

THE WATER WHEEL

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RECREATION AND WATER

Keeping our swimmers safe – SA study investigates water quality of public pools

HYDROPOWER

Turning the tide on cleaner energy, one community at a time

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A study lead by North-West University and funded by the Water Research Commission has investigated the potential health impacts of chemicals in public recreational waters. See article on page 12.

FLUID THOUGHTS

Vaal intervention – Mission critical



WRC CEO, Dhesigen Naidoo

The Vaal water system is not only the lifeblood of Gauteng, it is one of the most strategic water assets in the country, on this African continent and a water management area of global significance. The water security it provides daily to 19 million people, more than a third of South Africa's *de facto* population almost masks the fact that it provides water security to power and sustain this 1.4% of South Africa's land area that generates close to 34% of its GDP and 10% of that of all of Africa. It is also the recipient of one of the world's biggest transfer schemes, from the highlands of neighbouring Lesotho.

And yet, since the start of mining on the Witwatersrand, this river system has been taken for granted, is substantively overworked, and generally underinvested in post-Lesotho, with respect to infrastructure and very little investment on operations and maintenance. She has been abused. The knock-on effects of that abuse have played itself out in the obvious narrative. The water system can no longer cope. The perennial high demands, low maintenance and refurbishment, years of drought, frequent electricity outages have pushed this system beyond its resilience. And the cracks are widening. The last straw was the report by the South African Human Rights Commission of their investigation into the Vaal Water System. Their findings that the Vaal was "polluted beyond acceptable levels" with impacts on both the environment as well as people's health made national headlines. The further indictment that there were violations of constitutional rights, in particular, the right to human dignity and an environment that is not harmful to health and well being.

In the midst of this water crisis, we continue to see the worsening economic vortex spiralling down in the wake of COVID-19. The StatsSA Quarterly Labour Force Survey for the first quarter of 2021 makes for dismal reading. The official unemployment number now stands at 32.6%. The figures for the youth category are much higher, at an alarming 46.3%. The opportunity cost to the economy of having a potentially productive workforce forced into an idle mode is bad enough, and when you consider the future costs of an unemployed youth and the conversion of a potential demographic dividend into a demographic burden creates negative vistas of tragic proportions.

South Africa in 1976 had a similar picture with a different set of precipitants. Apartheid era Prime Minister, John Vorster, was in a comfortable space. The international outcry following the

Sharpeville massacre had long passed, even the international interest over the historical Rivonia Trial, which he presided over in his capacity as Minister of Justice, had transitioned into an era of engagements with newly independent African states, and a new Cold War relationship with Washington. The struggle against Apartheid was at one of its lower ebbs. Enter the Youth of June 1976, in a sweeping political innovation, these brave young people led a protest action that shocked the world with new revelations of the reality of the plight of black people living under Apartheid. It revealed to the global community the sheer brutality of the Apartheid Security machinery in crushing basic human rights, where even children were not spared. This was a crucial point in the Struggle and greatly energised the international Anti-Apartheid movement that eventually saw the demise of this political system that was declared a crime against humanity.

In that same spirit and in response to the various reports and outcries for action in the Vaal system, Minister of Human Settlements, Water and Sanitation, Lindiwe Sisulu, obtained Cabinet approval for a section 63 (Water Services Act) intervention in the Vaal system and specifically the Emfuleni municipality. The critical political innovation here is both the spirit and strategy of the intervention. In contrast with a national takeover of a provincial or local function as we have seen in other examples, this is one of partnership for which Emfuleni Mayor, Gift Moerane, expressed both gratitude and support. The R8 billion intervention covers the refurbishment of the water services infrastructure, a full-scale revival of the Leeukuil and Sedibeng wastewater treatment plants championed by the Department of Water and Sanitation, and an operation and maintenance component managed by Rand Water.

There are three features in the plan that are particularly attractive. The first is that it is a comprehensive plan as opposed to crisis management, with a firm view on long-term sustainability. The second is that the strategic rollout is paying particular attention to building capacity and capability to deliberately expand and diversify the water and sanitation team with a strong emphasis on local capability to make the new water management system sustainable beyond the intervention. Already the participation of women and youth are high on the agenda, and is already visible in the first set of contractors that have been appointed. The third is to take advantage of the best appropriate knowledge and innovations, flowing from the South African science community

via the Water Research Commission, so that we have genuine 21st century solutions in this strategic water area.

It is only the beginning and the critique of great plans not being realised in implementation is appreciated, but, in this Youth

Month 2021 we have a real opportunity to catalyse a change of water fortunes through this Vaal intervention. One that will be formative for water security, a step closer to the realisation of human rights and a point of inspiration.



The Vaal River is known as South Africa's hardest working river, supporting a population of 19 million people.

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50 Years WATER RESEARCH COMMISSION

NEWS

Sector mourns the loss of pioneer professor



The South African water sector mourns the loss of a beloved pioneer in the wastewater and sanitation space.

Prof Chris Buckley, co-Director of the Water, Sanitation & Hygiene Research & Development (WASH R&D) Centre, at the University of KwaZulu-Natal, passed away peacefully at home on 27 May from cancer at the age of 72.

“Chris was a well-known, iconic figure in the international water and sanitation field, and touched the lives of so many, both personally and professionally. He was one of those unique people that always managed to inspire everyone

with his astonishing general knowledge, and deep understanding of science and engineering,” said the WASH R&D Centre in a tribute. “Chris’s compassion, patience and dedication to students and young researchers resulted in the completion of over 100 Master’s and PhD graduates, the majority of whom are now well-established professionals in the water and sanitation sector. Each one of them carries a piece of Chris’s passion, determination to solve problems, and his love for life and learning. His charismatic personality, radiant smile and mischievous sense of humour will forever be remembered.”

Prof Buckley’s career in the water and sanitation field began in the 1970s as a post-graduate student in Chemical Engineering at the then University of Natal. He joined the Pollution Research Group (PRG) in 1972 – a small group of three or four people that had been formed in 1971. He took over the leadership of the PRG in 1985 and was appointed as the full-time head in 1987. Under his guidance, the PRG has delivered groundbreaking research in the water and sanitation field, and expanded its research scope beyond chemical engineering, to become a trans-disciplinary contract

research hub with local, national and international recognition for its work.

Over the span of his 50-year research career, Chris secured significant funding grants from organisations such as the Water Research Commission, the eThekweni Municipality and the Bill & Melinda Gates Foundation, as well as many other public and private organisations. His commitment to producing high quality research outputs, and his ability to adapt to the changing research landscape, has ensured that these funding relationships have endured under his leadership. In order to reflect the growing range of research undertaken by the group, the PRG was rebranded and relaunched as the Water, Sanitation & Hygiene Research & Development Centre in December 2020.

Prof Buckley was the recipient of the WRC’s first ever Legend Award early in 2021. He leaves behind his wife Ann, his daughter Pippa, his son Tim, his son-in-law Tim, daughter-in-law Stephanie and five granddaughters.

Minister Sisulu calls on engineers to contribute to SA’s development agenda

The Minister of Human Settlements, Water and Sanitation, Lindiwe Sisulu, has called on engineers to patriotically contribute to the development agenda of the country.

Sisulu made this call while delivering a virtual keynote address at a breakfast seminar hosted by the National Society of Black Engineers (NSBE). She was addressing members of the NSBE on the role of local engineers in the execution of the National Water & Sanitation Master

Plan.

“Today’s global challenges, such as climate change and the COVID-19 pandemic, require engineering minds that would offer ground-breaking solutions aimed at accelerating economic recovery,” she said.

Minister Sisulu added that the country needs engineers that will take a lead in realising “our vision of new human settlements that provide housing and

comfort to our people, engineers that will help change the spatial orientation of apartheid cities and towns.”

Addressing the issue of shoddy workmanship Minister Sisulu implored members of the NSBE to shy away from corruption, not sign off poorly constructed infrastructure projects and not bow to pressure to compromise technically sound decisions.

New guide on how to manage invasive alien plants



Landowners are required by law to take the necessary steps to control and eradicate invasive alien plants, but this is often more easily said than done – which is one of the reasons why WWF and its partners have published a new guide on the subject.

Available for free download in English and Afrikaans, ***A practical guide to managing invasive alien plants: A concise handbook for land users in the Cape Floral Region***, will be of value to landowners, land managers and clearing contractors, providing context, examples, and practical guidelines.

The Cape Floral Region is a renowned biodiversity hotspot and the world's smallest plant kingdom with the highest species variety. Yet, large parts of this special landscape are heavily infested with fast-spreading and thirsty exotic plants and trees. Most species of invasive alien plants found in South Africa come from Australia and South America. Without their naturally occurring pests, whether insects, fungi, or diseases, they grow undeterred and multiply rapidly.

The Madeira vine from South America, for example, smothers indigenous trees like the protected milkwoods while Port

Jackson, pine, wattle, and gum trees use far more water than indigenous vegetation. These 'alien' species also crowd out local species and compete for water and nutrients. And, as we've witnessed with the Cape Town fires recently, some cause wildfires to burn more intensely and spread more easily, putting people and property at risk.

Critically, though, the mountainous regions of the Cape Floral Kingdom are also important water-supplying areas generating freshwater for millions of urban dwellers, food-producing farms and other industries and communities.

Ruth Beukman, Freshwater and Policy Lead with WWF South Africa, comments: "With the invasion of water-intensive exotic plants being one of the top threats to the health of our critical water source areas and thus our water security, it is imperative that we all play a part in managing this threat. To this end, it is important that we work in partnership to enable and empower land users, landowners, local communities, and private companies to take ownership of, and action in, addressing this risk to the health of their land, the ecosystems, water supply, their property, and livelihoods."

The guide was a collaborative effort, put together with the help of subject experts in government, the City of Cape Town, private businesses, and other NGOs. It is a practical nine-chapter manual with colour-coded sections for easy reference. The numerous authors are experts in the field and have many years of combined experience in dealing with alien plants within their respective professions.

The information is based on the latest policies and legal requirements and consists of guiding principles of best practice methods to empower land users to develop a management plan to control these landscape-damaging alien plants. It also includes a section on how to successfully rehabilitate land that has been cleared.

To download the English guide, Visit: https://wwfafrica.awsassets.panda.org/downloads/a_practical_guide_to_managing_invasive_alien_plants_web.pdf and for the Afrikaans, Visit: https://wwfafrica.awsassets.panda.org/downloads/afrikaans_managing_invasive_alien_plants_web.pdf

GLOBAL

More than half of the world's rivers run dry now and then



Researchers have found in a new study that between 51% and 60% of the 64 million kilometres of rivers and streams on Earth that they studied periodically stop flowing, or run dry for part of the year.

The study is the first-ever empirically grounded effort to quantify the global distribution of non-perennial rivers and streams. The research, which appears in *the journal Nature*, calls for a paradigm shift in river science and management by revising foundational concepts which traditionally assumed year-round water flow in rivers and streams.

The map of non-perennial rivers resulting from the study, the first of its kind, also provides crucial baseline information for the assessment of future changes in river flow intermittence and for

determining and monitoring the role of these rivers and streams in global water and biochemical cycles, as well as in supporting biological diversity.

"Non-perennial rivers and streams are very valuable ecosystems as they are home to many distinct species that are adapted to cycles of water presence and absence," says first author Mathis Messenger, a PhD student both in geography at McGill University and at the French National Research Institute for Agriculture, Food, and Environment (INRAE).

"These rivers can provide critical water and food sources for people and they play an important role in controlling water quality. But more often than not they are mismanaged or altogether excluded from management actions and conservation laws as they are simply overlooked."

To identify the most important environmental characteristics in determining whether a river periodically ceases to flow, the researchers statistically associated long-term records of water flow in 5 615 locations around the world with information on the hydrology, climate, geology, and surrounding land

cover of the rivers and streams monitored at these locations. They found, as expected, that non-perennial rivers are most common in arid places (where there is much more evaporation than rainfall) and that smaller rivers and streams have generally more variable flow and are thus more likely to dry up. But they also occur in tropical climates and even in the Arctic where rivers freeze up for parts of the year.

The study also suggests, based on preliminary estimates, that more than half of the world's population lives in locations where the closest river or stream around them is non-perennial. Indeed, in many languages, multiple words exist to designate these types of watercourses and their mark on the landscape, highlighting the long history of inter-dependence between humans and seasonal freshwater systems.

To access the original article, Visit: <https://www.nature.com/articles/s41586-021-03565-5>

Satellite-based monitoring to reduce impact of natural disasters

A consortium of Inmarsat, the world leader in global, mobile satellite communications with SINTEF, one of Europe's largest independent research organisations, and fellow Norwegian company, Geonor, has been awarded a three-year contract with the European Space Agency (ESA) to develop a natural disaster early warning system.

Using Inmarsat's global L-band satellite network the consortium will develop a new government grade Internet-of-Things solution that can provide early

warnings in the event of a natural disaster, even in the most remote locations. This new technology has two important advantages over existing solutions: global coverage and security, thus making it suitable for government applications. "The objective is to demonstrate the use of a secure solution that will support civil government users to help reduce risks from geohazards, such as landslides, rock fall, avalanches, debris flow and floods," noted senior SINTEF researcher, Ivan Depina.

The solution is supported by ESA as part of the 'Space Systems for Safety and Security (4S)' programme, which is a new component of ESA's advanced research in telecommunications systems. The programme aims to transform research and development initiatives to successful commercial products and services.

The project is also supported by the Department of Energy and Water and the UK Space Agency and Norwegian Space Agency.

Re-thinking single-use plastics in the tourism sector



The World Travel & Tourism Council (WTTC) and the United Nations Environment Programme (UNEP) launched a new report in June addressing the complex issue of single-use plastic products within the travel and tourism sector.

The publication, *Rethinking Single-Use Plastic Products in Travel & Tourism*, launched as countries around the world begin to reopen, and the travel and tourism sector starts to show signs of recovery from the COVID-19 pandemic which has been devastating. The report is a first step to mapping single-use plastic products across the travel and tourism value chain, identifying hotspots for environmental leakages, and providing practical and strategic recommendations for businesses and policymakers.

It is intended to help stakeholders take collective steps towards coordinated actions and policies that drive a shift towards reduce and reuse models, in line with circularity principles, as well as

current and future waste infrastructures. The report's recommendations include redefining unnecessary single-use plastic products in the context of one's own business; giving contractual preference to suppliers of reusable products; proactively planning procedures that avoid a return to single-use plastic products in the event of disease outbreaks; supporting research and innovation in product design and service models that decrease the use of plastic items, and revising policies and quality standards with waste reduction, and circularity in mind.

Single-use plastic products can be a threat to the environment and human health and without deliberate effort across the sector, travel and tourism can and will contribute significantly to the issue. The COVID-19 pandemic has had both negative and positive impacts on single-use plastics pollution.

The demand for single-use plastics items has increased with safety being a high concern among tourists and take-away

services being on the rise. According to the Thailand Environment Institute, plastic waste has increased from 1 500 tons to a staggering 6 300 tons per day, owing to soaring home deliveries of food. However, the pandemic has also catalysed consumer demand for green tourism experiences around the world, with a 2019 global study finding 82% of respondents are aware of plastic waste and are already taking practical actions to tackle pollution.

The report recognises that global solutions are required to address corporate concerns about the use of single-use plastic products. It aims to support informed decision-making based on the potential impacts of trade-offs and of unintended burden shifting when considering the transition to sustainable alternatives.

To access the report, Visit: <https://wedocs.unep.org/bitstream/handle/20.500.11822/36324/RSUP.pdf>

SURVEY POINTS TO LACK OF REGULATION IN PLUMBING SECTOR

Do municipalities have the capacity to adequately control plumbing work conducted in their areas? This is the question asked by the Institute of Plumbing South Africa (IOPSA) in recently published research.



IOPSA is a non-profit organisation which represents the interests of approximately 1 000 companies active in the plumbing industry in South Africa. Around 80% of its members are plumbing companies and 75% of those are small, medium and micro enterprises.

The organisation embarked on a research programme in 2018 to gain better insights into the sector. In March the institute, with the assistance of the Plumbing Industry Registration Board, undertook a local authority survey. The aim of the survey was to obtain relevant information on the local municipalities and the knowledge and service of the building control officers and the water inspectors as well as the plumber's knowledge and access to the municipalities' bylaws.

The survey, which was distributed electronically, received 330 responses. Most respondents are located in Gauteng (145 responses), followed by the Western Cape (62) and the Eastern Cape (47).

In response to a question regarding municipal bylaws, the majority of respondents (72%) indicated that their local municipality does have water bylaws. Surprisingly, almost a quarter of respondents (24%) did not know if their municipality had water bylaws or not. Further, only 45% of respondents who advised that their local municipality had water bylaws actually had a copy of the bylaws, with the majority responding that they did not have a copy.

In response to a question regarding municipalities' capacity to control plumbers, over 65% of respondents indicated that they did not feel that their local municipality has the capacity to

control all the plumbers in their area. Almost half (43%) did not know whether their municipality had water inspectors.

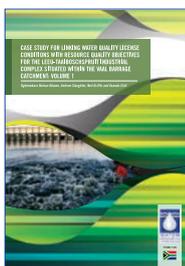
With regards to the registration of plumbers by local authorities, more than half of respondents (52%) indicated that their local municipality does not keep a register of plumbers. A further 20% indicated that they didn't know while 28% of respondents indicated that their municipality does register plumbers. Of the latter only 35% are registered with their local municipality.

"The survey results clearly demonstrate that there is little or no control of plumbers or plumbing work within municipalities," reported IOPSA in the final survey report. "Previous surveys and research conducted by IOPSA have revealed that the single biggest concern for most qualified plumbers is the impact of unqualified individuals on their businesses."

Research has also shown that of the estimated 125 000 people who identify themselves as plumbers, only around 15 000 to 18 000 of them are actually qualified. The apparent lack of enforcement within municipalities is likely a significant factor in this state of affairs.

The National Building Regulations stipulate that only qualified plumbers may conduct plumbing work, and places the responsibility on local authorities to enforce this. South Africa is a water scarce country and it is expected that by 2030 demand will significantly exceed supply. Plumbers play a crucial role in water management and ensuring that only suitably qualified individuals are allowed to work on water systems may prove critical for the future of South Africa, IOPSA concluded.

NEW WRC REPORTS

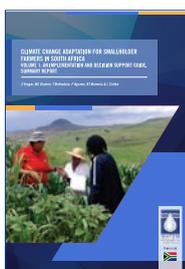


Case study for linking water quality license conditions with resource quality objectives for the Leeutaiboschspruit Industrial Complex situated within the Vaal Barrage Catchment

In South Africa, the resource-directed measures and the source-directed controls are the two complementary strategies designed to ensure that water resources are used and protected. To be able to use

the two complementary strategies effectively, it is important that the link between them is clarified. This study was thus aimed at developing a decision support system (DSS) for clearly linking water quality standards in water use licensing conditions to gazetted resource quality objectives, and/or site-specific conditions in the Vaal Barrage catchment, taking into account a range of complex interacting factors, such as all components of flow (flow regime, timing, pattern, frequency and magnitude), land use types, upstream waste loads, and diffuse and point effluent emitters. To realise the very essence of the project, the DSS developed in this way must be scientifically credible, defensible and transparent – based on scientific assumptions, observed and modelled data, confidence and limitations; and the process of its development must involve multiple stakeholders, including the regulator (the Department of Water and Sanitation) and resource users within the Vaal Barrage catchment.

Report no. TT 838/1/20 (Volume 1) and TT 838/2/20 (Volume 2)



Climate change adaptation for smallholder farmers in South Africa

Climate Smart Agriculture (CSA) promotes increases in productivity and adaptation to climate change that encompass socially and environmentally responsible agriculture. Numerous approaches, technologies and practices to support CSA are already available. CSA includes both traditional and innovative agricultural

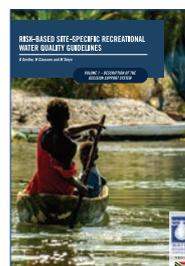
practices and technologies that promote agricultural productivity and generate income, while boosting resilience to climate change. The research objectives of this project were to, among others, evaluate and identify best practice options for CSA and Soil and Water Conservation (SWC) in smallholder farming systems in two bioclimatic regions in South Africa; amplify collaborative knowledge creation of CSA practices with smallholder farmers in South Africa; test and adapt existing CSA decision support systems (DSS) for the South African smallholder context; and evaluate the impact of CSA interventions identified through the DSS by piloting interventions in smallholder farmer systems, considering water productivity, social acceptability and farm-scale resilience.

Report no. TT 841/1/20 (summary report) and TT 841/2/20 to TT 841/9/20 (Support guide and farmer handouts)

Quantification, fate and hazard assessment of HIV-ARVs in water resources

South Africa still has one of the highest HIV incidence rates in the world, the largest treatment programme, and therefore the greatest consumption of antiretroviral drugs per capita, with prescribed amounts of up to several tons per year. The national rollout of antiretrovirals began in 2005, with the objective of one service point in each of the 53 districts of South Africa. Since then, it has improved the quality of life and the historical pattern of mortality in South Africa. However, there may be subtle, yet unquantified effects and processes that need to be better understood. These include environmental concentrations of the drugs, secondary human exposures, effects on aquatic life, and social considerations. These interactions are the subject of this Water Research Commission report. A major objective of this study was to standardise a method for sampling, extraction, and analysis of antiretroviral and antifungal compounds. It is already an achievement to identify these compounds in the environment at such low concentrations. However, these methods need to be accurate and trustworthy in order for universal standards and monitoring systems to be implemented in the future. This project includes the physical and chemical characteristics of the targeted compounds.

Report no. 2594/1/19 (Vol 1) and 2594/2/19 (Vol 2)



Risk-based site-specific freshwater recreational water quality guidelines

The South African Water Quality Guidelines of 1996 are one of the most widely-used tools in water quality management in South Africa. A Department of Water and Sanitation (then Department of Water Affairs) initiative looking at a needs assessment developed a general philosophy with general specifications

recommended for a decision support system for revised water quality guidelines for South Africa. The 1996 guidelines were based to some extent on a risk philosophy; the updated guidelines proposed follow a risk-based approach. While the scope of the guidelines remains applicable to any inland water used for recreational purposes, an important improvement of the revised guidelines is the site-specific and user-specific nature of the guidelines, allowing greater input and management of water use. In addition, they are available primarily in a software-based decision support system.

Report no. TT 831/1/20 (description of the DSS), TT 831/2/20 (technical support document)

To download any of these reports,
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RECREATION AND WATER

Keeping our swimmers safe – SA study investigates water quality of public pools

Everything's under control. It's cool in the pool. Certainly the municipal and holiday resort swimming pools many of us visit are refreshing, but are things quite as they ought to be, water quality-wise? Matthew Hattingh reports on a recently published Water Research Commission (WRC) study on the subject.



So, is the water quality in municipal swimming pools up to scratch? Yes and no, really. The accepted standards are, by-and-large, being met, according to a study commissioned by the WRC, titled, *Chemicals in Recreational Water: Occurrence and Potential Risk in Public Swimming Pools (WRC report no. 2804/1/20)*.

But the study questioned whether the standards themselves were fit for the task. It also suggested that bathers, particularly athletes who spend a lot of time in the pool, should become better informed about the effects of chronic exposure to chemicals. They should be encouraged to shower before as well as after entering the pool and discouraged from widdling in it.

Pool maintenance may need to up their game too. And the

study suggested backwash water, where flow has been reversed to flush a pool filter, should be watched more closely. The study's authors, ecotoxicologists, Prof Rialet Pieters and Dr Suranie Horn, of the North-West University's Unit for Environmental Sciences and Management, focused on the chemicals found in pool water.

They made the point that pool managers rightly work at meeting microbial parameters. But while keeping bacteria at bay and banishing protozoans – single-cell organisms that carry disease – the chemicals found in the same water may escape notice.

These chemicals have three origins:

- From municipal drinking water sources which by law must

- be used to fill public pools;
- Added to the pool as disinfectants, chiefly chlorine-based formulations and the byproducts of these; and
- Off the bodies of bathers (sunblock, cosmetics and other person grooming gunk), or excreted or shed from their persons (metabolised pharmaceuticals in urine, faecal matter and sweat).

All were examined, but it was this third main category that really interested the researchers. Pieters and Horn noted that although the health risks posed by personal care chemicals and cosmetics in general use have been well documented, rather less was known about what happens when these are mixed together with pool disinfectants and sunlight. And, more to the point, whether the watery chemical soup we leap into with hardly a care might be messing with our endocrine systems.

After all, some of the pharmaceuticals we take and lotions and potions we lather ourselves with are known to interfere with these systems. This includes the glands that secrete hormones and the receptors that detect and react to the hormones. At risk then, is the body's chemical messaging and regulating networks, which affect everything from our metabolisms and nervous systems to our tissue function.

"The biggest motivation for this study was to learn the endocrine disruptive effects of swimming pool water, because this is an effect not often considered in monitoring regimes. And the biggest contributor of endocrine disrupting effects by swimming pool water is likely to be pharmaceuticals and personal care products," the authors said. They noted that because of the broad and interwoven role hormones play in the body, disrupting their function can lead to cancer, heart and liver disease, reproductive disorders, learning and behavioural problems, and immune-related health problems.

Care for a dip, anyone?

Ok, so assuming we have made the leap into the water, how do those chemicals enter our bodies? The literature suggests that what with splashing about an adult, on average, swallows between one and two teaspoons of pool water and children may ingest up to five times this volume.

Chemical vapours are found near the surface of the water and bathers will inhale these, with the amounts varying depending on whether the pool is indoors or outdoors. Then, as we all know, the skin is the human body's largest organ, providing plenty of surface area for chemicals to creep in. The extent to which this happens depends on how long you are in the water, its temperature and the chemical compounds and concentrations concerned.

Now for a closer look at some of these chemicals

First up, the disinfectants. When chlorine is added to water it produces what are known as disinfectant byproducts (DBPs). According to 2015 research, at least 700 byproducts have been found in chlorinated water and many of these have been linked to cancer and genetic mutation.

One class of DBPs is trihalomethanes, which can be absorbed relatively easily by the body and stored in its fat, and have been known to cause cancer.

South Africa's drinking water standards (none exist for public pool water – more on this later) lists the maximum permissible levels for four trihalomethane compounds: chloroform, bromoform, dibromochloroform and bromodichloroform. The authors limited themselves to measuring levels of these, the most common DBPs, as well as "total trihalomethanes".

Metals were touched on in the study too. The drinking water standards lists a number of these and sets a level for each to avoid a wide variety of health risks that come with long-term exposure. Five are viewed as very toxic: cadmium, chromium, lead, mercury, and arsenic (not strictly a metal).

Pharmaceuticals and personal care products are commonly found in public pool water, but the researchers focused on those known to disrupt endocrine systems, noting that these, when combined with disinfectant byproducts, can create something more harmful than the products alone.

Parabens (a preservative) are found in sunscreens and other personal care products. Parabens have been found to affect levels of oestrogen, the hormone responsible for the development and regulation of the female reproductive system. Then there are phthalates. Used in beauty products, deodorants, lotions and, for example, to stop nail varnish from going hard, it is a testosterone receptor blocker and has also been shown



Photograph supplied

Children are at greater risk than adults to exposure from chemicals found in pools.

to have a role in the development of obesity and blood-sugar disorders.

Other hormone disruptors washing off bathers and into the pool's chemical soup include synthetic musks, antibacterial and antifungal agents. A veritable medicine chest of pharmaceuticals excreted from the skin or passed out in urine awaits bathers. These include non-steroidal anti-inflammatory drugs known to affect endocrine functions, including the reproductive systems of aquatic vertebrates. And there's no cause for complacency here.

"They are useful examples because if it can happen to fish, it may happen to a human, also a vertebrate," Pieters and Horn explained.

During 2018 and 2019, the researchers collected samples from the surface water of two outdoor, unheated municipal swimming pools in an undisclosed town in the North West Province. And in the same province they drew samples at a holiday resort known for its good pool water maintenance. The resort pools – two outdoor and one indoor, all heated – are filled from a borehole, occasionally topped up with municipal water.

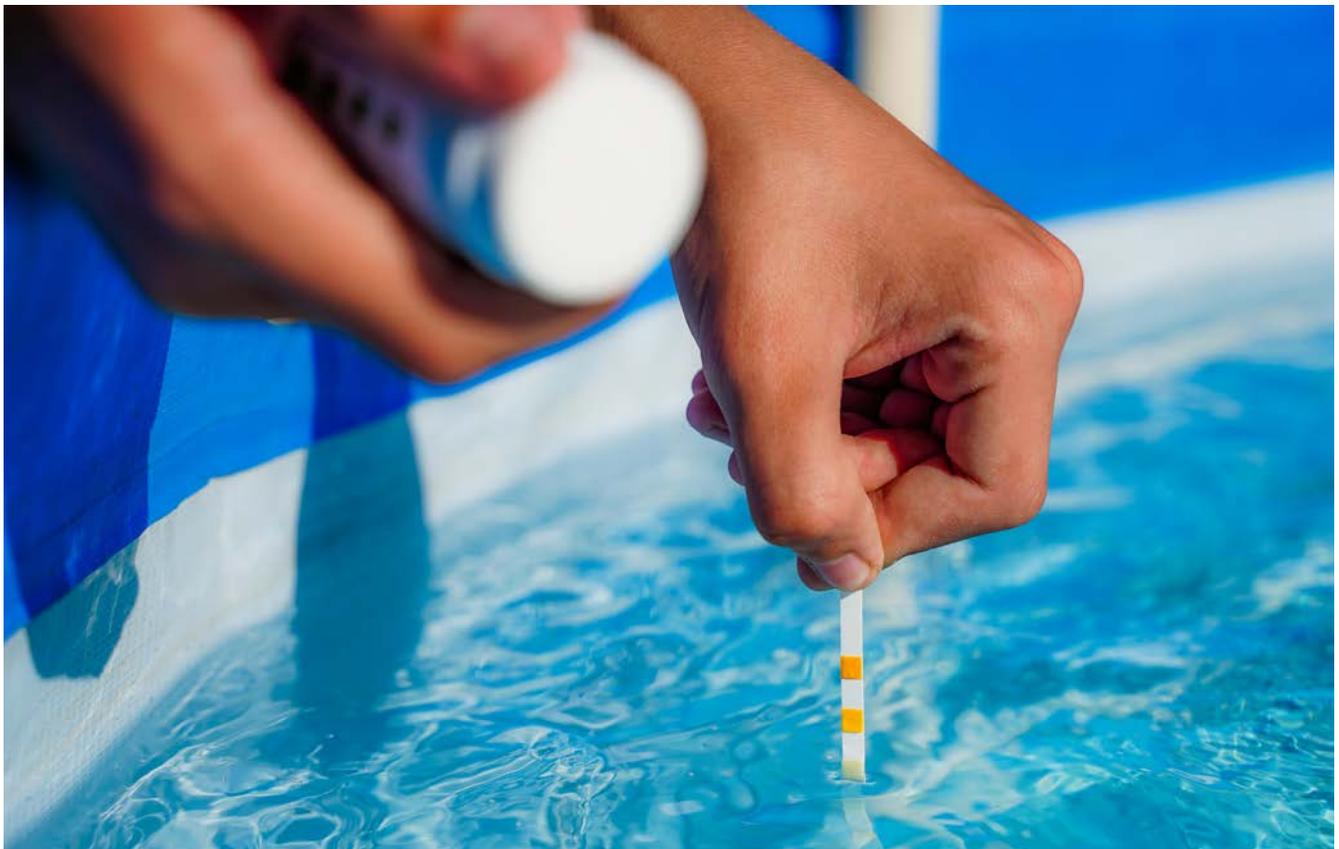
Levels were determined for the four common DBPs and a host of metals; and concentrations of these were recorded from pool samples as well as from source and backwash water. Measures of concentration were done mainly to establish if it differed in the morning (before bathers arrived) from the end of the day. The pools were also investigated for pharmaceuticals and personal care products.

Rand Water's laboratory analysed the samples for disinfectant byproducts, while an in-house lab at the North-West University's Potchefstroom campus handled the metals. The pharmaceuticals and personal care products were extracted for analysis using proprietary systems, with the water sample concentrated 2 000 times to near dryness. Chromatographic analysis (which separates chemical mixtures into their component parts) was used to identify compounds, with the process calibrated to detect endocrine disrupting hormones. This was facilitated by comparison against a database which includes 9 200 compounds – everything from human doping and designer drugs, to veterinary drugs, pesticides, pharmaceuticals, stimulants, benzodiazepines and a whole lot more.

So what were the findings?

None of the metals covered by the drinking water standards for chronic health risks exceeded the permitted levels in any of the pools. Lead levels in the water at the borehole exceeded the limits but, contradictorily, were much lower in the reservoir it feeds. The authors recommended follow-up investigations. The study also found "very high" lead levels in one of its backwash water samples, but this is fed into a pond where no bathing is allowed.

Real danger of these compounds lay in long-term exposure, rather than from a short spell in a pool.



It's important that pH levels are correct to make the most of the chlorine used and so avoid overdosing.

Organic compounds and the trihalomethanes they give rise to were within the drinking water standards, with the exception of an afternoon sample taken at one of the resort pools, which was over the limit for total trihalomethane. A number of the pools sampled, however, were close to or on the limit.

But these findings must be seen in perspective and Pieters and Horn noted that the real danger of these compounds lay in long-term exposure, rather than from a short spell in a pool. The testing for pharmaceutical and personal care products was calibrated to detect steroid hormones, but other compounds were found too. The study presented a shortlist of the 26 most frequently found.

Bumadizone (a non-steroidal anti-inflammatory drug) was topped the list across all pools, followed by citronellal hydrate (a terpenoid that gives citronella oil its distinctive lemon scent) and netilmicin (a semisynthetic antibiotic). Some compounds were detected at municipal pools but not resort pools and vice versa. For example, zoloperone, the sometimes habit-forming anti-anxiety drug, was found only in the resort samples; efavirenz, the HIV/Aids drug (which is not on the frequently-found list), was found only in the municipal samples.

Betamethasone, a steroidal medication, was detected in 64% of the samples. The drug may cause endocrine menstrual irregularities and growth retardation and has also been linked to problems with the vital adrenal and pituitary glands. But these side effects were reported by patients exposed to clinical doses. Topical corticosteroid fluorandrenolone, which was found in 36% of samples, had been linked to growth retardation among children, among other things.

But it's all very well determining the levels of certain metals and chemical compounds in a sample and comparing this with the drinking water standards, quite another predicting whether mixtures of these will affect people, in particular, their endocrine systems.

To get a handle on this, the authors tested samples on live tissue in the lab. These *in vitro* biological assays allowed the authors to evaluate a health risk without necessarily identifying all the compounds involved. "There were definite endocrine disrupting effects, both activating and inhibiting the oestrogen and androgen receptors," the authors said, noting these were evident in the samples collected at the end of the day – after many people spent the day in the pool.

They found that children were at greater risk than adults to exposure and more so through the skin than by swallowing.

The backwash water samples for all three resort pools scored highest on hazard and cancer risk measures. No-one bathes in this water, but it does go into a pond and from there to a river. Metals, probably from the source water, posed the bigger health risk at the time of sampling. But the authors acknowledged the values of some of the variables they used in the formulas, like average time spent in a pool, were selected randomly. They recommended analysing a larger sample of pools over a longer period to confirm their observations.



Photograph supplied

Backwash water samples from a resort's pools in the study scored highest on hazard and cancer risk measures. However, no-one bathes in this water but it does go into a pond and from there to a river.

Dedicated standards were needed for public pools as the drinking water and other standards used at present "do not address mixture effects at all", said the authors. They felt biological assays would be a particularly useful addition to testing.

Pool personnel should be made aware of the dangers of overdosing with disinfectants as well as the importance of maintaining correct pH levels (to make the most of the chlorine used) and of topping up pools to prevent harmful compounds accumulating.

Bathers needed a primer in pool health and etiquette too. They should be made aware of the risks they face, including from the compounds they bring into the water themselves. "Showering before swimming is common in some countries and is advised by the World Health Organisation. The advice... is to frequently shower during the visit to the swimming pool. Bathers should also be dissuaded to urinate in the water."

WATER RESOURCE MANAGEMENT

What's to be done about that dam silt!

Water storage and hydroelectric dams across the world are running out of water as they become increasingly gummed-up with sand and silt. The Water Research Commission (WRC) has been appointed to develop a new siltation management strategy for South Africa's large dams, writes Tony Carnie.

Dredging Africa



The Nqweba Dam was built in 1925 to provide irrigation. But over the last 96 years the dam has lost more than 40% of its water storage capacity due to siltation and currently has very low water levels.

More than 60% of the world's original dam water storage is likely to be lost within just three decades due to the growing accumulation of mud, sand and fine silt pouring into dams across the globe. That was the warning sounded by top hydrologists during the recent National Siltation (NatSilt) Symposium hosted by the WRC.

"We currently lose more storage than we build, and climate change will reduce water yields further due to increased sediment loads," said World Bank independent consultant, Dr Nikolaos Efthymiou, pointing to the threat of more severe storms

and hotter temperatures that are expected to accelerate the erosion of soils in many parts of the world.

Efthymiou said the heyday of dam building was between 1960 and 1990, with most dams being built in the 1970s. This meant that the majority of the world's dams were about 50 years old, and the building of new dams had slowed significantly because of economic factors and a shortage of suitable locations.

Though siltation rates vary widely according to local conditions and land care, dams silt up at the rate of about 0.8% per year at a

global scale – but in many cases the siltation rate is much higher and this means that billions of dollars in dam construction costs go to waste due to rapid siltation.

In South Africa, the mean annual loss in storage capacity is lower, at around 0.4% per year – but several local dams are nevertheless seriously affected already. The Welbedacht Dam in the Free State, for example, has lost more than 90% of its storage capacity.

Prof Gerrit Basson, one of South Africa's foremost sedimentation scientists, suggests that future population growth and land clearance/degradation will exacerbate the sedimentation problem further, especially in Africa. Basson, the head of hydraulic engineering at Stellenbosch University's civil engineering department, notes that the current total large dam reservoir storage capacity for the world is 6 100 km³. In 2006, the storage capacity left free of sediment was 4 100 km³, which means a build-up of sediment of 2 000 km³ (33%), which – if left unchecked – could potentially increase to a volume of sediment of 3 900 km³ by the year 2050 (based on current storage capacity).

"This means that by 2050 roughly 64% of the world's current reservoir storage capacity could be filled with sediment," says Basson, who is also a former chairperson of the reservoir sedimentation committee of the International Commission on

Large Dams (ICOLD) and a member of the World Bank-UNESCO Task Group on reservoir sedimentation management.

ICOLD assessments suggest that several countries – almost one third of them in Africa – could therefore experience critical sedimentation volumes by 2050.

At the local level, Basson has also been closely involved in several studies to assess the sediment levels of South Africa's major dams. He notes that sediment research and daily suspended sediment sampling of rivers in South Africa started in the 1920s. By the 1970s, with many new dams constructed, most of the river sampling programmes were stopped and replaced by reservoir surveys by the Department of Water and Sanitation (DWS), which are recorded in the so-called 'Dam List'.

These early sediment yield maps for South Africa were updated in 2010, and earlier this year the WRC developed a shortlist of 20 dams believed to contain some of the highest silt levels and which may be priority dams for further investigation for possible dredging.

Some dams of concern include Lake Arthur Dam on the Tarka River (52% silted), and the Darlington, Nqweba, Lubisi, Grassridge and Bospoort dams (all above 40%). In KwaZulu-Natal, the Hluhluwe Dam is estimated to be 25% silted up, while the Gariep



Dredging Africa

Sediment removal at Oliphantskop dam



The business end of a cutter suction dredger at Mvunyane dam.

Dam on the Orange River, South Africa's largest dam, was nearly 20% silted up.

At a global level, several options have been explored to combat the inevitable siltation of dams.

Basson says this includes soil erosion and land care management measures to reduce the problem at source, by focusing on land care on the worst 20% of the catchment which contributes most of the sediment yield. Other options include building expensive upstream check dams to trap sediment from large floods; by-passing sediments via tunnel schemes; flushing and sluicing; raising the height of dams or building brand new dams at enormous cost.

Because South Africa is a largely arid and water-scarce country, Basson says the option of sluicing and flushing dams is unlikely to be feasible, as most dams don't have enough excess water. "Dredging costs have come down in recent years with the use of the latest cutter suction dredgers from Europe. But it is important to note that dredging of all of the reservoir sediment is not required and that the aim should be to dredge the original river channel only, for the best firm yield increase."

"In conjunction with dredging, we are proposing that water from the deposited sediments in reservoirs could be used during droughts and from the aquifer formed by the original river beneath the reservoir, by retrofitting pumps at the dam wall."

He notes that by-passing sediment via tunnels or canals in South Africa is not new, and many dams were designed in KwaZulu-Natal such as Nagle Dam, Henley Dam and Shongweni Dam, more than 70 years ago, with sediment bypass facilities.

To tackle the problem of siltation, the WRC was appointed earlier this year to develop a National Siltation Management Strategy for Large Dams in South Africa. The three-year programme aims to develop a strategy that will guide, advise and ensure effective

siltation management and related improved storage capacity for 320 large dams in South Africa, to sustain bulk water supply to the domestic, industrial and agricultural sectors.

It will also consider pilot projects for three government water schemes: Welbedacht Dam (Free State), Hazelmere Dam (KwaZulu-Natal) and Darlington Dam (Eastern Cape). It will also be linked to a major dredging project to remove at least 1 000 000 m³ of sediment from the Nqweba Dam outside the Karoo town of Graaff-Reinet in the Eastern Cape.

The Nqweba Dam (formerly known as the van Ryneveld Pass Dam) was built in 1925 on the Sundays River to provide irrigation for farmers. But over the last 96 years the dam has lost more than 40% of its water storage capacity due to siltation and currently has very low water levels.

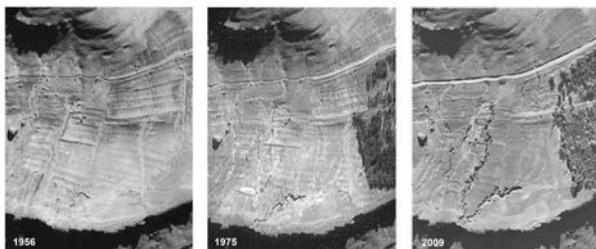
The Nqweba project, to be undertaken by the Pretoria-based Dredging Africa group, is one of the biggest sediment-dredging projects undertaken in the country to date – and it will also incorporate an innovative job-creation project in which the accumulated waste sediments are turned into bricks and blocks by local entrepreneurs.

Dredging Africa Director, Arend van der Wetering, says the first phase of the Nqweba project is underway, but the physical removal of silt with an imported cutter suction dredger can only commence once the dam's current low water levels are replenished by the summer rains.

The Nqweba project has an estimated price tag of €8 million (R135 million) of which €5 million will be provided as grant funding by the Dutch government and the remainder from local matching contributions.

However, major disturbance of silt deposits – whether by dredging, sluicing, flushing or venting – can cause significant environmental and problems downstream if they are not

Image supplied



Gully erosion in the Mzimvubu River catchment.

properly planned or implemented, warned Dr Bennie van der Waal from Rhodes University's Catchment Research Group. "Released sediments can smother all the life downstream and damage the river courses. So it is vitally important to release sediment in line with environmental flow specifications."

Van der Waal also emphasised the need to tackle the sedimentation problem at source, by reducing the volume of soil erosion in the river catchments feeding major dams. In a recent research project in the catchment of Thina River and Mzimvubu Rivers in the former homeland of Transkei, van der Waal and colleague, Prof Kate Rowntree, noted that marginal agricultural areas are prone to the abandonment of cultivated fields due to economic and social shifts that make it no longer worthwhile to cultivate land.

"When agricultural land is abandoned (or a landslide has stripped a hillslope) soil can remain bare for several years before being recolonised by vegetation. Sediment yields peak after land abandonment and eventually fall if and when vegetation cover increases, possibly only after several decades. But if erosion strips the topsoil from abandoned cultivated fields they may never recover their original cover and become 'erosion hotspots,'" the researchers warned.

Dr Bridget Shaddock, of the Golder Associates Research Laboratory, also cautions that care needs to be taken to avoid unleashing new problems if contaminated sediment is disturbed or released downstream during the restoration of sedimented

dams. In some cases, this can include releasing some very toxic and persistent farm chemicals or heavy metals into sensitive downstream aquatic environments.

Dr Jeanine Vonkeman, a hydraulic engineer at ASP Technology (Pty) Ltd, also cautions about the need to consider the impact of dredging from contaminated sediments and negative water quality impacts from higher turbidity, reduced levels of dissolved oxygen and the release of nutrients that can result in eutrophication of dredged dams. Vonkeman said it is, therefore, imperative that proper Environmental Impact Assessment (EIA) procedures are followed prior to sediment removal.

Nevertheless, the need for action was highlighted in a recent WRC study, which suggests that almost 25% of the total number of reservoirs that were analysed in South Africa had lost between 10% and 30% of their original storage capacity. WRC CEO, Dhesigen Naidoo, noted the national desiltation programme is absolutely critical to the country's water security.

"It is a difficult option, a hi-tech option and very expensive. And we have to be quite ingenious in how we motivate that," he said, noting that siltation could also be limited at the design stage, as has been the case with designs for the Umzimvubu water project, planned for the Eastern Cape, and for example, China's Three Gorges Dam."

Jurgen Kogl, special advisor to Minister of Human Settlements, Water and Sanitation, Lindiwe Sisulu, noted that dealing with siltation was sometimes viewed as a grudge purchase, in a similar way to how consumers often viewed buying life insurance. But the problem needed to be tackled swiftly and "head on" to extend the life-span and capacity of South Africa's crucial water infrastructure, he said.

* For more information, visit: <https://wrcnatsilt.org.za/> Watch a video summary of the NatSilt Programme here: <https://www.youtube.com/watch?v=7B0tiQIMm6o>



Dredging is one option available to physically remove decades of silt build-up from South Africa's dams.

COMMUNITIES AND INLAND FISHERIES

Investigating the potential of inland fisheries in South Africa

“Give a man a fish, he eats for a day. Teach a man to fish, he eats for a lifetime. Enlighten him further, he owns a chain of seafood restaurants.” Fish and their catching and selling have long been the stuff of wit and wisdom – and not a little development economics and ecology, writes Matthew Hattingh.

Courtesy Joseph Sara



Gillnet sampling on the Flag Boshielo Dam.

Consider South Africa's 700-plus public dams. Could fishing in these inland waters improve the lives of our rural poor? Yes, but to a point.

Commercial inland fishing in South Africa has been historically confined to a handful of dams and the lion's share to a single dam – the Bloemhof Dam, on the Vaal River. Efforts to develop a commercial sector have largely floundered. The business case has in the past been described as marginal, the prospects for creating jobs, poor.

Yet there is certainly an appetite for freshwater fish, including an undersupplied market among the African immigrant community. And there appears to be a good case for small-

scale or artisanal fisheries, but how best to balance the need to protect a natural resource with the imperative to advance economic development?

The answer is a bit like the bottom of some of our dams – murky – and the dearth of studies on the subject hasn't helped. Happily, a series of Water Research Commission reports is helping to remedy matters, with the most recent instalment published in March. The report, *Inland Fisheries Contributions to Rural Livelihoods: An Assessment of Fisheries Potential, Market Value Chains and Governance Arrangements* (WRC report no. 2497/1/20) brought together natural and social scientists from four universities and the South African Institute for Aquatic Biodiversity (SAIAB).

The researchers trawled the literature and fished for answers at four dams: Pongolapoort, in KwaZulu-Natal; Flag Boshielo, in Limpopo; Voëlvlei, in the Western Cape Province; and Loskop, in Mpumalanga. Among others, they sought to learn what kinds of fish and in what numbers lurked in the dams; how many were being caught; their size and maturity; whether more might be caught; and if so how to do this while guarding against a collapse of stocks.

They described governance of the sector as “very rudimentary” and in need of “fundamental reform” and suggested ways rural men and women might be helped to earn more for their catch including by processing it further or marketing it better.

It’s not like freshwater fishing is small fry in economic terms. More than 1.5 million South Africans are either freshwater anglers or are somehow linked to it. And the inland recreational sector, according to a 2008 study, is valued at R9-billion a year. It’s just that, for historical reasons, most participants are white. The subsistence sector by comparison is a tiddler – worth a minnow-esque R45 million. That said, its value lies beyond rands and cents. Elsewhere in Africa, freshwater fishing provides high-quality proteins (over 33% of animal protein consumed on the continent, according to one study) and a reliable source of affordable nutrition. Ultimately it eases the welfare burden on the state.

Prof Mafaniso Hara, the study’s lead author, noted that inland fisheries make up a “relatively small”, 11.47 million tonnes or 12.2% of total global fisheries production. But he stressed it offered a “wide variety of benefits for millions of people in many developing countries”.

“Benefits include food security, poverty reduction, income, social and cultural values, the well-being of communities,” said Hara, a social scientist with the University of the Western Cape’s Institute for Poverty, Land and Agrarian Studies. Policymakers worldwide know this. The United Nations, the African Union and its development agencies list investment in small-scale fisheries as a priority to cut poverty and spur regional development. But it’s one thing spotting what looks like a juicy opportunity, quite another reeling it in, and Hara provides a lengthy list of what makes this difficult to do: “Poor governance, insufficient organisational structures, limited access to finance resources, markets and social services, low level of participation of the

small-scale fishers in decision-making, lack of accurate data, overfishing due to open access, bad fishing practices, high post-harvest losses and lack of mechanisms for value addition.”

In South Africa, there is a historical component to this too. During apartheid, black people were barred from fishing in public dams for the pot or profit. The focus then was on recreational fishing. This has been changing in recent years, but the recreational sector remains the dominant voice and the legal and policy frameworks still reflect this.

“While small-scale fishers from local communities are generally regarded as having a legitimate claim to fish, in the absence of a supporting rights-based governance framework, their activities are usually illegal, unmanaged and often unsustainable, which has led to growing conflicts among water resources users (especially between small-scale and recreational fishers) on a number of public dams,” Hara said.

Meanwhile, access to public dams and the right to fish in these were controlled by a variety of government departments and agencies at national and provincial levels. It’s a muddle, frustrating efforts to develop fisheries, and the authors supported moves to bring the sector into line with the Constitution and the National Environmental Management Act. This would involve shifting governance from an “overly conservation approach” to managing fish stocks as a resource. It would mean giving black fisherfolk and rural communities more say in fisheries management.

With this in mind, the Department of Agriculture, Forestry, and Fisheries published a draft inland fisheries policy document for public comment in mid-2019. It will eventually reach the Cabinet before being gazetted. But even then, the policy will be a work-in-progress. Wide consultation must follow: local knowledge must be tapped; feasibility studies were needed.

With the exception of the Voëlvlei, the dams considered in this study are in the east and north of the country. Co-authors, JR Sara, SM Marr, HA Hlungwani and OLF Weyl (representing the University of Limpopo, SAIAB, and the Department of Forestry, Fisheries and Environment), reasoned these dams have more fisheries potential than those in the west and the south, being warmer and so more productive. They completed nine monthly fish surveys at Flag Boshielo Dam in 2016 and 2017 and rapid fishery appraisals at Loskop and Pongolapoort dams, in 2017. Rednose labeo (*Labeo altivelis*) and Mozambique tilapia (*Oreochromis mossambicus*) proved to be the most abundant species caught in the 1 288 ha Flag Boshielo Dam, together accounting for 80% – by numbers and weight – of the about 11 species caught.

But the researchers red-flagged “human health impairment from consuming contaminated fish”, noting that Flag Boshielo was on the Olifants River and its waters were among the most polluted in South Africa, including from acid mine drainage, effluent and agricultural run-off. The study found potential for an experimental gillnet fishery in Flag Boshielo, but the authors warned that net mesh must be no smaller than 100 mm to allow juveniles to slip through and so mature and breed. It emerged, though, that assuming the mesh size restrictions were successfully imposed, “harvest potential may be limited” as the existing informal gillnet

Courtesy E. Muchapondwa



Researchers set nets for catching samples on Flag Boshielo Dam.

Courtesy E. Muchapondwa



Women fish vendors of the Sizabantu cooperative sell their wares in the town of Jozini, near Pongolapoort Dam.

fishery had already depleted the larger fish.

A case, perhaps, of damned if you do, damned if you don't, and the study called for a comprehensive assessment of informal fisheries at the dam before any further development.

A greater variety of fish were found in Loskop Dam than Flag Boshielo Dam and production and catch yields were considerably higher too. The researchers attributed this to the ecology and management strategy at Loskop. The 2 428 ha dam is within a nature reserve and public access to fish is limited to anglers using resort facilities.

The authors worried that a commercial fishery at Loskop might spark conflict between small-scale and recreational fishermen, with economic consequences. "The tourism value of this venue is considered high due to the watersports undertaken and the recreational fishing value of the dam," said the authors.

Complicating matters further, evidence emerged that Loskop's populations of Mozambique tilapia (the dam's most abundant fish) and rednose labeo were ageing. Young fish had for a few years, it appeared, failed to survive to adulthood and the authors made a "strong recommendation" to hold off on exploiting either species until the reasons for this were clear.

At Pongolapoort, strong winds added to the difficulties facing the team on their visit to the 13 276 ha dam, noted for its

crocodiles and hippos – notorious for turning nasty at the sound of motorboats.

"The conditions and short duration of the assessment of Pongolapoort Dam did not provide a representative assessment of the fish stocks of the impoundment," said the authors. They called for further investigations.

What of the actual fishing and how does the catch come to market? Fieldworkers at Pongolapoort spoke to women fish vendors – nine of whom sell out of buckets on the pavement outside the Inkunzi tavern in Jozini town. The study considered how vendors might be helped to earn more, for example, by selling by weight rather than size. The fishermen, the study learned, faced a host of difficulties. They lacked facilities and capital which meant they battled to meet customer demand consistently. As a consequence, guesthouses and restaurants don't have local fish on their menu, nor do local supermarkets stock it.

The 50 mm gillnets Pongolapoort's small-scale fishermen rely on are a sore point and a subject that cuts to the heart of some of the debates around the form fisheries policy should take. At the time of the study, Ezemvelo KwaZulu-Natal Wildlife had lost its mandate to manage biodiversity at Pongolapoort. The provincial nature conservation agency viewed gillnet fishing as destructive and, according to local small-scale fishermen, had sided with recreational fishermen.

Courtesy M. Hara



A fisherman selling fish from Flag Boshielo at the roadside.

There was bad blood between the two groups. Recreational fishermen (mostly white visitors to the area) saw subsistence fishermen as poachers. They believed gillnets were inappropriate for dam fishing and worried their boats would get tangled in the nets. Subsistence fishermen accused the recreational fishermen of confiscating and burning their gear. The Department of Water and Sanitation, which controls the dam, and other members of its water users' association (the recreational fishermen were not members) felt gillnet use should be viewed as a livelihood and developmental activity.

The upshot of this was that monitoring and enforcement has been handled by the department and the police for some years now. The police used marine safety regulations, according to the small-scale fishermen, to harass them and even confiscate their boats. A sustainable-use plan for the dam was commissioned in 2004 by the then Department of Water Affairs and Forestry. It was supposed to meet a host of ecological, developmental and egalitarian aims, but at the time of the study had yet to materialise.

Water Research Commission Research Manager, Dr Samkelisiwe Hlophe-Ginindza, said it was clear that continual monitoring was needed to ensure the sustainability of fish stocks, but a "delicate balance" must be struck that improved the livelihoods

Courtesy M. Hara



Recreational anglers on Flag Boshielo Dam.



Recreational anglers on Flag Boshielo Dam.

Courtesy M. Hara

of communities. The study, she said, stressed the need for greater participation by fisherfolk in managing resources. Allied to this must be education and efforts to help them become better organised so they could add value to their products – to "create monopoly power and sell to niche markets".

Fieldwork at the other three dams in the study dealt with these and similar recurring themes and troubles. But as much as small-scale fishermen share common problems and have similar developmental needs, there were marked differences in circumstances, including in the physiology and ecology of the dams. It's a reality the authors grappled with as they pondered how governance ought to be arranged.

Could a general management system be fashioned to better organise and regulate fisheries across hundreds of different dams, each with its own characteristics, some more abundant than others? Or should some dams be grouped together for management purposes. And if so, based on which characteristics?

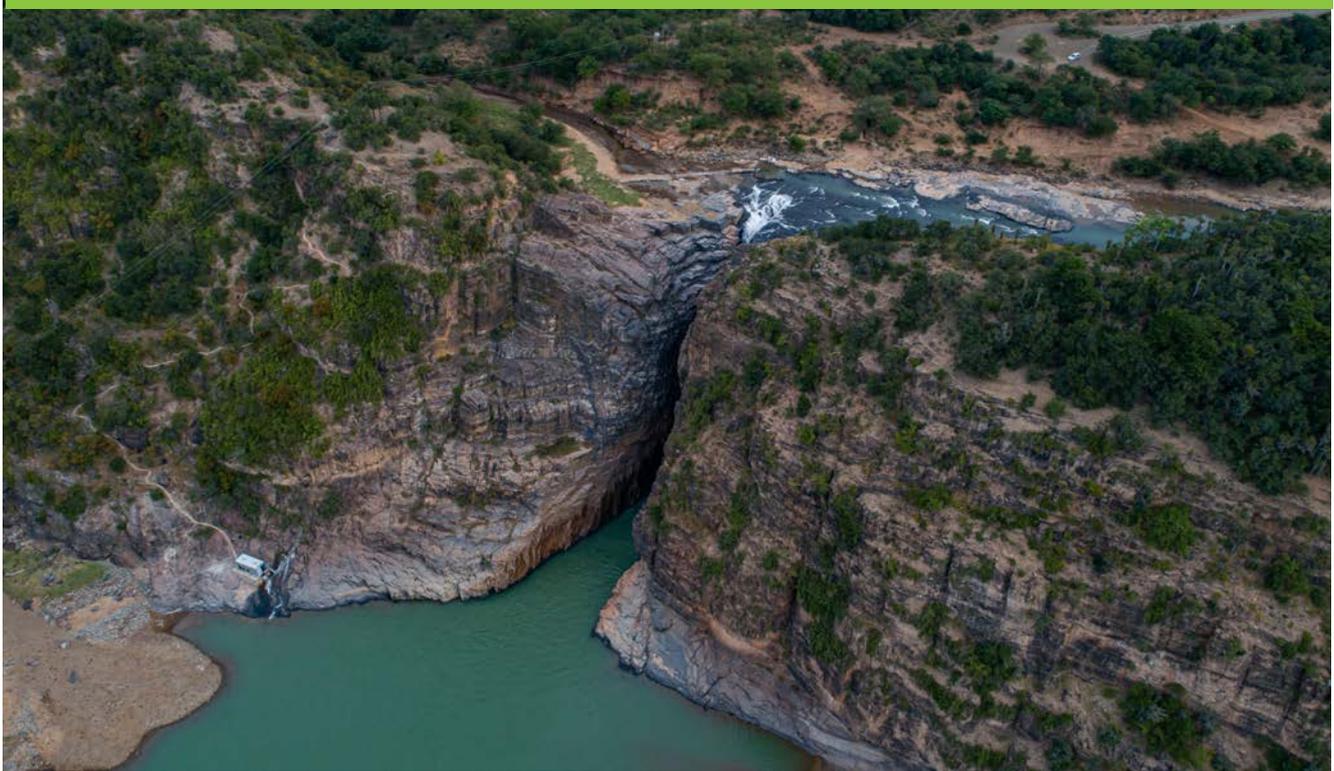
"Careful thought will need to be applied," said the authors. More questions than answers, perhaps... and more than fish to chew on.

To download the report, *Inland Fisheries Contributions to Rural Livelihoods: An Assessment of Fisheries Potential, Market Value Chains and Governance Arrangements* (WRC report no. 2497/1/20) Visit: <http://wrcwebsite.azurewebsites.net/wp-content/uploads/mdocs/2497%20final.pdf>

HYDROPOWER

Turning the tide on cleaner energy, one community at a time

Small-scale hydropower offers potential for rural electrification in parts of South Africa, according to the researchers involved in a recently completed pilot project, Jorisna Bonthuys reports.



The Kwa-Madiba micro-hydropower plant is located next to the Thina Falls, along the Titsa River, in the Eastern Cape.

A micro-hydropower plant situated northeast of Mthatha in the Eastern Cape illustrates the potential of renewable energy to help turn the tide for local communities.

This is the view of Marco van Dijk, a lecturer at the University of Pretoria's Department of Civil Engineering. Van Dijk and his team have been exploring this topic over the last few years. Adds Jay Bhagwan, Executive Manager at the Water Research Commission (WRC): "Imagine thousands of such systems serving remote villages, and its potential to create local jobs, industry and enterprises. This could be the green economy which can go far in uplifting local economies and stimulating a renewable industry."

This visionary initiative by the WRC, which is funded by the

Department of Science and Innovation, is aimed at changing the rural economy through innovative solutions. The Kwa-Madiba plant that they designed and constructed during this project provides a "useful roadmap" for implementing similar projects elsewhere in the country, Van Dijk says.

The unit, housed in a retrofitted shipping container next to Thina Falls, provides enough electricity for approximately 50 rural households. The electricity is used by people living in the remote village of Kwa-Madiba in the Oliver Tambo District Municipality.

The nuts and bolts

The plant employs the age-old strategy of generating electricity using the potential and kinetic energy of water, Van Dijk explains.

“This run-of-river, modular unit turns the potential energy of water flowing into clean electricity. Its turbine and generator harness energy from water, of which there is plenty all year round.”

Thina Falls is situated on the Thina River just before its confluence with the Tsitsa River.

The plant’s intake and headrace are at the top of the falls. Its turbine room and tailrace are located at the bottom. A 450 mm-diameter penstock was drilled through the mountain near the site, linking the headrace with the turbine room.

The plant’s design allows for rerouting a small quantity of flow for hydropower generation while still maintaining the bulk of the flow over the waterfall. The release from the turbine room is equal to the flow at the intake structure, namely 150 ℓ/s and thus not a consumptive use.

Due to the relatively small extent of the project, the screening process undertaken confirmed that neither a basic assessment nor a full environmental impact assessment was needed before work started.

The water authorisation process was managed in a cost-effective and timely manner, Van Dijk says. This is because a mini-scale hydropower project for non-grid rural electrification is included as an activity in the Department of Water and Sanitation’s General Authorisation for water users (in terms of the National Water Act).

The plant was constructed in two phases. Firstly, the intake, headrace, penstock and turbine room foundation were constructed at the site. Secondly, the turbine room was assembled as a containerised unit, prefabricated off-site, transported to the area and placed on the turbine room’s foundation.

The turbine room houses the turbine, generator, controls and regulators of the plant. The type of turbine selected offered a smaller power station footprint, hence less civil works. The plant is designed to allow for a complete unstaffed operation. “The system is efficient, dependable and cost-effective,” Van Dijk says.



The electricity generated by the plant is used by the remote village of Kwa-Madiba in the Oliver Tambo District Municipality.

Implementing this project was not without its challenges, Van Dijk acknowledges. The biggest challenge was the geology on-site, which affected the construction process. The plant’s development process was also “more complex than anticipated”, he says. This is due to the nature of the project consisting of civil, mechanical and electrical elements. The inaccessibility of the terrain also caused headaches and required redesigning some plant components.

Small but viable

Small-scale hydropower is a proven, mature technology with a long track record, including in Africa. The gold mines at Pilgrim’s Rest in Mpumalanga, for example, were powered by two 6 kW hydro turbines as early as 1892 and was later complemented by a 45-kW turbine in 1894 to power the first electrical railway.

Although not very well documented, small-scale hydropower played an important role in providing energy to urban and rural areas of South Africa. The first provision of electricity to cities like Cape Town and Pretoria was, for instance, based on small-scale hydropower.

Many smaller towns in South Africa also started local distribution of electricity through isolated grids powered by small hydropower stations. However, with the expansion of the national electricity grid and the cheap, coal-generated power supplied through this grid, many of these systems were decommissioned.

“Decentralised electricity generation options such as small-scale hydropower often remain the only viable solution to supply some areas with electricity.”

Historically, small-scale hydropower also played an important role in the development of the region. Since the mid-1960s, however, the main emphasis has been on centralised fossil fuel-based electricity generation. Developers and policymakers have only recently begun looking at small-scale hydropower again.

Recently, initiatives have seen the light in many African countries to revive the sector for small-scale hydropower, either through international development agencies or through initiatives led by the private sector. Particularly in Central Africa (Rwanda), East Africa (Kenya, Tanzania and Uganda) and in southern Africa (Malawi, Mozambique and Zimbabwe), new initiatives are focusing on implementing small-scale projects.

Pico- and micro-hydropower installations are often ideal electrification options for isolated communities (that are not grid-connected) in developing countries, Van Dijk says.

The South African classification of hydropower installations refers to plants with a generation capacity of up to 10 MW as ‘small’ hydropower. Small-scale hydropower schemes are classified into mini-hydropower (<1 MW), micro-hydropower (< 100 kW) and pico-hydropower (< 20 kW).



The plant is located inside a retrofitted shipping container and provides enough electricity for approximately 50 rural households.

Hidden potential explored

Although energy experts say South Africa has moderate hydroelectric potential, small hydropower projects around the country could help provide a sustainable future energy supply according to a WRC study. Van Dijk says: "Decentralised electricity generation options such as small-scale hydropower often remain the only viable solution to supply some areas with electricity."

Such plants can provide renewable options for communities that are currently off the mainstream electricity grid but living near rivers or existing dams that can be retrofitted. "Micro-hydropower can provide one of the most simple and consistent forms of renewable energy in deep rural settings," Van Dijk notes.

In remote locations, stand-alone systems like the Kwa-Madiba plant can be more cost-effective than extending a transmission line to the electricity grid. And, unlike large-scale hydropower plants, these small plants can be built in two to three years from inception, Van Dijk explains. These projects could be stand-alone isolated mini-grids or larger installations linked to the national electricity grid.

As South Africa is an arid country, there is a vast water infrastructure network that has been developed to dam, store, control, measure and convey water to the end users.

According to the researchers, municipalities, water utilities, and government entities (such as the Department of Water and Sanitation) also own and operate water infrastructure which could be retrofitted to generate small-scale hydropower. At many of these locations, there is hidden potential for hydropower, ranging from pico-, micro, or even mini-hydropower schemes, to possibly supply a school or clinic, a cultural village centre or even a whole community.

According to the researchers, the pilot project proves that small hydropower technology can provide grid-quality electricity to rural areas under the current legislative and policy framework. Van Dijk adds: "This kind of small-scale hydropower project also fits into national and regional green economy ambitions."

Bhagwan says this plant offers a case study on how a simple technology, which is smartly modernised in a prefabricated containerised unit, can be quickly expedited to very remote settings where electricity is needed, but access to the national grid may not be a feasible option.

Bhagwan says: "This [type of plant] offers huge potential for several other similar communities in areas such as the Oliver Tambo District Municipality, who are living within the proximity of an adequate water source."

Currently, many barriers are hindering small-scale hydropower development in the region. These include limited access to the appropriate technology as well as limited infrastructure for manufacturing, installation and operation of electromechanical equipment.

The knowledge to develop small hydropower plants is, however, available to implement such projects. Several turbine manufacturers want to enter the South African small-scale hydropower market, Van Dijk says.

Mapping for the future

As part of the Kwa-Madiba project, Van Dijk and his team outlined the necessary steps that must be followed when developing a hydropower plant. They are now also compiling a national hydropower atlas for the country as part of another WRC-funded project.

This atlas, the first of its kind in the country, will help identify potential areas where hydropower projects of different sizes can potentially be implemented. It will also provide information regarding the different technologies available, among others.

The researchers hope their efforts will provide policymakers with a way to address the lack of development in this field and facilitate government plans to exploit hydropower resource opportunities.

So far, work on developing the atlas indicates there are existing and new opportunities for hydropower in the country. There are, for instance, opportunities at existing dams and weirs as



KwaMadiba is a run-of-river, modular unit which turns the potential energy of water flowing into clean electricity.



The release from the turbine room is equal to the flow at the intake structure, namely 150 ℓ/s and thus not a consumptive use.

well as on the bulk supply and distribution pipe system. This infrastructure may be retrofitted with turbines to generate electricity to meet the base or peak electricity demands, Van Dijk points out. The advantage of retrofitted hydropower is that no new infrastructure is required for energy generation, he says.

South Africa has many other potential sites that are suitable for implementing micro hydropower schemes, he says. These include the outlets of existing dams (with South Africa having about 4500 dams across the country) and large-scale water transfer schemes.

Van Dijk says that micro hydropower schemes could provide economical energy output in areas with sufficient water resources. Rural communities from the Eastern Cape, Mpumalanga and KwaZulu-Natal have the most potential to benefit from small-scale hydropower schemes, he says. These provinces have better topography and water resources that can support such hydropower operations.

“Small-scale hydropower is an ideal, renewable energy

alternative for the electrification of many isolated communities and to assist in baseload supply,” he says.

Efforts are also underway to develop an assessment tool for investors, developers, utilities, and local communities to evaluate hydropower opportunities as part of this research.

The researchers are not propagating building new dams for hydropower, Van Dijk points out. “What we are saying is let’s harness (the resources) that we have responsibly, for the benefit of all,” he says. “Small-scale hydropower projects like Kwa-Madiba have the potential to be integrated into many of our river systems, wastewater treatment plants, bulk water pipelines and dams.”

*The Kwa-Madiba plant has a projected lifespan of approximately 40 years. The local municipality is the owner and will now be responsible for its operation and maintenance. Read more about the project here.

CAPACITY BUILDING



Namhla Mbona – wetland mapping maestro and citizen science champion



This article forms part of a series of profiles on high achieving water researchers supported by the Water Research Commission as part of the Commission's 50-year celebrations.

Most freshwater scientists are zoologists or botanists who got their feet wet doing postgraduate research projects on aquatic ecosystems. Namhla Mbona took a slightly different route and brought a set of skills to the table that are in high demand. Sue Matthews spoke to her about her career journey at the South African National Biodiversity Institute (SANBI).

"After finishing school in Keiskammahoek in the Eastern Cape, I signed up at the University of Fort Hare for a zoology degree with the aim of it being a pre-med, but within that first year I was introduced to GIS," she explains. "I had a love of maps and computers, so I took computer science too and married the use of GIS and zoology for my third-year project. The linkages of using GIS as a tool in understanding biodiversity was what brought me to SANBI."

It was while she was doing a GIS internship at the Department of Public Works, based in Bisho and tasked primarily with capturing spatial data for Expanded Public Works Programme projects, that she heard about internships at SANBI, and duly applied.

"They called me to say I was successful and gave me a choice of protected areas expansion or wetlands. Growing up, I knew a bit about wetlands, but I didn't know about ecosystem services – I mainly thought of a dirty smelly place, where livestock had been stuck a few times. But I chose wetlands for my six-month internship, and that's when I became part of the Working for Wetlands team based at SANBI."

Her first week, in October 2006, was effectively a crash course in wetlands because she attended the National Wetlands Indaba in Stutterheim, even before she had moved to Pretoria. During the Indaba, the first version of the National Wetland Map was launched, but it was very much a broad-brush, desktop effort



Mbona was given the WRC Knowledge Tree Award in the category 'Informing policy and decision making' in 2017. Here she accepts the award from WRC Deputy Chair, Prof Sibusiso Vil-Nkomo, while WRC CEO, Dhesigen Naidoo, looks on. Mbona's contributions in the wetland sector had also been recognised in 2014, when she was given the inaugural Young Wetland Scientist Award at the National Wetland Indaba.

produced by applying terrain-based hydrological modelling to the wetland data derived from Landsat imagery in the National Land Cover 2000 project.

Mbona soon got to work, assisting the project manager of the National Wetland Inventory (NWI) to improve the dataset for the map, develop a GIS-linked database, and integrate the data into other projects, including Working for Wetlands ones. The NWI had been set up to be the repository for wetland information – such as locality, size, type and condition – as it became available, in accordance with South Africa's obligations in terms of the Ramsar Convention and the Convention on Biological Diversity.

In 2008, Mbona began a BSc Honours degree in Geo-informatics at the University of Pretoria, and towards the end of that year she was promoted to NWI project manager, a position she held until December 2013. Apart from all the responsibilities associated with the job, including administration and stakeholder management, coordination of NWI activities countrywide, mapping and metadata compilation, as well as training and mentoring interns and staff, she was heavily involved in the multi-partner National Freshwater Ecosystem Priority Areas (NFEPA) project, completed in 2011.

"The NFEPA project was a big team, and being part of it was really great," she says. "We invested about two years in data gathering and crunching, getting data from municipalities and provinces, and then going through to regional areas for review. We'd get people into a hall with print-outs of our draft maps, ask if we'd represented everything and they'd point out what we'd missed, then we'd go back to the computer and redigitise that area."

"I'm not a seasoned wetland ecologist, so I'm always learning, and always linking what we see on the computer and what is happening on the ground."

The GIS layers developed in the NFEPA project were adopted by SANBI as National Wetland Map 4, and were used for the freshwater component of the 2011 National Biodiversity Assessment (NBA). In the previous NBA, conducted in 2004, wetlands had been given short shrift. The lack of spatial data had meant that a full assessment was not feasible, so the freshwater component dealt only with rivers and the terrestrial component included just a limited analysis of wetlands. In NBA 2011, however, wetlands were comprehensively assessed, and found to be South Africa's most threatened ecosystem type.

Nevertheless, the shortcomings of National Wetland Map 4 soon became apparent. Mbona says the best-available data was used for it at the time, but the NFEPA team always emphasised that a national-scale dataset would have limitations in terms of accuracy and detail, and that ground-truthing was needed for fine-scale mapping at local level. The opportunity to do this came in the form of a Water Research Commission (WRC) project, which Mbona – in her new position as SANBI's freshwater biodiversity planner – headed up as project leader.

Given that regulatory authorities were using the NFEPA data in their decision-making pertaining to mining, and that SANBI was in the process of developing both a decision support tool

applicable to coal mining in the Mpumalanga Highveld and a guideline on wetland offsets, the WRC-funded project honed in on this area. The final report, *Supporting better decision-making around coal mining in the Mpumalanga Highveld through the development of mapping tools and refinement of spatial data on wetlands (WRC Report No TT 614/14)*, was published in February 2015.

The methodology involved thoroughly reviewing the existing data and delineating wetlands using aerial imagery and topographic data, then selecting a subset of wetlands for ground-truthing and validation, after which the collated data was reviewed by wetland and GIS specialists. Apart from generating new polygons of wetland boundaries, information on wetland type and condition was collected at each step.

The project gave Mbona plenty of time in the field, something she enjoys most about her job.

"I'm not a seasoned wetland ecologist, so I'm always learning, and always linking what we see on the computer and what is happening on the ground," she says, but jokes there are downsides too. "In that project, we spent a lot of time driving up and down, with long days working in the forestry lands. The frustrations of fieldwork sometimes take hold and you end up not speaking to each other by 8 pm when you're trying to find the accommodation!"

The research confirmed that National Wetland Map 4 had significantly under-represented wetlands in the Mpumalanga Highveld. The total area of wetlands leapt from 213 579 ha to 590 391 ha, which amounted to almost 20% of the study area's surface. The improved data also allowed the ecosystem threat status depicted in NBA 2011 to be updated, and 23 of the 49 wetland types in the Mpumalanga Highveld moved to a less threatened class, with none upgraded to a higher class.

Mbona drew upon the research for her thesis, 'Using GIS as a

tool to map and type fine-scale wetland data', for her MSc GIS degree awarded by the University of Salzburg in early 2016. The degree is offered through the UNIGIS Salzburg Global Campus programme, which had formed links with universities in South Africa. This meant that Mbona completed her coursework at the University of Pretoria and Nelson Mandela University, but she did get to do a month-long winter school in Salzburg.

Shortly thereafter, work began in earnest to improve upon National Wetland Map 4 in preparation for NBA 2018. Mbona was project leader of the WRC-funded project 'Enabling more responsive policy and decision-making in relation to wetlands through improving the quality of spatial wetland data in South Africa'. She spent months trying to source wetland data and coordinating a team of interns, who she trained in desktop wetland mapping.

"I did a survey where I requested people who had data, no matter how small, to share it with us," she explains. "Then we cut up the country into pieces and allocated them to about a dozen interns, who were sitting in CSIR Stellenbosch, CSIR Pretoria, SANBI Kirstenbosch and SANBI Pretoria. Each person was responsible for either a whole province or certain district municipalities, and I was working with them week to week. If data was received from a municipal official or a consultant, you compared it with what you got from the topographic maps and then created the most true polygon that you believed represented the wetland. In some areas, we didn't receive any additional data so just had to clean the data from the topographic maps, which are actually provincial geodatabases updated by the Department of Rural Development and Land Reform's National Geo-Information Directorate."

Wetland experts with specialist knowledge of each area were contracted to provide input, undertake ground-truthing and review the data. Essentially, the project conducted the mapping and ground-truthing using the same approach outlined in the Mpumalanga Highveld project's methodology, which had been



During a career talk organised by the United States Embassy in May 2018, Mbona spoke about environmental research and conservation, and the importance of wetlands.

further developed into a wetland digitising guideline by Heidi van Deventer and wetland mapping guidelines produced by Nancy Job and co-authors.

The process and outcomes are comprehensively covered in the report for which Mbona was lead author, *Improving the spatial inland wetland data for National Wetland Map 5 in South Africa to Inform policy and decision-making (WRC Report No. TT 778/18)*, published in February 2019. The nuts and bolts are also succinctly summed up in the paper 'National Wetland Map 5: an improved spatial extent and representation of inland aquatic and estuarine ecosystems in South Africa' by Van Deventer and co-authors, including Mbona, in the January 2020 issue of *Water SA*. The new map depicts over 2.6 million hectares of inland wetland area, representing a 23% increase compared to the previous version and making up 2.2% of South Africa. Its limitations are also outlined in the paper – only 7% of the country's surface area was mapped by experts and less than 17% by the interns, with the rest relying purely on the provincial geodatabases and therefore ranked low confidence.

Even the interns' contribution is ranked low-medium confidence, but this doesn't bother Mbona.

"I always believe half a look is better than nothing. The first version of the map was literally just a computer model, and each version since has had more human input, which I consider an improvement," she says. "Learning how to interpret imagery is a process of training your eye and understanding wetland



Ground-truthing in the field was an important part of the wetland mapping projects.

ecology. In some cases, the wetland boundary might not be the key issue – we've at least been alerted to the presence-absence of a wetland, and that's a good start. Besides, the national dataset always comes with a disclaimer that you cannot use it as your only decision support tool. It's meant to be part of a pre-screening process, so before using it people should at least check on Google Earth that it's a reasonable reflection of their area of interest and then do their own verification."

Mbona says she's pleased to see more young people coming into wetland mapping, but after 15 years she feels ready for a change. She's moving divisions within SANBI and will now be focusing on citizen science – a passion of hers. She's a big fan of the iNaturalist app, and has been the City Nature Challenge coordinator for Tshwane for the past two events.

"I go everywhere and just bioblitz," she laughs. "Cape Town always beats us in the Challenge, but I engaged 130 people this year compared to 25 last time, so it's a win – people know about it and are interested. I tried to cover the whole of Pretoria and was out the entire weekend, focusing on aquatic plants. If we can collect photos of them and get them in the database so they can be identified, they could potentially be useful for wetland mapping assessments and riparian audits."

"We always say that we're not progressing in most of our projects because of limited resources, or that we don't have enough information about our wetlands, so it's difficult to plan for them. But what if we can use citizens' knowledge about the history of wetlands they've been seeing in different climates and flooding regimes. There also seems to be a lot of interest from citizen scientists in terrestrial life, but in the aquatic environment it's not really happening, and I'm wondering whether it could be because we're using complicated tools. I'd like to see whether we can take GIS and simplify it into an app, with a one-page questionnaire that a person can use to identify water quality or the ecological condition of that ecosystem, and how the barrier of language and scientific terminology can be overcome."

In the immediate future, she will be applying some citizen science to the Living Catchments project, a SANBI-WRC-DSI partnership, and will also remain involved in the Data Acquisition Management Strategy, a project SANBI is driving for the Department of Water and Sanitation. The idea is to create a 'one-stop shop' for data, focusing on wetlands initially, and groups have been set up to obtain data from different sources, including citizen science contributions and *ad hoc* projects such as EIAs and WRC projects.

"I've been fortunate to have been involved in so many areas of work that I was exposed to because of the need for wetland data or mapping, such as the wetland classification scheme, the NBA, or resource quality objectives. The project management side and working with SANBI's publications unit to turn some of the reports into glossy booklets was also good experience. Being given two awards was very gratifying, of course, and another highlight was attending the Ramsar COP13 in Dubai in 2018 as part of the Ramsar technical review portfolio. But I'm now looking to grow, and hope I can make the same level of contribution in the citizen science sphere going forward."

WATER RESOURCE MANAGEMENT

Rehabilitation of eroded watercourses at Vergelegen

Vergelegen wine estate in Somerset West, which is renowned for its biodiversity and commitment to environmental sustainability, has just completed an extensive programme to rehabilitate eroded watercourses. This complex environmental undertaking on five sites has seen the removal, storage and replanting of some 15 000 indigenous plants that were housed temporarily while the programme was underway.

Sean Alterm



Plants being collected from the Vergelegen nursery.

The R12 million project has saved rehabilitated wetlands and Lourensford Alluvium Fynbos vegetation, which could have been badly affected by sediment washing onto the area. In addition, it has halted sediment contamination of the Lourens River, part of which runs through the estate. This is the only river in South Africa where a section of adjoining land is a Protected Natural Environment.

Causes of erosion

Vergelegen has been acclaimed for completing the largest privately funded alien vegetation clearing project in South

Africa. Some 2 200 hectares of the 3 000-hectare estate were cleared of alien vegetation by 2019. It is likely that the woody alien vegetation laid the foundation for erosion by displacing the indigenous deep-rooted species which protect the soil against degradation in the event of heavy rainfalls. Structures that concentrate the flow of water, such as roads and road culverts, also contributed to the erosion.

Says Vergelegen risk and commercial manager Leslie Naidoo: "We had completed a large portion of the alien vegetation clearing when, in 2013, we experienced heavy rains and severe flooding. This increased peak flow rates of water run-off and

created gullies in many of the watercourses. In some areas, rocks were washed out and blocked the natural watercourses flowing to the river, forcing an unnatural distribution of higher flows to be channeled onto the estate.

“The resulting erosion was initially not easy to see because the land was still covered with vegetation. A wildfire in January 2017 exposed the areas and signs of damage could be identified; without the standing vegetation to stem the water flows, the situation worsened during the winter rainfalls. We immediately brought in experts and in due course received reports from an environmental consultant, a specialist engineer and a wetland expert.”

There was agreement that, without suitable interventions, there would be degradation resulting in “escalating and irreversible ecological damage and huge financial costs.”

Tackling erosion

In a massive undertaking, 30 erosion control weirs were constructed, sediment was removed, and rocks and other materials were placed in the watercourses.

Of the five zones, section five was particularly challenging. Specialist engineer Hans King visited the estate in 2017 to stabilise a 40 m long gully. He noted “a strange, very narrow (about 500 mm) but very deep (about 2 metre) groove in the soil extending for maybe 100 metres upstream of the gully.”

A few months later, photographs revealed that the groove had become part of the gully, and the existing gully had become much wider and deeper.

An examination of the soil structure revealed why the erosion was so rapid and serious. The top 50 mm was reasonably resistant to erosion, but beneath it lay deep, highly decomposed granite. Once the erosion was deep enough to penetrate the decomposed granite, vertical erosion was swift.

There was the danger that a wide area around the gully, a large portion of which is home to the critically endangered Lourensford Alluvium Fynbos, could be covered by a deep layer of weathered granite and silt. Approvals required in terms of the National Environmental Management Act turned out to be a lengthy process and the erosion worsened with every rainfall. The rehabilitation finally got underway in August 2020.

Vegetation replanting

As part of the rehabilitation programme, local indigenous vegetation was prepared for replanting after the erosion control weirs had been constructed and other containment measures put into place.

The team erected a 10m x 30m tunnel in August 2020. Plants from the eroded areas were stored in the tunnel for replanting, while new plants were also propagated.

This aspect of the programme was delayed when 120+ km/h strong winds lashed the estate in October 2020, damaging the

tunnel and destroying some plants. Nonetheless, many survived and more were propagated, and in 2021 replanting began.

In addition, green, well-rooted palmiet was gathered from a dam spillway stockpile and placed vertically in the weirs. Palmiet initially requires flowing water over the rhizome and stem until the roots re-establish in the soil. Water was pumped in using the Vergelegen firetruck.

“This project has been a major undertaking, but it has ensured that we have controlled the erosion that would have had an extremely damaging impact on the land,” says Naidoo.

“With 1900 hectares of the estate promulgated as a private nature reserve with the same protection status as the Kruger National Park, we are committed to the long-term sustainability of the estate so that it can be shared with future generations.”



Eben Oldervagen

Site four before treatment.



Eben Oldervagen

Site four after treatment.

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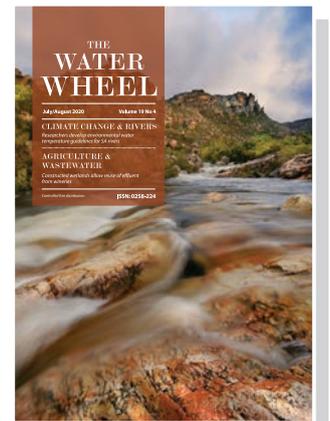
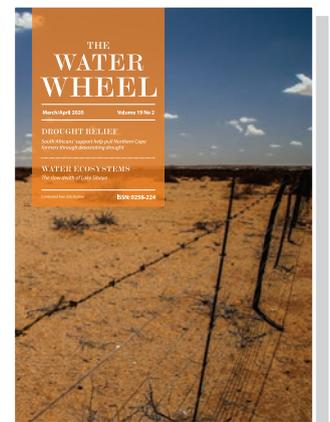
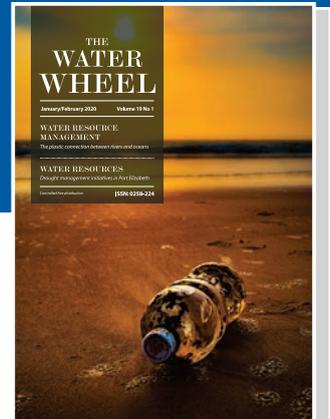
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