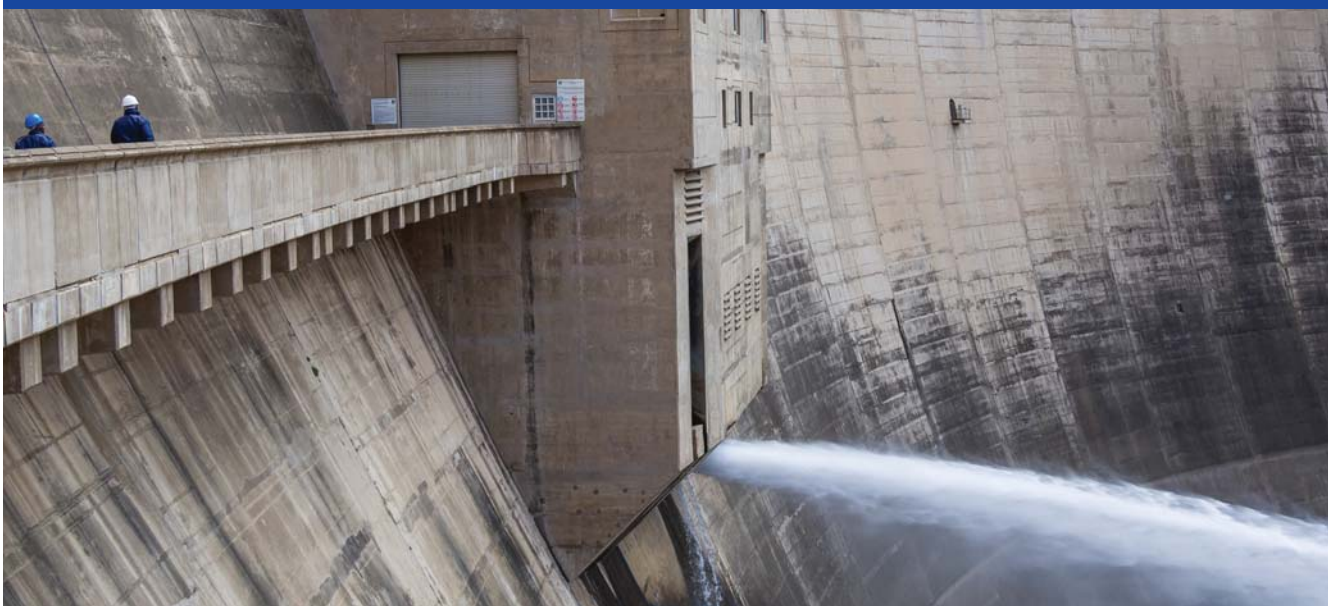
WATER CRISIS

Gauteng: Multipronged solution required to keep SA's economic heart beating

To avoid a water crisis that could cripple Gauteng will require a concerted effort by authorities at all levels as well as all water users in the province. This is according to Department of Water and Sanitation (DWS) DG, Dr Sean Phillips. Speaking at a webinar hosted by the Strategic Water Partners Network (SPWN) and the NEPAD Business Foundation in June, he said that neglected infrastructure, ballooning demand, and mismanagement have pushed Gauteng's water supply to the brink. "We are now in a situation where the demand for treated water in Gauteng is already occasionally exceeding the supply, particularly during peaks of demand." The consequences of inaction could be catastrophic. Article by Lani van Vuuren.



Water supply to the economic heartland of South Africa has always been a precarious issue. The first challenge is Gauteng's unfortunately location. The province sits on top of the watershed that divides the Limpopo and Orange River basins with rain falling north of Johannesburg's Parktown ridge draining into the Limpopo River and Indian Ocean while rain falling south of the ridge drains into the Vaal River and eventually into the Atlantic Ocean.

The discovery of gold on the Witwatersrand in 1886 did not only result in the establishment of large mines and industries in an area devoid of large rivers, but also led to an influx of people and the founding of cities such as Johannesburg. Through the decades Gauteng has had to meet its steadily rising demand for water by the creation of a sophisticated engineered bulk water storage and delivery system, the Integrated Vaal River System (IVRS). The system includes the transfer of water, through dams, canals and tunnels, from the high rainfall regions of the upper Thukela and Usutu rivers as well as the Senqu River in the highlands of Lesotho. Together, the 14 dams in the IVRS store over 9 300 million m^3 of water, equivalent to nearly five years of average flow in the Vaal River.

In 2009, the DWS, through its reconciliation studies highlighted

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that Gauteng's water situation once again necessitated the augmentation of bulk water supplies. The second phase of the Lesotho Highlands Water Project (LHWP2) was approved. The project, which includes the construction of Polihali Dam and associated infrastructure, will increase the yield of the Vaal River basin by around 15%. Initially planned to be completed by 2018, endless delays have resulted in the LHWP2 now only expected to come on stream in 2028. Phillips admitted that much of the delay was due to the change in leadership experienced at the DWS. Since 2013, the department has had 5 different ministers (with a sixth just appointed) and 11 different DG or acting DGs, resulting in delays in decision-making and frequent changes in policies and strategies.

Rampant urbanisation and population growth

Certainly, Gauteng's water consumption will have to be kept at sustainable limits until the new bulk water infrastructure comes on stream. However, LHWP2 alone will not solve Gauteng's water woes. A major contributing factor to the province's water demand / supply dichotomy is population growth, both as a result of the increase of the province's own population as well as in-migration.

Gauteng's population sits at 15 million at present, making it the most populous province in South Africa. This population is growing by around 3% a year, meaning that every year water needs to be supplied to over 400 000 additional people.

The bulk water supply for Gauteng water users is provided by Rand Water through its network of 3 500 km of pipes and 60 reservoirs. (In addition to Gauteng, this network also supplies municipalities in the Free State, North West and Mpumalanga provinces). Rand Water is licenced to withdraw a maximum of R1 600 million m^3/year from the IVRS. The licence is granted by the DWS and based on calculations to enable the system to remain sustainable, even in times of drought.

However, over the last six years the water utility has exceeded this licenced amount, this despite initiatives such as Project 1600, a collaborative effort with Rand Water's major consumers to reduce water use to enable it to comply with its water licence conditions. Phillips noted that water users would have to make do with the allowable volume of extraction until LHWP2 came on stream. "It would be irresponsible to allow [Rand Water] to abstract more. If we had a drought, this could mean a day zero situation in Gauteng".

The tight water supply-demand situation has made the system vulnerable to disruption caused by high-stage loadshedding, electro-mechanical breakdowns or theft of cables or severe heatwaves, as Gauteng experienced in March. "Usually,

Water enters South Africa from the Lesotho Highlands Water Project. Phase will increase supply from the system by around 15%.

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Table 1. Increasing demand in Gauteng

Financial year	Actual abstraction by Rand Water
2018/19	1 668 million m^3/year
2019/20	1 691 million m^3/year
2020/21	1 664 million m^3/year
2021/22	1727 million m^3/year
2022/23	1 755 million m^3/year
2023/24	1 793 million m^3/year

Source: Rand Water

breakdowns would not have a noticeable effect on water supply due to the ability to draw on reserve supply capacity, however, there is not such reserve in the Gauteng water system," Dr Phillips said.

Curbing non-revenue water and high water use

Compounding the problem, according to Dr Phillips, is the fact that municipalities have neglected to keep up maintenance of their water-supply systems. The province is experiencing staggering water losses at municipal level. The largest municipal water user, Johannesburg's, physical losses stand at 25%. The city's overall non-revenue water stands at 40%. (Non-revenue water refers to physical water losses as well as unpaid and unmetered water suppliers to users).

"Municipalities must have efficient revenue collection systems and reduce non-revenue water losses, or they won't be able to pay Rand Water for the water provided," noted Salome Chiloane-Nwabueze, Head of Integration, Monitoring and Evaluation at Rand Water. The water board has been assisting municipalities to draw up adequate water infrastructure and maintenance budgets to remedy the situation.

Rand Water embarked on an extensive proactive maintenance of its own infrastructure from 22 June to 29 July. Proactive infrastructure maintenance is important to preserve the quality and integrity of the infrastructure, reduce maintenance costs in the long term and increase the lifespan of the infrastructure and assets. It is important to note that as a result of this preventative outlook, the water board experiences only 4% water losses in its own infrastructure system.

The province also has a high per capital water consumption. Standing at 250 litres per person a day (this figure includes leaks), Gauteng residents' water use far exceed the international average of 170 litres per person per day, an unacceptable situation considered South Africa is a water scarce country. Dr Phillips decried what he called the 'trust deficit' that currently existed between residents of the province and government

Johannesburg is the largest municipal water user in Gauteng.

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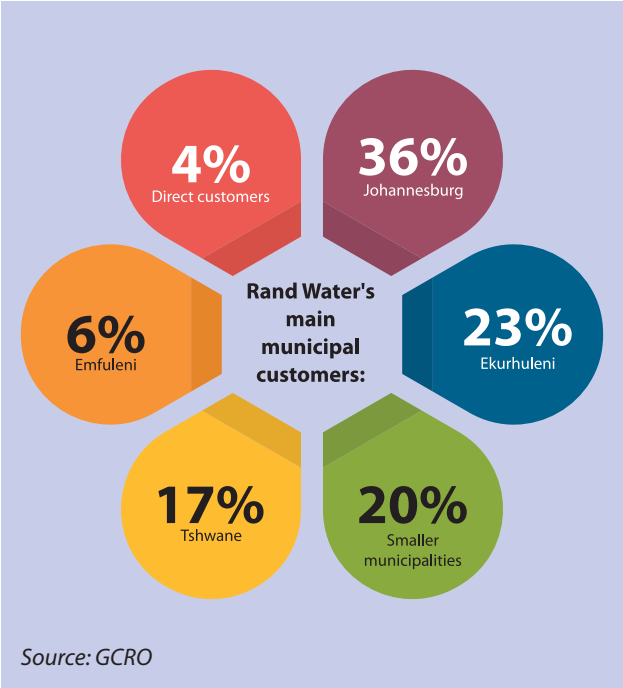
authorities. "When residents are asked to use less water, there is the perception that they are being blamed for the province's water situation. This certainly is not the case, but we all have a responsibility to alleviate the situation."

The department is currently working with the World Bank and other partners towards a large-scale awareness campaign, drawing on lessons from the Cape Town experience that saw the city narrowly miss a day zero situation during an extended drought a few years ago.

Clearly, a multipronged approach is required. As Phillips pointed out: "If we do only 2 out of the 4 or 5 things, then we are still going to have a high risk of disruptions." Chiloane-Nwabueze added that each person and entity in the province had to play their part. "It is not just the responsibility of water boards or municipalities or the [DWS] – it [is] the responsibility of each and every individual to ensure water is consumed wisely for sustainability."

To watch the webinar, Visit: https://www.youtube.com/watch?v=kTJtuuf5Z68



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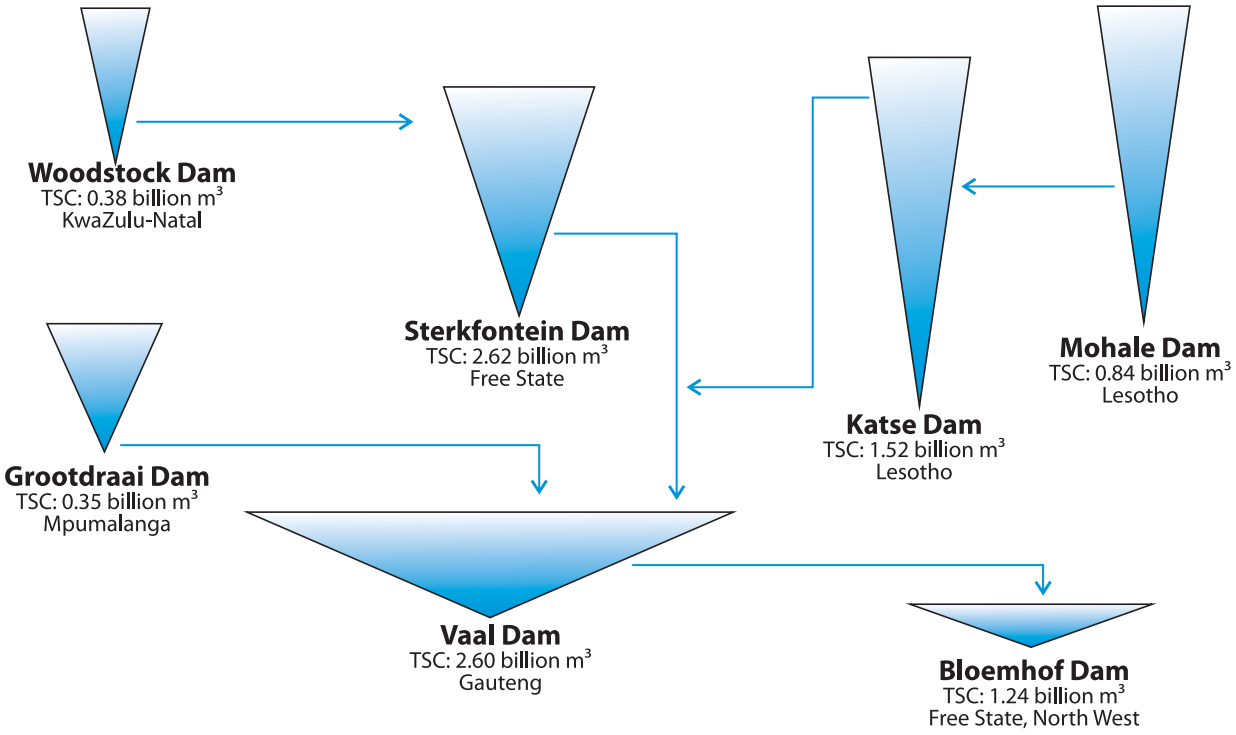

The main dams of the Integrated Vaal River System.

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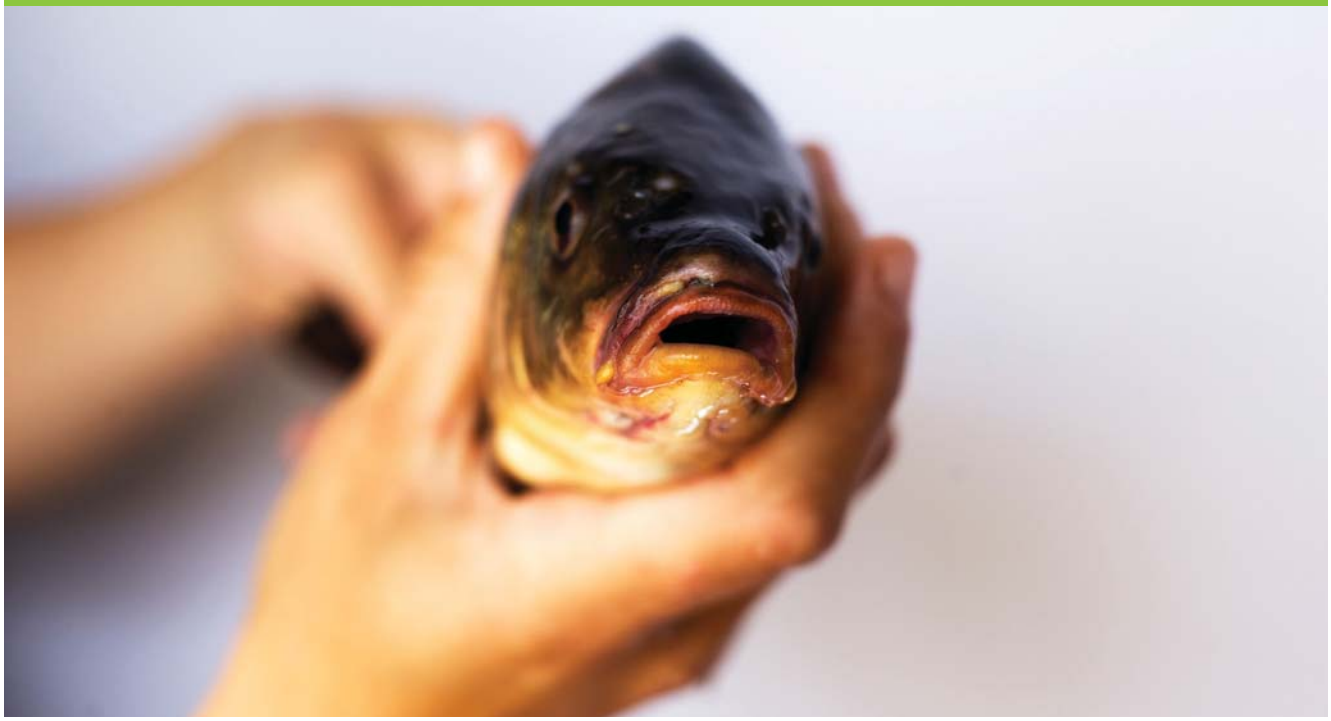
AQUACULTURE

Buna boon: online platform to boost aquaculture

Wags will tell you that if you teach a man to fish, he'll sit in a boat all day and drink beer. Maybe so, but when it comes to fish farming, improved technical know-how leads to bigger harvests. A new Water Research Commission (WRC)-backed digital initiative does just that, while developing data collection. Matthew Hattingh reports.



Here's something fishy to chew on: more people worldwide now eat farmed fish than beef. The trend is expected to continue, and while Africans lurk at the tail end, trailing every continent in consumption, and all but Oceania in production, that's changing. Aquaculture production on the continent, although less than 3% of the global total, is evolving from subsistence to commercial, cashing in on a growing demand and a favourable environment, including water.

Trouble is, aquaculture takes considerable technical know-how to do well. Give your fish too little feed and they won't grow big in good time; give them too much and you're throwing money down the drain (or at any rate, into the pond). The weight of a fish at a particular age has a direct bearing on profitability. Then there's everything from water temperature and oxygen content that the poor fish farmer must manage.

Authorities in Africa know this, which is why there's increasing interest in helping our fish farmers become more productive and profitable. Fourteen years ago, a Rhodes University team and the WRC developed a manual (**WRC Report No. TT 463/P/10**) to provide small-scale fish farmers with technical knowledge and support. Seven years later the project was revisited. Printing the manual proved costly and it was cumbersome to update. Meanwhile, the growth of the internet allowed a move away from paper.

The WRC supported an initiative to take the manual online in

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the form of a platform called Buna Africa (www.bunaafrica.org). Buna is Sepedi for harvest. Developed by the Rural Fisheries Programme, within Rhodes' Department of Ichthyology and Fisheries Sciences, it worked relatively well, and has been widely used in Southern African Development Community countries by farmers and agricultural extension officers. However, it remained beyond the reach of many potential users who lacked access to computers.

The soaraway growth of smartphone ownership suggested a solution. What if Buna was retooled so anyone with a fairly basic device and some data might access it? A proposal to do just that was accepted by the WRC in 2021 and the project that followed has been detailed in ***Addressing accessibility of online platforms for low-literacy users in small-scale aquaculture*** (**WRC Report No. 3136/1/24**). The report, published in May, tells how the look, feel and functionality of Buna have been transformed and why the project far exceeded the more modest digital makeover originally envisaged.

It explained how team Buna set about making the manual more user-friendly. This was crucial because the literacy of rural fish farmers was often lacking and typically, they were still finding their feet in the digital world. The project involved repackaging the manual's content, including switching to simpler, more direct written language, bolstered by voiceovers in English and vernaculars, and video material, all carefully sorted, cleaned and gutted as far as possible of 'dense, jargon-heavy text'.

But it didn't stop there. "We realised we could do much more than provide the manual online," said Qurban Rouhani, Director of the Rural Fisheries Programme. He told the ***Water Wheel*** that a central aim of the project had been data gathering, especially production figures. "We realised that in many countries on the continent and beyond, governments don't have regular and reliable production data."

This dearth of data made it difficult to set policy, plan, assign resources and manage the sector, including supporting agricultural extension officers. "In this age, worldwide, data is the new currency," said Rouhani. He told how Buna learned from the likes of Google and Facebook. The tech titans discovered if you give people incentives, useful, free services, they wouldn't be too fussed if you used their data.

In the case of Buna, the services and tools included access to Rhodes-WRC and other aquaculture manuals; a fish production calculator for Nile tilapia (with plans to expand to other species); a WhatsApp-like messaging function that puts farmers in touch with their peers; and a service that links farmers with service providers, such as netmakers, feed producers and pump suppliers.

Photo supplied

For most freshwater fish farmers in South Africa, aquaculture is still a secondary activity. New technologies, such as Buna, make it possible that aquaculture will become more commercially orientated.

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Africa aquaculture production, although less than 3% of the global total, is evolving from subsistence to commercial, cashing in on a growing demand and a favourable environment, including water.

Also included were links to YouTube videos on aquaculture; a weather service with farm-level forecasts and current conditions; and government documents such as funding calls and notifications. Plans for a fish health service that facilitates diagnostics and connects farmers with state vets and laboratories was still in the pipeline.

Rouhani reckoned the tools and resources represented 95% of Buna's content. The balance was about submitting data, with facilities that let fish farmers enter production figures, which would be visible to government officials on Google Maps. He said because farmers benefited from using their own data on Buna, "they can see the truth" so were less likely to fudge facts. Data would be more accurate and timely than if sourced conventionally, which involved extension offices going into the field with clipboards and later transcribing their findings. "The problem with that is you may not go out to the farm for three or four months," said Rouhani, mentioning logistical difficulties facing officials in some countries like a lack of petrol or broken motorbikes. Worse, some farmers "tell the extension officer what they want to hear, or the extension officer tells his bosses what they want to hear".

From the outset, the project sought to rope in fish farmers as co-creators and contributors in Buna's redevelopment. The research-study's authors are Adrie Haese of Pretoria University, Rouhani and Nyiko Mabasa of Rhodes, Buna Africa's Paul Chisenga, and Bethanie Trollope and Christa van Zyl of the University of Johannesburg. The involvement of Haese, an information design fundi, and Trollope and Van Zyl, an Honours student and head, respectively, of their university's Department of Graphic (Communication) Design, reflected the priority the project placed on design and software development.

To quote the report: "The challenge within the South African aquaculture sector (and across the developing world) is not so much the limitations of the development of digital platforms that fish farmers can use, but rather with limitations on the part of farmers. Fish farmers, based in rural areas, may lack access to internet infrastructure and also have low literacy and/or digital literacy skills. As such, the development of digital technologies should not only look to innovate, but also consider how to do so in a way that is inclusive of populations with diverse literacy levels and digital skills."

To develop the platform the team worked with a group of small-scale fish farmers in Thohoyandou, Limpopo, who had assisted with earlier versions of Buna. Also involved was an extension officer from the area. A "participatory design" process was pursued to hatch and trial ideas, figure out what would work in practice, and understand what suited users best. The thinking was to discover, refine and press into service knowledge

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individual farmers intuitively possessed, drawing on their experiences, insights and expertise.

The team knew the platform had to look good and be easy to navigate if it was to attract and keep users. Pains were taken to present information, tools and design elements in a clearer and consistent way. At the same time, it was necessary to strike a balance between the needs of low-literacy users and not alienating more tech-savvy and literate users.

"The development of digital technologies should not only look to innovate, but also consider how to do so in a way that is inclusive of populations with diverse literacy levels and digital skills."

The report explained the phases and series of focus groups the design process involved. In July 2022 the team met the Limpopo farmers to reacquaint them with the platform. New team members were introduced and there was discussion on Buna's layout, content and accessibility. Farmers were given a chance to talk about their experiences and the difficulties they faced. Site visits to five farms followed. "The goal, or design brief, that developed from our interaction with the farmers was to update the design of Buna to be mobile-friendly and accessible to users with varying levels of literacy, both in a traditional and digital sense, to improve their businesses and foster a sense of community," the authors said.

The literature reviewed and with consensus on the desired outcome shaping up, preliminary changes were made to Buna, bringing on board suggestions from the extension officer. Some months later, the team met the farmers again and showed them a "low fidelity", paper version of the redesigned Buna. The farmers were encouraged to suggest changes. They were also invited to enter their information into the system, navigate the platform and say what they thought of it.

The farmers' views were sought on "icons, article formats, video links, and other aspects", with the goal of "envisioning a solution tailored to meet their specific needs". Next, high-fidelity prototypes were developed and presented to the farmers for their views, with an emphasis "on the platform's visual appearance, colour schemes, iconography, information presentation, and responsiveness across different devices".

A further focus group was held in May last year when printouts were shared, and computers made available for farmers to try out the platform. At a final focus group and testing session in September last year farmers tried out a high-fidelity prototype. Field notes, recordings and other data from the focus groups were collected and analysed and the report presented a host of conclusions and recommendations.

For the most part, farmers felt their voices had been heard and their suggestions applied.
"Buna platform is very helpful. I can teach us managing and lead us to better," said one. Another farmer said it would teach "us to harvest good and health(y) fish" and "how many fish can fit into a certain space".

Thanks to the farmers' participation, a need for instructional support was identified. Although the calculator tool was well received, the farmers' interactions with it led to the development of a video library of frequently asked questions and demo videos on each page of the platform. Community building was not initially a primary focus of the project, but farmers were keen to use the platform to connect.

"The farmers were particularly enthusiastic about the potential of the platform to build a community. They expressed the view that it could help foster the growth of a fish farming community in Thohoyandou, as well as nationally and internationally." The farmers also hoped the platform would improve communication with officials and extension officers, reducing frustrations and improving government support.

What was the state of fish farming in South Africa? the ***Water Wheel*** asked Rouhani. He said aquaculture started in the country in the 1890s with the introduction of trout, but the sector remained small, with production of 8000-tons a year. By comparison, it was growing vigorously elsewhere in Africa. Zambia, for example, produced over 100 000-tons a year, while Egypt topped one-million-tons. The focus on the continent had shifted too, from subsistence and providing cheap protein to commercial production.

Rouhani mentioned Buna had partnered with the agency WorldFish in Zambia and Malawi, and was working with the UN's Food and Agriculture Organisation (FAO) in Uganda and Rwanda. At the time of the interview, he was preparing to travel to Ghana to meet the FAO to explore how Buna could be expanded to other African countries.

He hoped Buna data would spur and support the South African government to develop policy and grow the sector. Rouhani said the new WRC report was part of a work-in-progress and he was excited about what the next version of Buna might look like. "This kind of research is not something that ends. We have not reached perfection; there is no end point. Farmers improve. Literacy improves. New technology comes into play," he said, mentioning the internet-of-things (where objects equipped with sensors are networked) and artificial intelligence (AI).

"We used it in a very small way (in the study, to simplify complex language), but we have our eye on it. We really see AI becoming the engine of digitalisation. Can you imagine if we unleash AI, it can help fish farmers manage water quality, price of feed and stocking and to predict demand and fish prices. You can hold your fish back a bit or squeeze a few more out. The power of digitisation is there to be harnessed. It's exciting."

To view the report, ***Addressing accessibility of online platforms for low-literacy users in small-scale agriculture*** (**WRC report no. 3136/1/24**), visit: https://wrcwebsite.azurewebsites.net/wp-content/uploads/mdocs/3136%20final.pdf

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MUTALE PEAT WETLAND

South Africa's 40 000-year-old Mutale Peat Wetland: threats from historical land transformation and changing climate

Norbert Hahn from the Department of Biological Sciences, Faculty of Science, Engineering and Agriculture, University of Venda draws attention to the unique Mutale Peat Wetland, one of only a few functioning wetland systems remaining in the Soutpansberg.

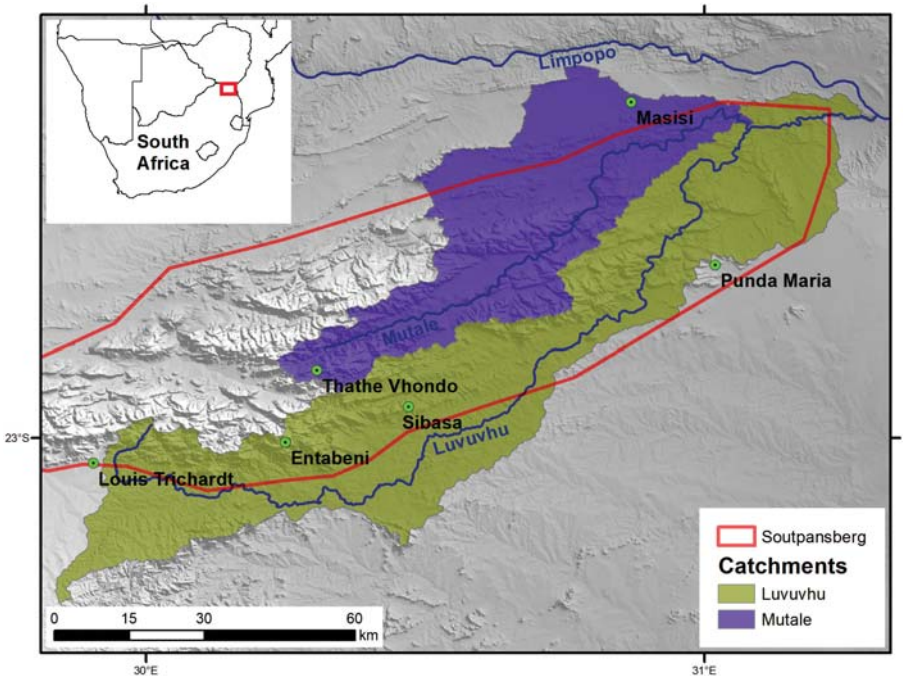

Figure 1. The Luvuvhu and Mutale catchments relative to the extent of the Soutpansberg mountain range and the main rivers in these catchments, tributaries of the Limpopo River.

Physical setting

The Mutale Peat Wetland is situated within the Soutpansberg geomorphic province and forms part of the greater Luvuvhu River catchment, a main tributary of the Limpopo River (Figure 1) (Partridge ***et al.*** 2010, Hahn 2011). The Mutale River originates in the uplands of the Soutpansberg at Thathe Vhondo, first flowing west-southwest before turning north and discharging into Lake Fundudzi after 10.5 km (Figure 2). The Mutale Peat Wetland lies along a tributary of the Mutale River and is situated 3.2 km downstream of the latter's source. The wetland forms part of the upper Mutale River catchment, an area of approximately 3.2 ha at an elevation of 1 180–1 200 m above sea level (Figure 2). Within a catchment of ~76 ha, the wetland is not fed by any major river system and is totally dependent on rainfall to sustain itself.

The upper Mutale catchment in turn forms part of the greater Lake Fundudzi catchment which also includes the Godoni and Muiladi as well as the smaller catchment surrounding the lake (catchment names follow Van der Waal [1987]) (Table 1). A large portion of the Mutale Peat Wetland is made up of extensive peatlands with a peat accumulation of up to 3 m (Baboolal 2014). The wetlands of the Mutale system are poorly represented on the South African National Wetland Map and warrant further study (Van Deventer ***et al.*** 2020).

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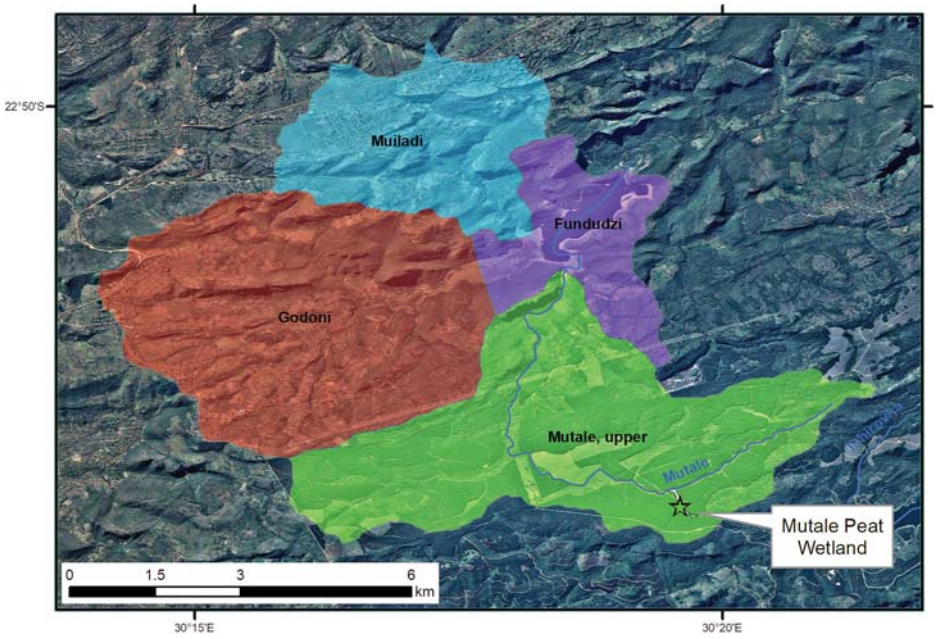

2008 image from the Chief Directorate: National Geo-Spatial Information, Mowbray, Cape Town).

Figure 2. The four catchments of Lake Fundudzi (2008 image from the Chief Directorate: National Geo-Spatial Information, Mowbray, Cape Town).

Table 1. The four catchments of Lake Fundudzi and their sizes.

Name	Size
Fundudzi	6.5 km^2
Godoni	21.8 km^2
Muiladi	10.2 km^2
Upper Mutale	21.3 km^2
Total	59.8 km^2

Rainfall

Entabeni (Figure 2), situated ~10 km south of Thathe Vhondo, has the highest recorded annual rainfall for the Soutpansberg with 1 874 mm whereas Sibasa, situated ~17 km to the south-east, receives 1 063 mm (Hahn 2006). As no rainfall data exist for Thathe Vhondo it is postulated that the annual rainfall lies between these two figures. The high rainfall regions of the Soutpansberg are identified as one of South Africa's Strategic Water Source Areas (Lötter and Le Maitre, 2021).

Photograph from the late Pierre Cuénod

Figure 3. A view across the grassy slopes of Entabeni about 1902. Today the area is covered by plantations and secondary bush encroachment (photograph from the late Pierre Cuénod).

"The Mutale wetland's main importance is its supportive function to the hydrological integrity of Lake Fundudzi."

Historic landscape

Visiting Lake Fundudzi, Trevor (1919) described the landscape as: '*. . .an open down-like plateau, with scattered* Protea *trees and close-growing grass, which might be taken for a portion of the Transvaal high veld, though the actual altitude is under 4 000 ft* [1 219 m]'. At present, most of this area is exotic timber plantations, bush encroachment and rural settlements.

Both Scott (1987) and Baboolal (2014), in their palynological studies of the Mutale Peat Wetland, recorded a sharp increase in charcoal accumulation towards about 1 500 BP (Before Present), correlating to the first Iron Age settlements south of the Limpopo River at 1 550 BP. Both studies confirm, through pollen spectra, that even though historical anthropogenic disturbances led to a reduction of the woody component in the area, grasslands were always predominant.

The high rainfall grasslands of the Soutpansberg situated on clay soils derived from weathered basalt, previously covering approximately 10% of the area, are extinct (Hahn 2017). The demise of these grasslands was rapid with the main period of transformation across the wider landscape between the 1920s and 1950s. Grasslands growing on soils derived from both quartzitic-sandstone and basalt constituted the largest part of the historical Thathe Vhondo habitat with only a few degraded patches remaining, with soils too shallow to be planted (Figure 3). The development of Thathe Vhondo into a commercial timber operation started in about 1939 with the building of roads and the main transformation, the establishment of plantations, began after 1951 (Figure 4).

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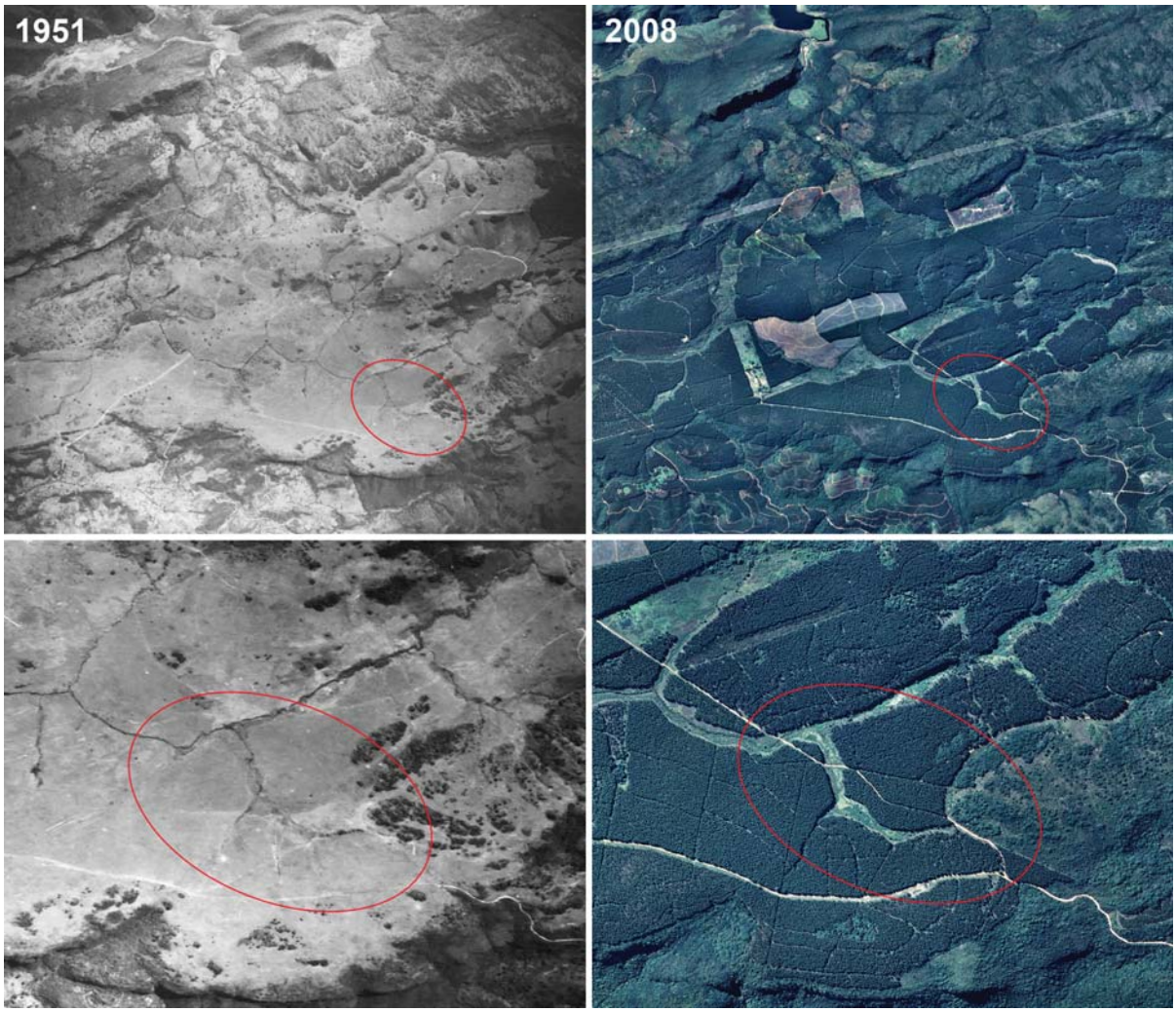

The Chief Directorate: National Geo-Spatial Information, Mowbray, Cape

Figure 4: Thathe Vhondo as it was in 1951 (left) and in 2008 (right). The red oval indicates the location of the Mutale Peat Wetland

Significance of the site

Figure 5: Lake Fundudzi in March 2001 photographed from the west (22° 51′ 5,184″ south & 30° 17′ 23.496″ east) and looking in an eastly direction.

The Mutale wetland's main importance is its supportive function to the hydrological integrity of Lake Fundudzi (Figure 4). Lake Fundudzi is the only limnetic depression in South Africa formed by a landslide and is of considerable age, probably 100 000 years (Partridge & Scott 2000). Most of the Godoni and Muiladi Rivers catchments are transformed by human habitation, agriculture and land degradation leading to extensive erosion (Figure 6). The silting up of Lake Fundudzi due to erosion is clearly visible from the delta formation at its inflow, most prevalent in the catchment of the Godoni (King 1951, Van der Waal 1987) (Figure 6 & Figure 7). The still-functioning wetlands in the upper Mutale catchment are critical in maintaining water quality and reducing siltation of the lake.

The Mutale Peat Wetland is one of only a few functioning wetland systems remaining in the Soutpansberg. What sets it apart from most other wetlands in the mountain range is that it is a peat driven system with an age of at least 40 000 years (Baboolal 2014) (Table 2). At present no equivalent intact system has been recorded for the Soutpansberg. Scott (1987) was the first to study the wetland, obtaining a 12 000-year palæoclimatic record from it. Baboolal (2014) conducted a later study which extended the palæoclimatic record another ~30 000 years.

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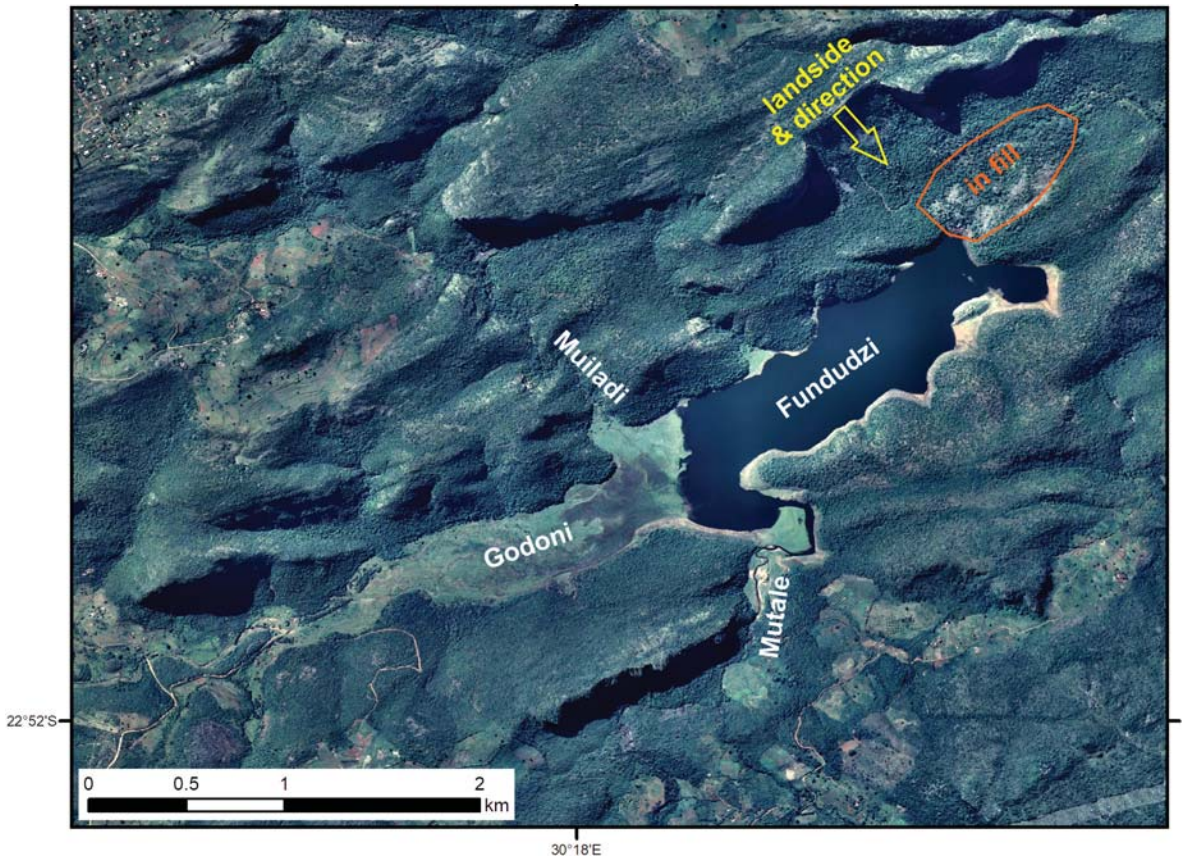
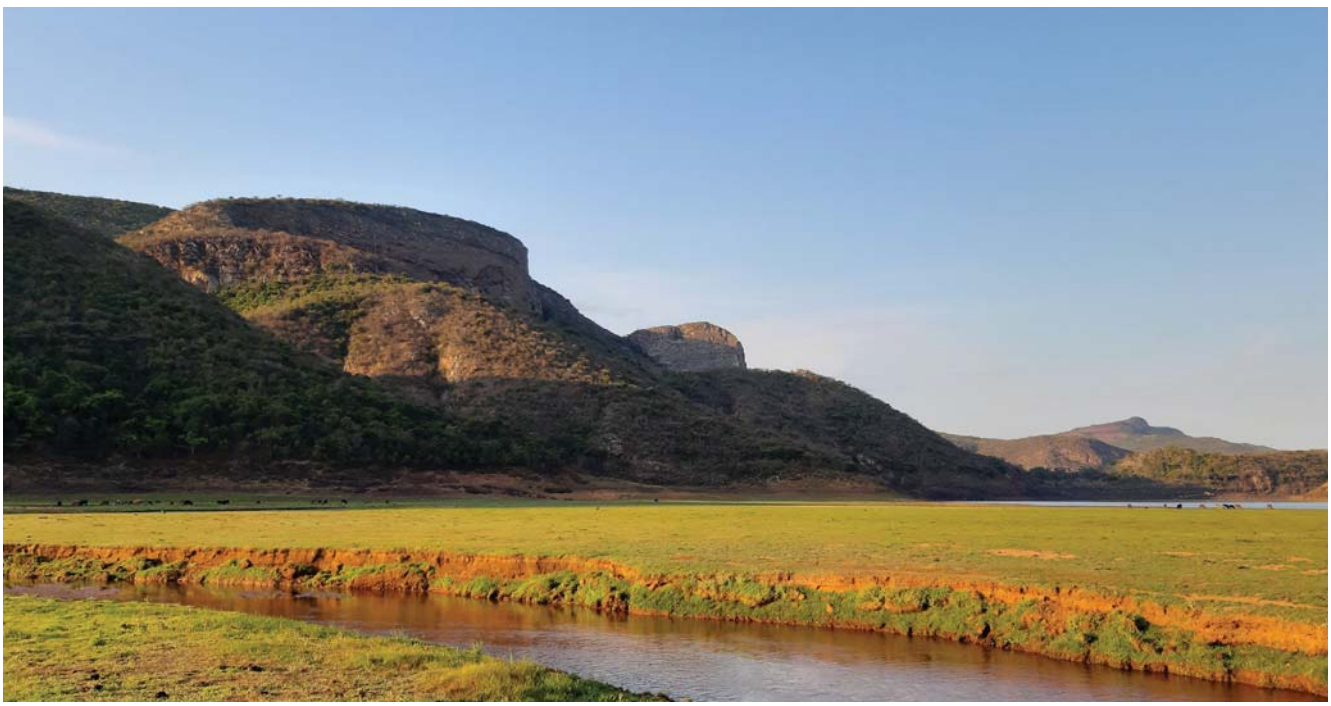


The Chief Directorate: National Geo-Spatial Information, Mowbray, Cape Town

Figure 6: 2008 aerial photograph of Lake Fundudzi showing the delta formation at the inflow of its three main rivers and the location of the landslide which formed the lake.

Lake Fundudzi is also of significant cultural importance to the VhaVenda people, being considered the most sacred site in all of Venda. It is believed the lake is inhabited by water spirits known as the Vhatavhatsindi. From time immemorial, at the beginning of summer, the inhabitants surrounding the lake make sacrificial offerings to the Vhatavhatsindi in the hope that they will be accepted and that the land will be blessed with a good rainfall season. It is also believed that in times of floods the red, murky silt-laden water of the Gondani does not mix with the clear dark water of the Mutale which sinks to the bottom of the lake passing through it (Van der Waal 1987).



Heidi van Deventer, 2019.

Figure 7: The inflow of the Godoni river into lake Fundudzi clearly showing the heavy siltation.

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Figure 8: The Mutale Peat Wetland looking upstream from the road culvert. The photograph shows pond formation caused by the culvert, pine trees establishing within the wetland, Passerina montana *dominated bush encroachment on the upper banks and pine plantations surrounding it.*

Threats

As South Africa is a semi-arid region, peatlands are extremely rare and under pressure from degradation, especially as a result of water loss (Grundling ***et al.*** 2021). The Mutale Peat Wetland is severely threatened by habitat transformation including silviculture, alien invasive infestation, aided by land transformation, and infrastructure (Figure 3 & Figure 8). The road crossing the wetland has led to a channel forming causing the lower section of the wetland to become incised. The building of roads in the area has potentially major effects on run-off leading to erosion and downstream siltation, including of Lake Fundudzi. Plantation establishment has huge ramifications for water loss in such wetland systems as, unlike grasslands, they do not function as well to hold water in times of flood, leading to major fluctuations in river inundation, greater erosion and the river becoming incised (Figure 9). The planting of alien monocultures has had a huge impact on the consumption of ground water leading to a significant reduction in the flow of the Soutpansberg rivers (Hahn 2017, Ramulifho 2020).

Conclusion

For the period 2021–2050 relative to 1961–1990, the maximum temperature increases may exceed 3 °C in the northern interior of South Africa and up to 7 °C for the 2070–2099 period (Engelbrecht 2019). The incidence of heatwaves will also drastically increase, while rainfall may increase over eastern South Africa.

The Mutale Peat Wetland is totally dependent on rainfall to maintain itself as it is not fed by any rivers. Future temperature increases will place the existing plantations under greater heat stress leading to increased water consumption alongside an upsurge in evaporation. In all likelihood, water consumption and evaporation will exceed any increases in precipitation, leading to the demise of the wetland.

To possibly preserve the Mutale Peat Wetland a drastic reduction in the extent of pine plantations surrounding it is needed. A comprehensive study of the wetland to understand its functioning would be invaluable for the management of it, and for similar systems.

Acknowledgments

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OPINION

Mine drainage and rehabilitation: some comments

Handré Brand provides an overview of the environmental challenges experienced by mining in South Africa.

"Our forebears deferred the environmental costs associated with mining, and we now have to pay those costs. Are we going to do the same to future generations? If we do, their problems are likely to be far more severe than ours because the effects are cumulative and in the future, once mining is on the wane, the funds to address the problem might not be readily available." (McCarthy 2011:1)

Water with increased acid content as well as acid-neutral metal-rich water from obsolete metal mines is often a source of pollution for rivers (Nordstrom 2011). The former contain metals such as iron, copper, and aluminum, while the latter may contain arsenic, antimony, and uranium, among others.

The contamination of both surface and groundwater can result from poor or faulty water drainage systems (adits) in well-mapped mines. In many cases, however, it also stems from mines that have long been closed and for which there is little if any historical data.

In the UK, Todd and colleagues (2024) from the Department of Geography at the University of Swansea, undertook a long-term study of the changes in water quality of three Welsh metal mines. All three mines – Nantymwyn, Paris Mountain and Frongoch – have been abandoned and/or closed since the early twentieth century.

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Using available data from blind samples (spot/grab sampling)-(Dixon u.d.) provided by environmental regulators, the researchers found that metals were constantly leaching or seeping to riverbeds, and that the metal concentrations of the mine water decreased little if at all. This figure out occurs at mines where no mine-water remediation has been applied, and continues despite time lapse and/or weathering.

At the Nantymwyn mine, comparisons between five monthly samples in 2019 showed no significant changes ($p > 0.05$) in metal concentrations compared to the same period in 1985. At Paris Mountain, there was a 2% increase in filtered zinc concentrations from 2004 to 2020. The environmental impact at Frongoch, in turn, diminished significantly after mine-water remediation commenced: For example, the total lead concentration dropped by 90%.

Water pollution from metal mines therefore does not necessarily spontaneously decrease in the decades following their closure. This observation should be a wake-up call for industry and relevant government departments to give priority attention to mine assessment and rehabilitation.

Similar international examples at the sites of mine management, mine drainage, groundwater contamination, and mine water rehabilitation are the Cadia gold mine in Orange, Australia (Hambrett 2024), Berkeley Pit, United States (PitWatch 2024), and the Ranger uranium mine in Australia (Johnston and Needham 2002). Hattingh (2024) mentions that in South Africa the surrounding water supplies and land were negatively impacted for decades or even centuries by the active discharge, seepage, run-off, and dust emissions from abandoned or inadequately repaired mines.

Local state of affairs

South Africa's mineral wealth developed over a geological period of approximately 3.7 billion years (Wassenaar 2011). A total of 80% of the world's manganese reserves, 73% of the chromium reserves, 88% of the platinum reserves and 45% of gold reserves are found here. The national economy is therefore closely intertwined with the exploitation of mineral resources. However, the groundwater level and unweathered rock bottom were not penetrated through mining activities until the 1860s. Mineral ore in its original form is non-renewable, and thus many of the current mining practices in mining are putting the industry's reputation at serious risk.

According to Wassenaar (2011), a researcher at the Unit for Conservation Ecology of the University of Pretoria, the chemical and radiological pollution of water at the coal mines on the Highveld is a good example of the interactive nature of mining and natural systems and consequently points to the complexity of environmental management in a modern mine. Pyrite comes into contact with oxygen-rich water, which gives rise to acidified surface and groundwater, and has catastrophic consequences for the ecology further downstream. Large parts of the Olifants River and dams at Witbank and Middelburg are affected. Many of the mines have long been closed, limiting the possibility of rehabilitation.

McCarthy (2011) from the School of Geosciences at the University of the Witwatersrand points out that the fragmentation of rock masses during mining and mineral extraction dramatically increases the surface area and thus the rate of acid production. Certain host rocks, especially those containing large amounts of calcite or dolomite, possess the ability to neutralise the acid. However, this is not the case for coal

Surface and groundwater pollution from mines is a thorny issue in South Africa. In particular, the gold mines on the West and East Rand and the coal mines in Mpumalanga are significant polluters.

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and gold deposits: Here the natural neutralisation processes are overwhelmed, and mining operations release large quantities of acid water into the environment – initially into groundwater, and eventually into streams and rivers. The acidic water increases the solubility of any aluminium and heavy metals that may be present in the affected area. The overall result is that the water is polluted to varying degrees. Finally, the water is neutralised by a combination of dilution and reaction with river sediment or various soil minerals. Nevertheless, certain ingredients (including sulfates) are extremely soluble and continue to exist in the water.

Not all of South Africa's mineral deposits are associated with acid production: Diamond, iron, manganese, chromium and vanadium mines, for example, do not create acid wastes, and most platinum mines apparently do not have this problem either.

Surprisingly, in certain circumstances, polluted mine water can be used to irrigate crops. Scientific tests show that in the short term, water with high concentrations of calcium or magnesium sulfate has minimal effects on crop health and the environment (Wassenaar 2011). Annandale and colleagues (2002) investigated the sustainability of crop irrigation with gypsum-containing mine water. Gypsum is a soluble source of calcium and sulphur (in sulphate form) which can be used as a plant nutrient source. In the researchers' multidisciplinary study, different irrigation methods were used, and crop response to the gypsum water as well as its impact on soil and groundwater were examined. Field trials were conducted at two mines – Landau and Kleinkopje coal mines in Mpumalanga. A wide variety of crops were irrigated with gypsum water, and could be successfully harvested for commercial purposes. Chemical analyses of water quality in the soil placed under irrigation showed no significant soil water contamination over a three-year period.

Cole, Chimbganda, Esau, Abrams and Broadhurst (2024) developed a mine closure framework for South Africa. The main goal of this project was to create national maps and classifications of local mine closure risks and opportunities. This information is intended to guide and support mine closure planning and policy in the country (for more information, see the May/June 2024 edition of the Water Wheel)..

Policy matters

The overall objective of the Department of Water and Sanitation's (DWS') Mine Water Management Policy (DWS, 2022:4) is to provide guidelines for a coherently integrated approach to mine-water management by government, the private sector and civil society. This occurs by building on existing legislation, addressing glaring gaps, constraints and shortcomings, and by utilising existing mine and acid water management solutions and strategies as best as possible.

The Mine Water Management Policy is guided by, and is based on, existing initiatives to support mine water management, such as the full implementation of the National Water Amendment Act 27 of 2014 and the National Environmental Management Laws Amendment Act 25 of 2014. Therefore, the comprehensive policy supports a number of principles enshrined in existing legislation.

These include cancelling the mining rights, permits or prospecting rights of mining companies that cause unacceptable pollution of water resources (DWS 2022:21), and an insistence on proper infrastructure transfer after mine closures to ensure sustainable management (DWS 2022:26–27). The policy states that the 'polluter pay' principle will be applied to mine-water in all forms in the context of national environmental management principles, and that this approach to retroactive accountability will be applied in conjunction with international norms and definitions to cater for multinational mining companies (DWS 2022:27–28). In addition, the policy aims to protect and empower poor and vulnerable communities throughout the entire mining value chain, which includes the mine water management cycle (DWS 2022:29).

Both the Water Institute of Southern Africa (Division of Mine Water) (WISA u.d.) and the Water Research Commission (Division of Water and Wastewater Management) (2018) encourage practical and academic collaboration between the community, state and private sector to promote proactive mine water management and rehabilitation (Van der Merwe 2024). The South African Chamber of Mines (2007) emphasises that the quality of surface and ground water flowing from mining sites must continuously – in other words during production, after mine closure and in the future thereafter – meet the following criteria:

- Surface water drainage systems and surface water quality

The operation of surface water drainage systems should be monitored annually, preferably after the first major rains of the season, and again after any major storms. This will ensure that mine drainage goes according to plan and that drainage structures that are not working properly are repaired well in advance before they break and cause significant erosion damage. The quality of the water leaving the premises (as well as water anywhere else on the premises, as specified by the DWS) must be monitored regularly. Water samples should be analyzed for particle and soluble contaminants and biological contamination (SA Chamber of Mines 2007:51).

Mines can pollute the environment decades after closure if appropriate rehabilitation measures are not taken.

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- Groundwater quality

The quality of groundwater should also be measured at certain designated locations. A hydrogeologist should determine the location of the monitoring points in conjunction with the regulatory authority. Monitoring points should be located (hydrologically) downhill from the rehabilitated area. The regulator determines the regularity of monitoring, although monthly monitoring is usually required in the first year or two after the installation of the monitoring wells. After that, monitoring can be reduced to once a quarter or, in extraordinary circumstances, even once a year, provided that monitoring results over time indicate little or no change (SA Chamber of Mines 2007:51).

Some research studies

In 2018, the Centre for Environmental Rights analysed eleven listed mining companies' feedback on their financial provision for environmental rehabilitation (in other words, their budget allocation for the redress of environmental damage arising from their operations).

The purpose of corporate disclosure legislation and accounting standards is, among other things, to ensure transparency and accountability in companies' financial provision for environmental rehabilitation. These include budgets for and the cost of environmental rehabilitation. Nevertheless, the information provided by the mining companies involved in the Centre for Environmental Rights' survey was inconsistent, unclear and in some cases unreliable, and also not mutually comparable (Centre for Environmental Rights 2018:2). Thus, it seems an impossible task for shareholders or taxpayers to hold companies or regulators to account.

Regarding this, Almano (2022) from the University of Cape Town says the following:

"So, while legislation places a duty on companies to ensure they prevent damage to the environment where possible, it is not difficult to see that policy and legislation have failed to provide a regulatory framework which adequately and effectively scaffolds the closure and rehabilitation of mines in South Africa. Rehabilitation rarely seems to occur. This is evidenced by a reported 6000 abandoned mines across South Africa. These issues are furthered by the Department of Mineral Resources ("DMR") and its poor compliance, enforcement, and monitoring of mining rehabilitation".

In the same vein, Tempelhoff highlights the profound environmental implications of the occurrence of acid mine water at Tweelopiespruit on the West Rand. According to Du Rand (2016), affiliated with the Department of Zoology at the University of Johannesburg, macroinvertebrate aquatic mammal species are largely absent in the Tweelopie and Rietspruit, whose pH has ranged from 2,4 to 4,6 since 2011.

Surface and groundwater pollution from mines is a thorny issue in South Africa. In particular, the gold mines on the West and East Rand and the coal mines in Mpumalanga are significant polluters. Other sources are the vanadium mines, which release extremely toxic vanadium pentoxide into soil and surface water. For example, Lötter (2024) points out that significant numbers of deaths among large bird species such as Egyptian geese (***Alopochen aegyptiaca***) were found at a dam on the Steelpoort vanadium mine. The source of pollution was tracked using geophysics procedures to a burst pipe near the metallurgical plant on the mine.

A research group affiliated with the Central University of Technology (Belle e.a. 2021) argues that the gold mining tailings of mines in the Welkom and Virginia area of the Free State contain several contaminants. The extent of groundwater contamination in the area was studied by measuring several water quality indicators at eight sampling points that fall into three different zones. The overall groundwater contamination was quantified against a drinking water quality index. The finding was that most groundwater in the Welkom and Virginia area is unsuitable for drinking purposes. At only three test sites, the water samples were suitable for human consumption. Water quality was poor at 40% of test sites, and particularly poor at one site.

These results were substantiated by the high scores for all microbiological indicators. Fecal coliform bacteria counts exceeded both the limits of the World Health Organisation and the South African National Drinking Water Standards. At 50% of the measurement points, E. coli scores were also higher than the prescribed limit for drinking water. In terms of the appearance of harmful elements, lead and iron were present in toxic concentrations. Since groundwater is the main source of drinking water for the local residents of the Welkom and Virginia area, their health is therefore in serious danger.

Conclusions

International research on pollution from abandoned metal mines indicates an ongoing deterioration in water quality even decades after the closure of the mines. This highlights the urgent need for continuous mine assessment and innovative rehabilitation techniques. The information consulted highlighted the seriousness of water pollution from mines in South Africa, especially in regions with extensive mining activities such as the West and East Rand and Mpumalanga.

There are significant gaps to be found in the regulatory framework and its practical application. This is testimony to the occurrence of polluted soil and surface water around numerous abandoned mines, as well as discrepancies in mining companies' financial provision for environmental rehabilitation. Continued research is essential to form a better understanding of the complex interaction between mine drainage and the environment, and to develop new and innovative mitigation strategies. Regular scope surveys by independent institutions such as the Water Institute of Southern Africa and the Water Research Commission should be considered.

This contribution is by no means presented as a complete overview of the complex research site of mine drainage and rehabilitation. However, the hope is that it will help give renewed focus to South Africa's approach to this complex and significant environmental problem.

To view the references for this article, visit: https://wrcwebsite.azurewebsites.net/wp-content/uploads/mdocs/WW%20July-August%202024_Mine%20drainage%20bibliography.pdf

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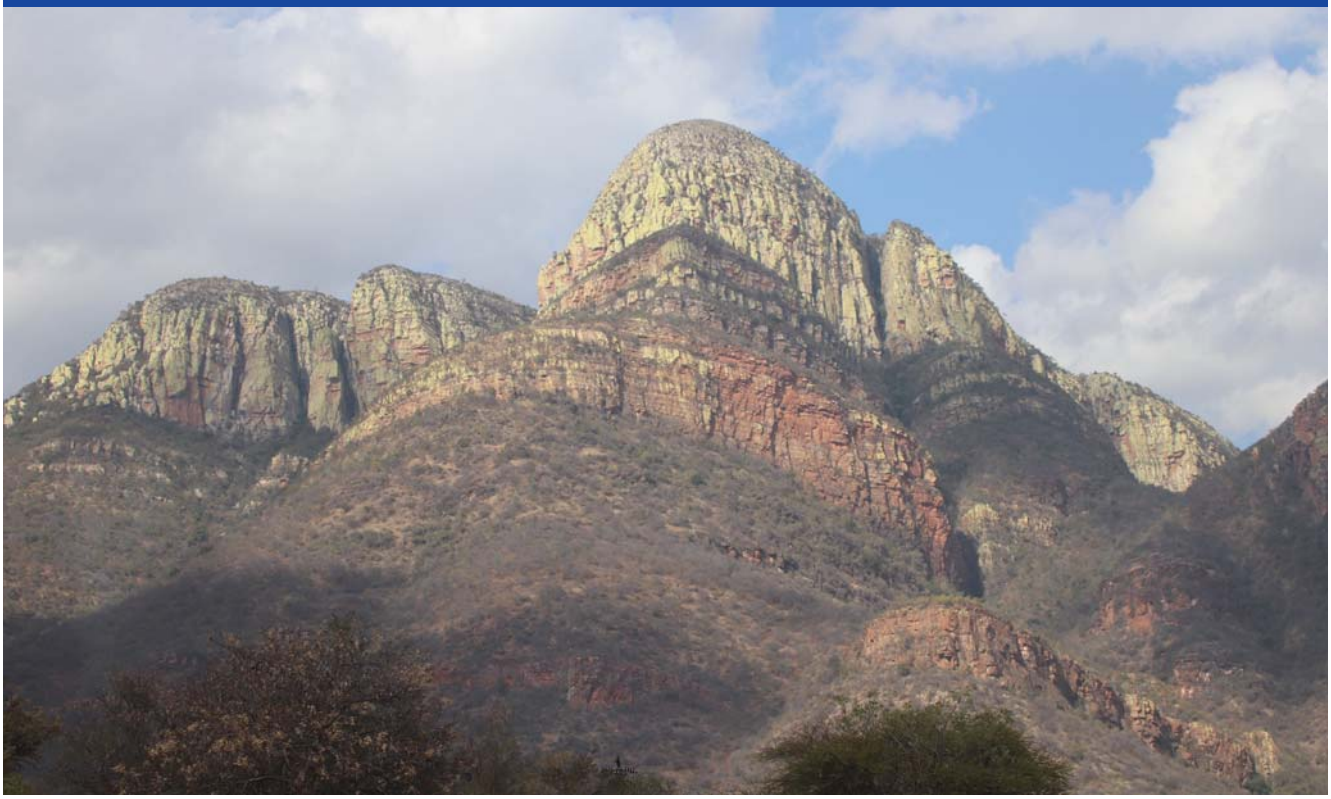
WATER AND THE ENVIRONMENT

New Drakensberg nature reserve will protect ancient rock art, wildlife, livelihoods, grasslands and water

South Africa's Drakensberg mountains have a new 6,500 hectare nature reserve. The new Northern Drakensberg Nature Reserve is working with communities and will preserve ancient rock art, vital grasslands and water resources for millions of people. It connects a neighbouring world heritage site to another nature reserve, expanding a huge transnational protected area from South Africa to neighbouring Lesotho. Caitlin Blaser Mapitsa reports.



Most importantly, it will open a new and important wildlife migration corridor. Migratory animal populations will be able to recover as they will no longer be isolated and fragmented.

It took six years for landowners and conservationists to get the new park formally declared, much faster than it usually takes to have land declared protected. It was only possible due to a high degree of consensus among landowners that a commitment to conservation was the best way to manage their land for future generations.

I research how land and ecological systems are governed across boundaries. I believe the new reserve takes forward a commitment made by South Africa at the COP15 biodiversity conference in 2022 that it would protect 30% of its land (including mountains) and oceans by 2030. So far, only 9.2% of South Africa's land is under protection, and biodiversity loss is increasing. This is why strategic additions to protected areas are particularly important.

Nearly 20% of water in the Vaal River system originates in

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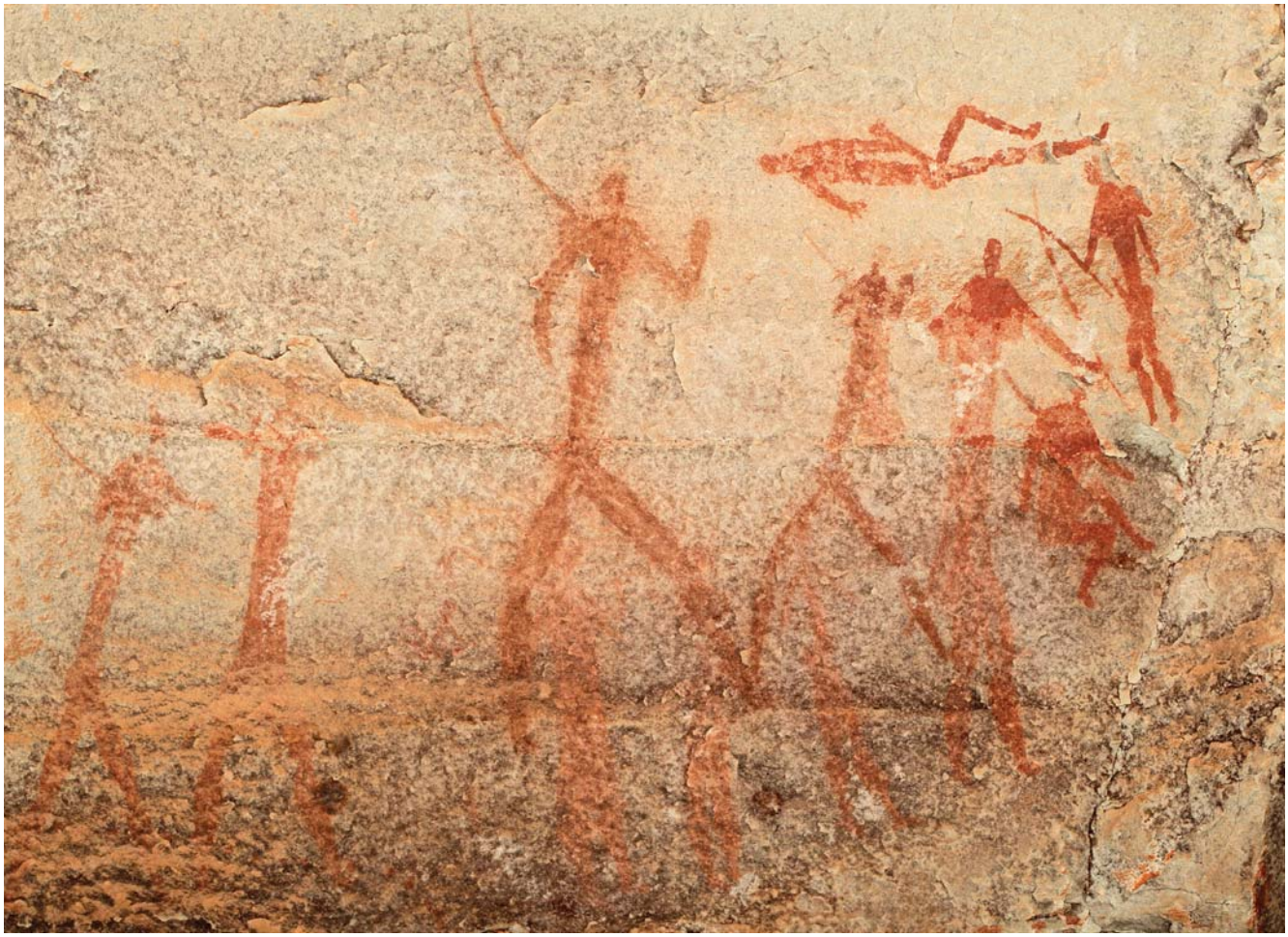

The area includes some of the best rock art in the world, with over 600 sites dating back as far as 3000 BC.

the Northern Drakensberg – in other words, the Northern Drakensberg supplies water for about four million people. The way water is managed at the source matters for everyone who will eventually use the water.

A remote and magical place

The greater Drakensberg protected areas include a broad mountainous region that stretches all along the eastern border between South Africa and Lesotho, from the northernmost tip near Phuthatditjhaba at the Golden Gate Highlands National Park, to the southern tip near Mount Fletcher. It also includes wetlands and grasslands and some of the best rock art in the world, with over 600 sites dating back as far as 3000 BC.

There are many historical sites that are yet to be explored by archaeologists such as iron smelters and places where tools have been discovered that date back more than 25 000 years. It's sparsely populated, with single farms often comprising more than 2 000 ha.

Much of the Northern Drakensberg is difficult to reach apart from on foot. It is full of dramatic rock formations, and home to wildlife such as endangered vulture colonies, herds of eland and other grassland animals that benefit from expanded migratory corridors. It is an attractive tourism destination for hikers, birders and people who are looking for wildness experiences.

Why has a new nature reserve been declared?

Firstly, it is an important high altitude water catchment area. It straddles the border of the Orange River basin – the largest water resource in South Africa – and the smaller catchments that flow into the Indian Ocean. Protecting water sources in the Drakensberg allows people to have potable water. Maintaining pristine water quality in this area is extremely important.

Secondly, grasslands cover the Drakensberg mountains, and serve many important functions, such as absorbing water during times of heavy rainfall and releasing it slowly throughout the year. Grasslands are also a carbon sink in ecosystems. Only 2% of grasslands are under formal protection in South Africa.

The grasslands in the new nature reserve include some of the country's most endangered vegetation types, such as the Income Sandy Grassland and the Mabela Sandy Grassland. Nearly half of South Africa's endemic mammals are found in grasslands. Four are endemic to this landscape alone: the black wildebeest, rough-haired golden mole, Natal red rock rabbit, and Slogget's rat. The area is also home to a large number of endangered birds that are found nowhere else.

The reserve takes a new approach to conservation, by integrating environmental protection with ongoing economic activities. It works with communities, instead of excluding them from the protected area. The hope is that the new park will increase

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The grasslands of the northern Drakensberg are the habitat of numerous birds, animals and plants, many endemic and/or scarce.

economic activities locally, such as agriculture, tourism and natural resource beneficiation, such as using reeds and grasses to make mats and baskets.

The creation of the new reserve was driven by dedicated, conservation-minded landowners, who shared a vision of conservation and economic development. They witnessed corporations taking over farms and commercialising them with forestry. Most residents in the area were committed to finding a model for more sustainable development.

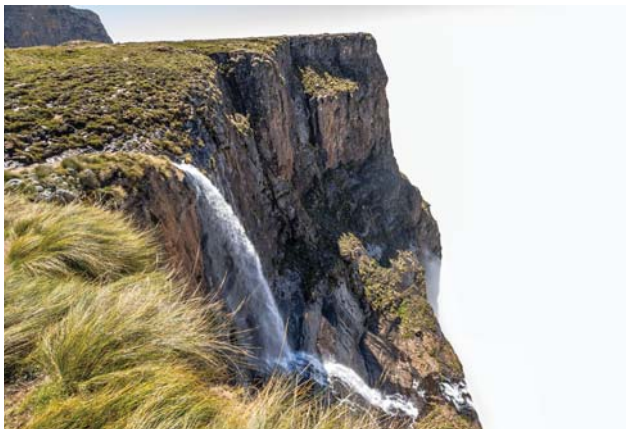
A final consideration is that the Northern Drakensberg Nature Reserve connects the Maluti Drakensberg Transfrontier Conservation Area to southern grazing lands. Soon, conservationists hope, there will be a continuous protected area across the Drakensberg.

Why it matters

South Africa has so many unique ecological resources that need different kinds of involvement and protection, whether it is urban green spaces, individual critically endangered species that benefit from citizen science and awareness raising, or the governance of our just energy transition.

The new Northern Drakensberg Nature Reserve is a small but important step forward. Land owners, local government and civil society have come together take positive steps towards better land governance.

- This article was first published on The Conversation, https://theconversation.com/africa



The northern Drakensberg is a strategic water source area.

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THE WATER WHEEL

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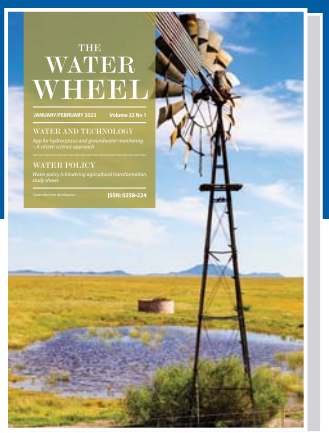

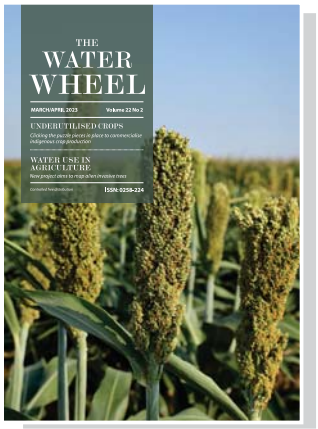

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