THE WATER WHEEL

November/December 2020 Volume 19 No 6

ENVIRONMENTAL REFUGEES

Extreme events driving people from their homes

RIVERS AND ECOSYSTEMS

Embracing biodiversity stewardship to help protect SA's unique frogs

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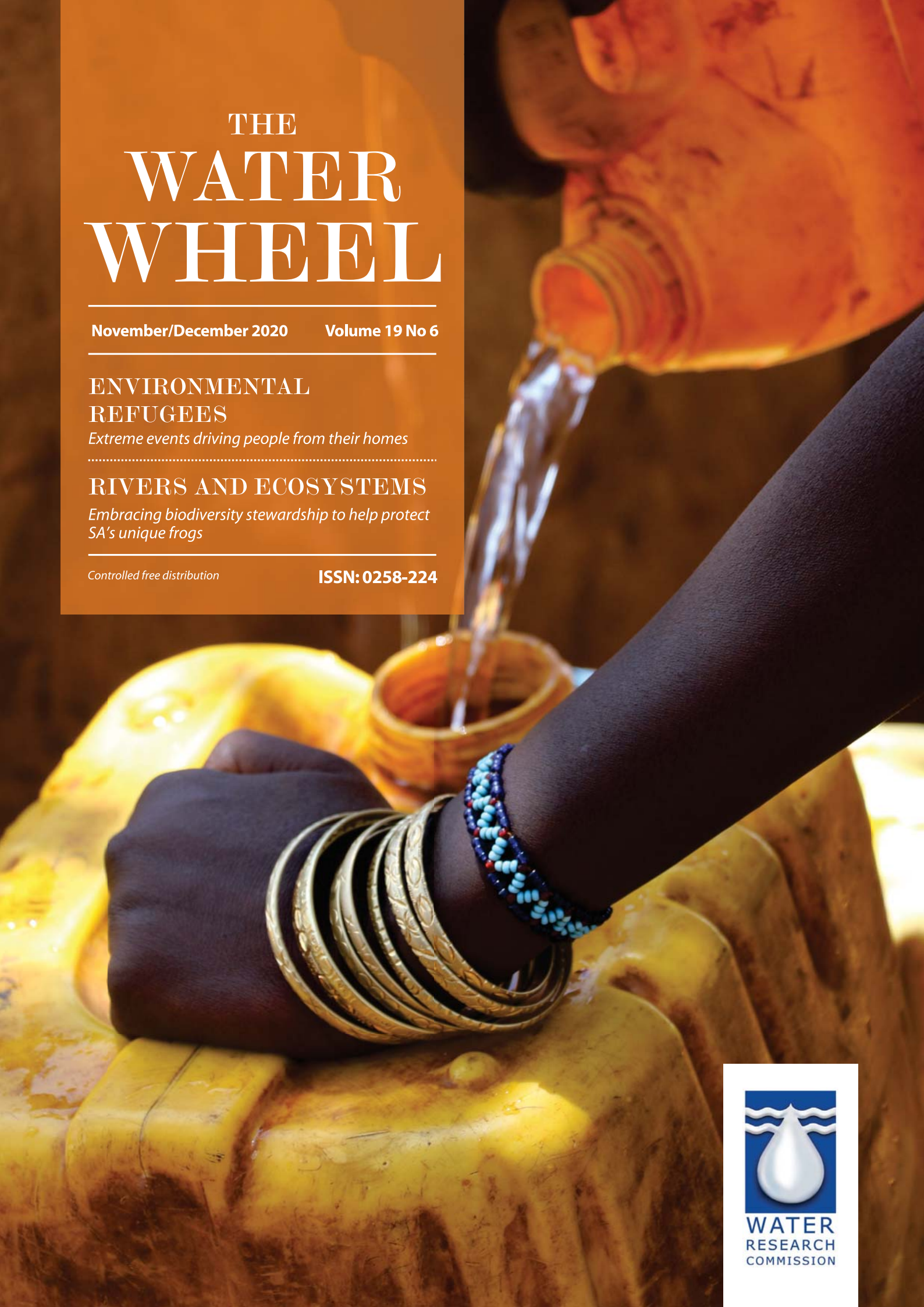

WATER RESEARCH COMMISSION

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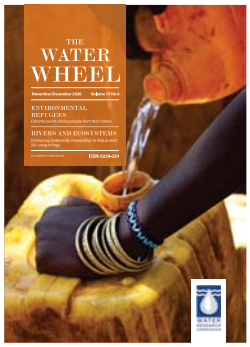

The plight of Southern Africa's environmental refugees has been the focus of a study by the CSIR and WRC. See the article on page 12.

FLUID THOUGHTS

WRC CEO, Dhesigen Naidoo

Municipalities as the theatre of change

The municipal level challenges in South Africa are well known.

Implementation challenges, financial sustainability, social delivery protests and, more recently, impropriety scandals have become commonplace in the media and the public discourse.

Add to this the stark challenges of the Covid-19 pandemic, and the promise of a 'better life for all' seems under the most severe threat. As we expand outwards to the national and continental level, the accumulative negative effect is plain to see.

The United Nations (UN) Sustainable Development Goal (SDG) progress reports indicate that for Africa, and even better resourced South Africa by comparison, the development and delivery of water and sanitation solutions are not happening at the pace that will guarantee universal access to clean water and safe sanitation sustainably by 2030. This, unfortunately, is in line with the current global trends. All of which has prompted the UN Secretary General, Antonio Guterres, and UN Water to launch the SDG 6 Global Acceleration Framework and the Decade of Action (2020-2030) in order to catalyse a series of measures in the Global SDG project (for more on this see the September/October 2020 edition of ***the Water Wheel***).

The Global Acceleration Framework is characterised by five critical pillars. Three are the mainstays of finance, capacity building and governance, which remain critical success factors. The other two are new and, like the virus that prompted us into action, novel. These two pillars are data and information, and innovation.

"We want our citizens to be the beneficiaries of the best water supply, wastewater treatment and state-of-the-art affordable sanitation."

This is prompted by the realisation that trying to solve twenty-first century problems with twentieth century technology and nineteenth century operating rules is doomed to failure. We must harvest the best that the Fourth Industrial Revolution (4IR) toolbox has to offer us in the form of intelligent control systems, big data-enhanced design, planning and implementation, as well as artificial intelligence driven monitoring, evaluation and behaviour modification to better practice, smart and more efficient water use and waste treatment.

One of South Africa's ironies is that it is a top-20 producer of new water knowledge, technologies and solutions worldwide, with an unfortunately weak record of scaleup and appropriate commercialisation of these new groundbreaking inventions. This is in spite of having such forward-looking achievements such as the Water and Sanitation chapter of the Industrial Policy Action Plan, and a sophisticated Water Research, Development and Innovation (RDI) Roadmap embedded in the Water and Sanitation Master Plan.

The Local Government Technology and Innovation Forum, a partnership between the Water Research Commission and the South African Local Government Association (SALGA), is a critical intervention to reverse these negative fortunes. The forum seeks to enable four critical pillars.

The first is to set up and expand a network of testbeds for groundbreaking water and sanitation solutions emanating from South Africa and the global RDI partnership. We want South African districts, towns and cities to be among the leaders in sustainable water and sanitation solutions. We want our citizens to be the beneficiaries of the best water supply, wastewater treatment and state-of-the-art affordable sanitation.

We have a number of very important international partners, including the likes of the Bill & Melinda Gates Foundation, the Global Water Research Coalition, the Toilet Board Coalition, the International Water Association and many others that are keen to walk this journey with us. It will hopefully stimulate a positive knock-on effect in Africa and the developing world. We are hopeful that this will further stimulate the private sector to invest in developing and manufacturing these new products and solutions for both the South African and global markets.

The demonstrator test-bed network in our own municipalities will significantly de-risk the enterprise and attract investors foreign and domestic. We can and should be world leaders in such domains as New Sanitation, next generation wastewater treatment where these new plants will become net energy

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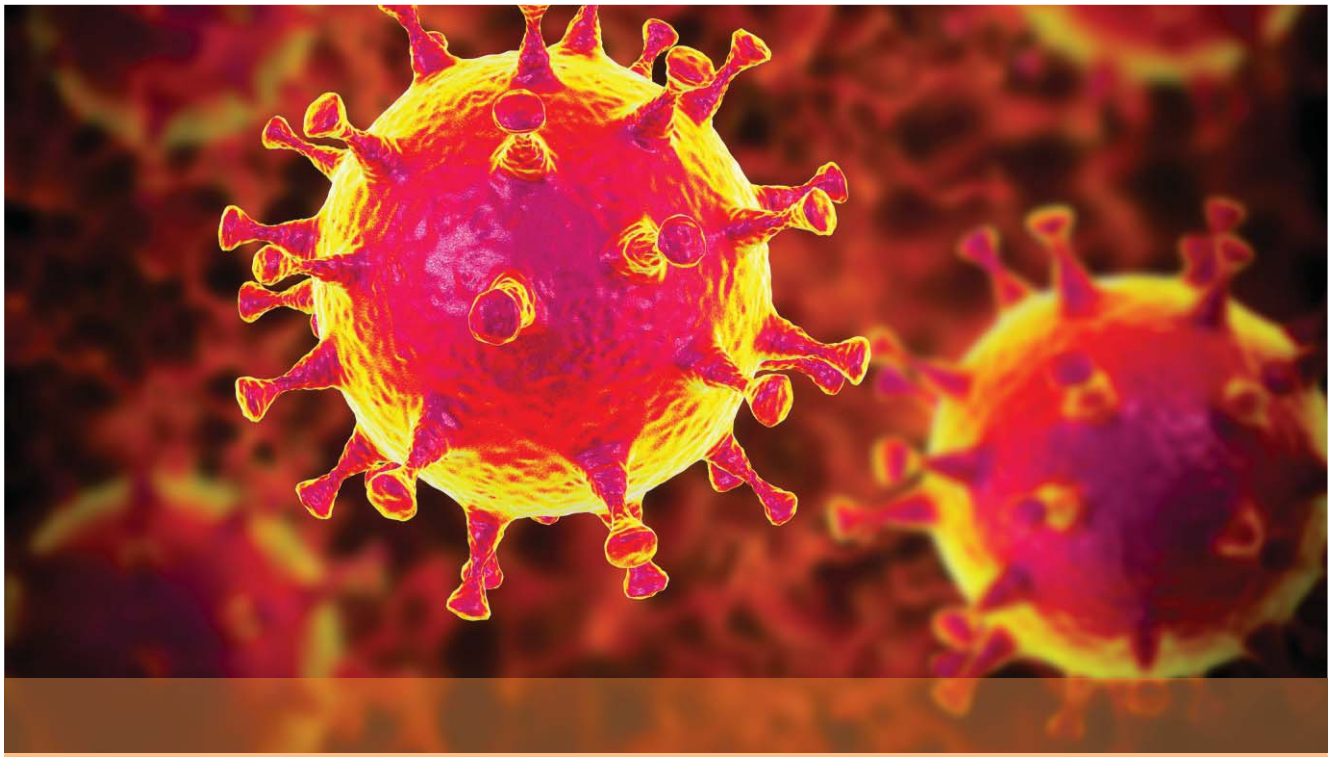
producers alleviating our energy security challenges, and producing clean water from seawater and acid minewater through smart low energy and low-cost desalination technologies already proven in our own laboratories. When we add to this the possibilities related to urban agriculture and water sensitive design, we have the promise of water, energy and local food security enhancements in every municipality in the country.

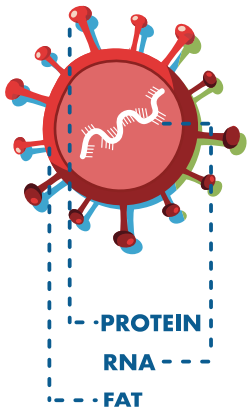
However, access to advanced solutions and 4IR tools are not enough. The other three pillars of the forum are a knowledge and learning partnership network among municipal officials, bridges to influence decision-making and the strength of a collaborative partnership to improve our chances for increased funding and resources to enhance water and sanitation delivery at local level – for all uses and all users.

The pathway to improved water security is a challenging one, especially since all long-term climate change scenarios for the southern African region point to a drier and hotter future. As a country we are already a net recipient of climate change refugees. Let us through this Local Government Technology and Innovation Forum help to stimulate the investments (financial and political) and actions by all parties that enable our municipalities to become the theatres of change and transformation to a better and greener future.

- WRC CEO, Dhesigen Naidoo, delivered this address at the Launch of the Local Government Technology and Innovation Forum in September.



Information resources on water and Covid-19



The following Covid-19 and water related resources are available:

- Water Research Commission http://www.wrc.org.za/corona-virus/
- International Water Association https://iwa-network.org/news/information-resources-on-water-and-covid-19/
- Global Water Research Coalition http://www.globalwaterresearchcoalition.net/
- World Health Organisation https://www.who.int/water_sanitation_health/news-events/wash-and-covid-19/en/
- Water Supply and Sanitation Collaborative Council https://www.wsscc.org/2020/03/31/covid-19-transmission-and-sanitation-and-hygiene-services/

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NEWS

SA President calls on world leaders to prioritise environmental conservation

As countries across the world grapple with rebuilding their economies amid the destruction caused by Covid-19, President Cyril Ramaphosa has called on governments to prioritise environmental conservation.

President Ramaphosa made the call during his address at the virtual Summit on Biodiversity taking place on the sidelines of the 75th United Nations General Assembly in September.

"The Coronavirus pandemic has badly affected the ability of national economies to respond to challenges like environmental degradation and climate change. But even as we prioritise economic revival and reconstruction, we must maintain our collective commitment to environmental conservation," he said.

The President said this was even more important considering that there are strong linkages between environmental destruction and the emergence of new deadly diseases in humans.

"Biodiversity loss, deforestation, the loss of farmland, animal habitat loss and the consumption of wild species are creating conditions for infectious diseases that we will soon be unable to control.

"South Africa commits to working with the UN Environment Programme in the development of tools to track the future emergence of Zoonotic disease," he said.

South Africa is the third most mega biodiverse country in the world, with unique species and ecosystems found nowhere else on earth. South Africa as a signatory to the Convention on Biological Diversity, is working to conserve its biodiversity, promote its sustainable use and ensure the benefits of the commercial use of genetic resources are fairly distributed.

Source: SAnews.gov.za

SA firms commit to less food waste

The Consumer Goods Council of South Africa (CGCSA) has launched the South African Food Loss and Waste Voluntary Agreement, which commits food manufacturers and retailers to reduce food waste.

Launched in September, the Food Loss and Waste Voluntary Agreement was developed by CGCSA in partnership with the Department of Trade Industry and Competition (DTIC) and the Department of Environment Forestry and Fisheries (DEFF). It was co-funded by the European Union (EU) through the SA-EU Dialogue Facility.

Government's partnership with CGCSA and cooperation with the SA-EU Dialogue Facility have been instrumental in the development of the Voluntary Agreement, which will assist South Africa to reduce food waste, in line with the Sustainable Development Goals (SDGs) 2030. It will also showcase the value of public-private partnerships in developing innovative strategies to bolster the circular economy.

The agreement commits CGCSA food manufacturing and retail members to implement measures to minimise and reduce food waste in the country. Speaking at a virtual launch, Environment, Forestry and Fisheries Minister Barbara Creecy welcomed the initiative and its potential to ensure more sustainable consumption patterns in the country.

Creecy noted that water scarcity, land degradation and burgeoning food and packaging waste are some of the major environmental problems of our time. "Organic waste is a major component in any landfill and all efforts to divert this waste through ensuring better use of food products is a significant contribution to our joint efforts to promote resource efficiency," Creecy said.

CGCSA Food Safety Initiative Executive Matlou Setati said the current estimates show that about 10 million tonnes of local agricultural produce in South Africa is wasted each year.

"This is equivalent to an estimated R60 billion a year. In a country where an estimated 14 million people go to bed hungry every night, this is a monumental unnecessary waste, which cannot be allowed to continue," Setati said.

Source: SAnews.gov.za

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Groundwater brings relief to Karoo town

Groundwater specialists from SRK Consulting have assisted Prince Albert Local Municipality in the Karoo to ensure a reliable and sustainable supply of groundwater to local communities at Leeu Gamka.

According to Ashley America, Manager Infrastructure Services at Prince Albert Local Municipality, the addition of three boreholes was able to resolve supply issues arising from the low yield from existing boreholes, and the poor water quality that strained the municipality's reverse osmosis (RO) treatment system. America said that Leeu Gamka had three communities requiring a more stable water supply – Bitterwater with 606 households, Newton Park with 26 households and the Transnet housing scheme with 40 households.

Leon Groenewald, principal hydrogeologist at SRK Consulting, said the most productive of the existing boreholes in the area was able to deliver an hourly yield of between 15 000 and 18 000 litres, supplying a maximum volume of 432 000 litres per day.

"This fell considerably short of the peak daily demand for Leeu Gamka during the summer season between November and January, which reaches 610,000 litres," said Groenewald.

To supplement the shortfall, the municipality were forced to use two other production boreholes which were unsustainable and low-yielding. Their poor water quality also meant the water required extensive treatment by the RO treatment plant before it could be rendered potable.

SRK began work with the municipality during the drought in 2017, when initial geohydrological work began, followed by drilling and testing of potential boreholes. This was funded by the Drought Relief Fund through the Western Cape Department of Local Government.

The first phase of the project involved an extensive geophysical survey and geological mapping. Boreholes were sited and a drilling contractor selected and supervised by SRK. Based on what the client required, the yields were tested and interpreted, to ensure that the pumping regime could meet the communities' water needs while remaining sustainable.

"Our drilling and testing programme produced three boreholes that could be used by the municipality, with a combined yield of 518,000 litres per day," he said.

The second phase of the project – which was completed earlier this year – involved the equipping and commissioning of the boreholes. SRK was again engaged by the municipality for phase two, for a range of services. These included borehole pump design and installation, pipeline design to connect boreholes to existing infrastructure, as well as project and contractor management.

SA research institute celebrates 75 years

The Council for Scientific and Industrial Research (CSIR) has marked 75 years of conducting research aimed at improving the quality of life of all South Africans on 5 October.

The council was established through an Act of Parliament in 1945, with the organisation's executive authority being the Higher Education, Science and Innovation Minister.

The CSIR plays a significant role in supporting both the public and private sectors through directed research that is aligned with the country's priorities, the organisation's mandate and its science, engineering and technology competencies.

Nothing this research excellence, Higher Education, Science and Innovation Minister, Dr Blade Nzimande, said that the CSIR has put South Africa on the global map by leading research and technological development in the country. "Over the years I have been observing, with great pride, the work that the organisation does; work that had made a huge contribution to our country. We are proud of what the CSIR has achieved in the past 75 years through science, technology, engineering and innovation.

"We also pay tribute to the leadership; the scientists and all the support staff, who over the years…have passionately, and are continuing to contribute to the transformation of the organisation", he said.

Source: SAnews.gov.za

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GLOBAL

New malaria mosquito threatens mass outbreaks in Africa

Africa has just months to react to an invasive malaria mosquito that thrives in cities, before the situation escalates beyond control, experts warn.

Scientists predict that more than 125 million city dwellers across Africa will face a higher malaria risk from a type of Asian mosquito that is quickly moving across the continent. The mosquito, ***Anopheles stephensi***, is one of the few malaria mosquitos that thrives in urban areas because of its ability to find clean water to lay its eggs.

Malaria is traditionally considered to be a rural disease. In Africa, city centres can be completely free of malaria transmission, according to experts from the London School of Hygiene and Tropical Medicine (LSHTM).

But, the invading mosquito could drastically alter the location and movement of malaria in Africa, which records 94% of global malaria deaths, mostly in children under five. "I think it's really quite scary," says Jo Lines, professor of malaria control and vector biology at LSHTM. "It's part of our duty as [scientists] to be saying: 'Look here, something's happening here.' If we don't shout now it will be too late."

New research led by Marianne Sinka, a senior postdoctoral researcher at the University of Oxford, says that ***An. stephensi*** may already be adapting to its new environment and becoming active year-round.

"If it continues its incursion into the African continent unchecked, there is a very real possibility of mass outbreaks of malaria," Sinka's team says. "In a continent striving to improve and strengthen its health systems, such a huge burden could be catastrophic. Targeted vector surveillance is therefore urgently needed."

The research has been published in the Proceedings of the National Academy of Sciences of the USA (PNAS). To view the original research article, Visit: https://www.pnas.org/content/early/2020/09/08/2003976117#sec-7

Guidelines proposed for sustainable use of invasive trees

A team of international scientists, including several with current or previous affiliations with the South Africa Centre for Invasion Biology (CIB), have collaborated to propose a series of global guidelines for the sustainable use of non-native tree species to help protect biodiversity and ecosystems around the world already threatened by climate change.

The paper, published in the journal ***NeoBiota***, uses the Council of Europe – Bern Convention Code of Conduct on Invasive Alien Trees as a starting point to present eight recommendations aimed at maximising the benefits of non-native trees, while minimising their negative impacts.

The guidelines include using native threes wherever possible, or non-invasive non-native trees as opposed to invasive non-native trees; being aware of the risk of invasion and considering global change trends and developing and supporting global networks and collaborative research and information sharing on native and non-native trees.

The scientists suggest that the guidelines are a first step towards building a global agreement on the precautions that should be taken when introducing and planning non-native trees. The aim is that the guidelines should serve to complement statutory requirements under international and national legislation.

To view the original article, Visit: https://neobiota.pensoft.net/article/58380/

Source: CIB

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Water scientists warn of risks in shift to monoculture crops, tree plantations

Conversion of large swaths of land to uniform tree plantations and single-crop species may lead to unintended consequences for the water cycle, putting ecosystems at greater risk for fires, floods, droughts and even hurricanes, warns a think-tank group of almost 30 water scientists from 11 countries.

Worldwide, policies are increasingly aimed at planting more trees and crops both to combat climate change and increase food and fuel production. Already about 40% of the world's ice-free land surface has been converted to forestry and agriculture – often with only a few choice tree species and crops where biodiversity once thrived. This trend is poised to continue or even accelerate.

But in an article published in ***Nature Geoscience***, the scientists argue that mixed-species diversity is crucial to the water cycle pathways that enable soil-plant-water systems to recover quickly from environmental stresses. Forestry and agricultural monocultures (growing a single species repeatedly on the same land) can constrain these pathways, adversely affecting conditions such as soil moisture and erosion, streamflow, evaporation, and groundwater quality--and ultimately reducing ecological resilience.

The authors urge policymakers and land managers to take into account critical water-vegetation interactions to guide decisions about what to plant and where. "When we modify landscapes to help combat climate change or meet human demands for food and energy, we need to be smart about it," said Irena Creed, a University of Saskatchewan hydrologist who co-led the think tank paper with University of Delaware researcher Delphis Levia.

"We need to emulate what was natural by not relying on just a few choice crops or trees but instead embracing biodiversity. When you narrow biodiversity to a few select crops, it makes the whole ecosystem vulnerable."

Creed explains that the rate, timing and magnitude of water released to the atmosphere varies with each plant species. "By having a diverse range in the rate of water movement, you are building a more diverse water system that can withstand water stresses such as droughts and fires," she said.

Read the paper here: www.nature.com/articles/s41561-020-0641-y

World aquatic scientific societies call for drastic action against climate change

Aquatic scientific societies around the world, including South Africa, have called for urgent action to be taken against climate change.

In a published statement the societies noted how the world's aquatic resources are now under their greatest threat in human history. "Human-caused climate change is accelerating the degradation of aquatic ecosystems and the services they provide. Aquatic ecosystems are among the most affected worldwide (e.g., in case of freshwater ecosystems, one measure of biodiversity, the freshwater living planet index for species populations, declined 83% from 1970 to 2014).

We, the world's aquatic scientists, spend our lives studying these systems. We see exceptional and disturbing changes in the world's aquatic ecosystems due to climate change and believe that we must continue to share peer-reviewed scientific findings with the public and policymakers to emphasise the seriousness of this threat and the need for immediate action."

Climate change impacts already occurring range from increased frequency, intensification, and severity of droughts, heat waves, floods, wildfires, and storms; melting glaciers; destabilisation of major ice sheets; shifting ocean currents, rising sea level; ocean acidification and deoxygenation; shifts in species ranges, including expansion of alien-invasive species; aquatic plant and wildlife disease outbreaks; mass coral bleaching events; and more, with a mounting toll on vulnerable ecosystems, human societies, and local and global economies. These events are precursors of even more damages to fisheries, biodiversity, and human society at large.

"If humanity wishes to avoid calamitous consequences for our aquatic ecosystems and humans that depend on them, the time to curb greenhouse gas emissions, sequester greenhouse gasses, and adapt to an already changing climate is now," the scientists said. "Intelligent, rapid movement toward such goals will provide great benefits to aquatic ecosystems and the humans that depend on them."

The scientist further propose a rapid transition towards energy sources and other products and services that do not release greenhouse gases, and research and policies that favour an efficient transition to a low carbon world to slow the degradation of aquatic systems.

"Done intelligently, movement to curtail human-caused climate change can result in advanced, novel technologies; strong economies; healthier aquatic ecosystems; greater food security; and human well-being."

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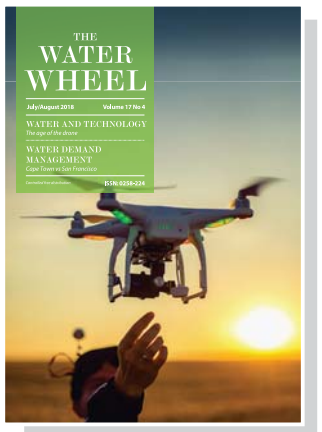

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WRC MOVES TO PILOT STUDY TO MONITOR COVID-19 IN WASTEWATER

Following the conclusion of a successful proof-of-concept study to test various monitoring techniques, the Water Research Commission has moved to the next step to establish Covid-19 monitoring through wastewater in South Africa. The research programme is being undertaken in association with the South African Local Government Association (SALGA).

Many Covid-19 infections are asymptomatic and, unless tested, remain undetected. Recent studies have shown that environmental surveillance of SARS-CoV-2 biomarkers – called RNA – can be a low-cost solution for tracking COVID-19 outbreaks in communities. This is because, once in the body, the virus can be shed through faeces and urine, as well as through saliva and other respiratory discharges. The virus and/or its remnants are introduced into water resources and wastewater through the discharge of human waste, coughing and sneezing while bathing or showering, washing of hands or clothes, and discarding tissues and wipes into the toilet.

Therefore, the presence or absence of SARS-Cov-2 in wastewater entering a sewage treatment plant can determine the presence of infected individuals in a community, and can be used as an epidemiological indicator, especially where community testing is not possible. Critically, this will provide decision support for officials determining the timing and severity of public health interventions to mitigate the overall spread of the disease. A number of countries have since the outbreak of the Covid-19 pandemic introduced wastewater-based epidemiology.

Proof-of-concept study

For this reason, the WRC, with SALGA, launched a project earlier this year to test the concept of detecting RNA signals of the SARS-CoV-2 virus in wastewater samples in South Africa. The study served as a short-term, proof-of-concept study prior to the rollout of a national surveillance programme.

Wastewater was collected from ten wastewater treatments works in several provinces over a period of four weeks. Samples were also collected from a hospital and a prison. In addition, samples were collected from small wastewater treatment works serving industries and mines.

As an indicator for SARS-CoV-2 prevalence in non-sewered communities, four surface water grab samples were collected from the Jukskei River downstream of Alexandra informal settlements, the Hennops River, downstream of Tembisa informal settlement, as well as the Blougatspruit in the Cradle of Humankind. A surface water runoff sample was also collected from Alexandra.

Three virus recovery methods were tested, based on their ease of use and cost-effectiveness. All three these methods tested were effective in the recovery of the SARS-CoV-2 virus.

Main results

SARS-CoV-2 RNA was detected in 98% of wastewater samples collected. This confirms and demonstrates the power of wastewater surveillance of the SARS-CoV-2 virus responsible for Covid-19, and has demonstrated the proof of concept. An increase in viral load also corresponded with an increase in clinical cases in the same area. All the environmental samples tested positive for the presence of Covid-19 as well.

Sampling of combined sewage for a defined population, such as a prison, hospital or hostel can be useful for surveillance of increased viral load to give early warning of a possible surge in infections, the study has established. It is important, however, that regular samples be taken over time to establish trends and baselines, due to the inherent variability of sampling from smaller populations compared to a regional wastewater treatment plant. This could provide a cost-effective and less invasive means of continuous screening. Where increasing trends in viral load are noted, additional clinical test methods could be rolled out based on an early warning system.

Way forward

Phase two of this initiative, which involves pilot-scale monitoring, is expected to kick off before the end of the year. Partnerships for pilot-scale monitoring have been established through phase one between laboratories, municipalities, the Department of Water and Sanitation, private sector and research organisations. This phase will see the scaling and commissioning of a collaborative monitoring initiative in provision hotspots using the sampling and testing protocols developed in phase one.

To download the report, ***Proof of Concept study: Application of wastewater-based surveillance to monitor SARS-CoV-2 prevalence in South African communities*** (**WRC Report no. TT 832/20**)
https://bit.ly/3mji1YK

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ENVIRONMENTAL REFUGEES

Extreme events driving people from their homes

A recently completed research project by the CSIR and co-sponsored by the Water Research Commission (WRC) has highlighted the plight of Southern Africa's environmental refugees. It is the first time that such a project has been completed in the region. Sue Matthews reports.

EU Civil Protection and Humanitarian Aid)

A little over 20 years ago, on 1 March 2000, Rosita Mabuiango was born in a tree in southern Mozambique as floodwaters from the Limpopo River swirled below. The story made headlines around the world and highlighted the human element of the devastating floods, during which some 800 lives were lost and more than 100 000 people displaced. It helped open hearts and minds to the people's plight, and foreign aid and donor funding poured in for humanitarian assistance. Mozambique was able to establish resettlement camps and subsequently work-for-assistance programmes to encourage people to relocate to areas further away from floodplains.

In 2013, the region experienced severe flooding again, and the impact in Gaza Province exceeded that of the earlier floods, with 150 000 people temporarily displaced. Apart from significant damage to homes, schools, shops and health centres, infrastructure such as roads, electricity networks and drainage systems was affected, disrupting service delivery and the ability of people to resume normal life once the floodwaters had subsided. Those relying on agriculture to sustain their livelihoods had lost livestock and crops in the floods, so relocating to the resettlement camps – upgraded after the 2013 floods – was seen by many as a sensible choice. Some of the inhabitants now commute between the camps and their former lands to practice subsistence agriculture, while others depend entirely on government grants and NGO-facilitated aid.

Should these people be considered environmental refugees, or migrants? And what about the thousands of Zimbabweans who have crossed into South Africa, partly in response to El

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Niño-induced drought? Climate change is expected to increase the frequency and intensity of extreme events such as floods and droughts, and the World Bank predicts there will be 0.9–1.5 million internal displacements linked to climate change by 2050. Clearly, getting a better understanding of the drivers and impacts of environmental displacement and migration is important.

This was the motivation for a three-year project, called 'Kukimbia – the impact of environmental refugees in Southern Africa', which was conducted by the Council for Scientific and Industrial Research (CSIR) and co-funded by the Water Research Commission. Kukimbia is the Swahili word for 'run', referring to the need to flee from an environmental disaster or threat, and the project team used the Mozambique and Zimbabwe examples as case studies. More specifically, the 'Gaza Province case study' dealt with internal displacement and planned relocation within Mozambique in response to flooding – a rapid-onset event – while the 'Limpopo case study' in the Musina area addressed cross-border migration into South Africa, linked to slow-onset events, primarily drought.

Data collection for the project relied mainly on surveys, semi-structured interviews and focus group discussions. In their Final Report, the researchers used the case studies to discuss why people move and whether they can be classified as environmental migrants, to investigate the adaptive capacity of interview respondents in their new location, and to consider the impacts of the migrants on the areas to which they have moved.

The project team used the term 'migrants' rather than 'refugees' in the report, because the latter term is reserved for people who are 'unable or unwilling to return to their country of origin owing to a well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group, or political opinion', according to the 1951 Refugee Convention.

In the Limpopo case study, some survey respondents indicated that they did see themselves as refugees rather than environmental or other types of migrants. This was particularly the case for respondents from the Democratic Republic of the Congo (DRC) and Burundi, who said they had left their home countries because of political tensions and violence there that made them fear for their lives. By contrast, respondents from Zimbabwe mostly came to South Africa in search of employment opportunities, and did not consider themselves refugees. Some respondents indicated that environmental conditions strongly affected their decision to migrate to South Africa. This is because drought conditions in 2015/16 had exacerbated food shortages in their home country, where almost three-quarters of the population survives on less than US$1.25 per day.

"There was a drought – we had no rainfall for a very long time and could not grow crops, and we could not feed our families," said one. "Regardless of the drought, I would have moved to South Africa because there are no jobs back in Zimbabwe, and I wanted my kids to go to school."

Another said that even once the drought had broken, the

Arjan van der Mewer/UN Photo

Experts are expecting increasing displacements of people due to extreme events linked to climate change.

Hanna Butler/EU Civil Protection and Humanitarian Aid

An abandoned village in Gaza Province, Mozambique, following the floods in 2013.

economic and political situation was too dire to make them want to stay in Zimbabwe. "When we do receive rainfall, harvest is plenty, but how can we sell our harvest when people have no money … Politics is a huge problem."

The project team emphasise that – given South Africa's attractiveness to people from elsewhere in Africa – the country is unlikely to be able to implement a strictly enforced 'keep out' policy successfully. One reason is the relative ease with which people can cross the border illegally from Zimbabwe, by walking across the dry riverbed of the Limpopo River in the winter months and clambering over the broken-down border fence.

"The government's intentions to document and regularise international migrants already in South Africa is probably a step in the right direction," says project leader, Nikki Funke from the CSIR. "This can be supported by various initiatives, such as strengthening and improving upon existing formalised labour exchange programmes outside of the normal general work permit procedures. An example is the current Zimbabwean Exemption Permit, which legalises Zimbabweans living, working and studying in South Africa."

In the Gaza Province case study, almost 70% of survey respondents had been affected by severe flooding in 2000 and/or 2013. Most of those interviewed in Chinhacanine resettlement camp said that they preferred to stay in the area rather than return to their place of origin. This was partly because government had provided infrastructure and services at the camp, such as schools and water supplies, whereas the respondents had previously collected water from ditches near their homes, and their children had to travel to secondary schools 30–40 km away, resulting in a high drop-out rate. But it was also simply because they understood the risks of returning to the floodplain.

"We lost our belongings. We lost them twice, in 2000 and in 2013," said one. "We will not want to experience this three times. We will not return."

Another said, "We are no longer willing to live there. Because we have had enough of rain and floods. We are tired of water. We don't want to be worried about any kind of rain. In the past once it rained we got worried that our houses would get flooded."

However, at the Chiaquelane resettlement camp in Chokwe district, many people had returned to live in low-lying, flood-prone areas near Chokwe town. The reasons included wanting to resume their farming activities or to be closer to the services and opportunities available in the town. And as mentioned previously, some people are commuting between the camp and the more fertile agricultural land in the floodplain.

"While the Mozambican government has expressed a concern about people returning to their areas of origin, it should perhaps try to embrace such movements and develop ways of enabling people to benefit from both their areas of origin and the safe havens to which they have been resettled, for example through secure tenure of both parcels of land," says Funke. "An alternative may be to further develop the resettlement areas, by providing more economic opportunities, amenities and services, in order to make them more attractive to stay in."

Apart from writing up the research in a technical Final Report, titled 'Environmental migrants – the forgotten refugees affected by slow-onset and rapid-onset events in two case study areas in the Limpopo River Basin, Southern Africa', the CSIR team produced a video about the project, which is available on the WRC's YouTube channel.

In addition, having investigated the policy landscape and the preparedness of the South African and Mozambican governments to respond to future internal and cross-border displacements as a result of environmental disasters, the project team developed three sets of policy guidelines – one directed at each of the countries' governments and the third for SADC decision-makers.

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The project team's documentary Environmental Migrants: The forgotten refugees can be found on the WRC's YouTube channel, or at the link below: https://www.youtube.com/watch?v=QSONXA2yB5I

In the South African guideline, the authors point out that our country is obligated to provide humanitarian assistance in cases of emergency to the six neighbouring countries with which it shares borders. Its disaster management structures are designed to respond to rapid-onset events like floods and storms, but it is far harder to assist with slow-onset disasters such as drought, and manage the associated migration into South Africa. Both the White Paper on International Migration and the 2011 National Climate Change Response White Paper make reference to environmental migration, providing some legal framework to address the issue.

The policy guideline therefore includes the following recommendations for improved management of this migration.

- *Make migration one of several possible adaptation options*
  Building the adaptive capacity of rural communities by, for example, providing financial support and expertise to adapt agricultural practices to the effects of changing climate, could help reduce the number of people migrating to urban areas in search of better opportunities.

- *Adopt shared responsibility for cross-border environmental displacement and migration at the bilateral, regional and international level*
  South Africa should not have to bear sole responsibility for taking care of migrants who enter the country as a result of environmental and other factors. The African Union (AU) and its regional communities, in consultation with global migration governance bodies such as the United Nations High Commissioner for Refugees (UNHCR), need to collectively develop a coherent and systematic approach based on the AU's Migration Policy Framework for Africa and Plan of Action (2018–2030).

- *Prevent and mitigate environmental displacements and migration of individuals living in areas of risk*
  Human mobility aspects need to be integrated into South Africa's disaster risk reduction and climate change adaptation policies and strategies

- *Address the need for rigorous and robust research on the extent and impacts of migration in South Africa*
  Conflicting data on the number of international migrants residing in South Africa makes it impossible to determine their true impact on the economy and on local services and systems, let alone plan for and address such impacts.

In the policy guideline as well as the technical report, the project team conclude by noting that a better understanding of the impacts – both positive and negative – of international migrants could help avert xenophobic attacks in South Africa, given that these are typically fuelled by rumours and emotional reactions.

- Funke N, Jacobs-Mata I, K Nortje K, Nohayi N, Raimundo I, Meissner R, Kgaphola J, Mngadi T and Moyo E, 2020. ***Environmental migrants – the forgotten refugees affected by slow-onset and rapid-onset events in two case study areas in the Limpopo River Basin, Southern Africa***. Water Research Commission, Pretoria (in print)

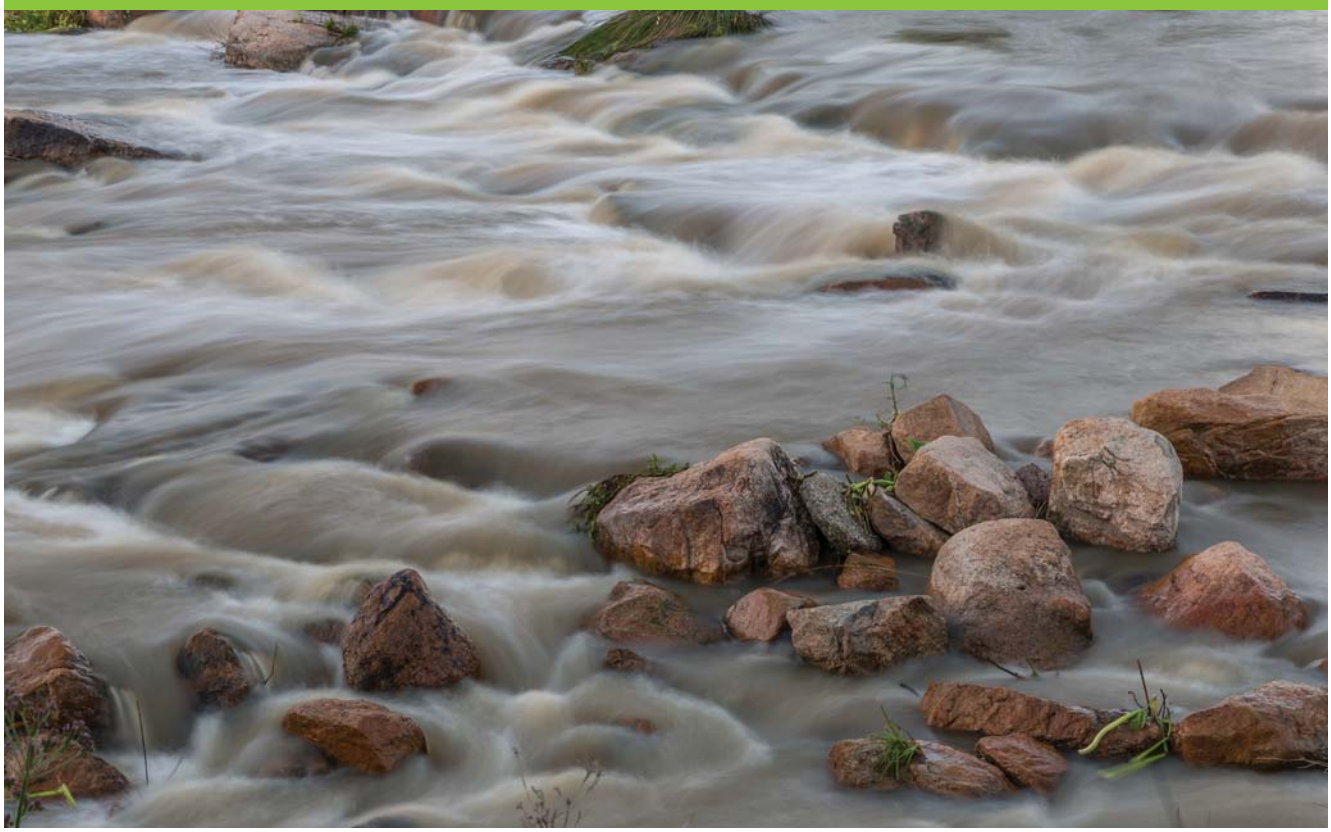
Hanna Butler/EU Civil Protection and Humanitarian Aid

Makeshift shelter at Chiqakalane Cam, Mozambique, following floods in 2013.

FRESHWATER BIODIVERSITY

Mapping for the future: Taking stock of priority freshwater priority areas

A decade after a comprehensive atlas of freshwater ecosystem priorities areas in South Africa was produced, planning is underway to update and improve it. Article by Jorisna Bonthuys.



There is no doubt that South Africa's freshwater ecosystems are under pressure and have already been degraded. Currently, our wetlands and associated river systems are in a critical state, with over 65% reported to be damaged and 50% estimated to have been destroyed.

This situation is even more alarming when future pressures on water resources are considered – the demand for water is predicted to escalate dramatically over the next few decades.

South Africa's water resources are already scarce and limited in extent. South Africa is one of the driest countries in the world, with an annual average rainfall of less than 500 mm, a significantly lower amount than the world annual average of 860 mm. A fifth of South Africa receives less than 200 mm rain a year. The country's average rate of potential evaporation is more than three times the rainfall.

Many parts of the country are also expected to become drier as a result of climate change, threatening local water supplies. Demand outstrips supply in parts of the country and compounds water issues.

Identifying freshwater priority areas remains key to ensure water security, as does the uptake of this information to ensure effective decision-making and planning.

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Spotlight on freshwater ecosystems

South Africa's national atlas of freshwater ecosystem priority areas, commonly known by its acronym NFEPA, was first published in 2011. It is a data-rich, visual tool that helps planners and policymakers identify strategic spatial priority areas for conserving rivers, wetlands and estuaries.

This information is visualised in maps of those areas considered the most important for sustaining the integrity and functioning of freshwater ecosystems and which ones should be kept in a natural or near-natural condition. The NFEPA project ran as a partnership between research institutions, government agencies, and non-government organisations.

Its outputs included the atlas (showcasing the maps), an implementation manual (a practical guide on how to use the maps in policy mechanisms), management guidelines for the different map categories, and a technical report (explaining the science that underpinned it).

The research that underpins these outputs was undertaken by the Council for Scientific and Industrial Research (CSIR), the South African National Biodiversity Institute (SANBI), the WRC, the Department of Environmental Affairs, the Department of Water Affairs, WWF South Africa, the South African Institute for Aquatic Biodiversity and SANParks.

Now efforts are underway to produce a second version of the atlas. This version will be informed by the best available science and knowledge generated over our freshwater areas over the last decade. This planned review was the focus of a symposium titled 'NFEPA review: A decade of service', organised by the WRC earlier this year. The need for improving national-level data of priority freshwater resource areas, through ongoing research and monitoring, was discussed in detail during this event.

Taking stock of the NFEPA project

The NFEPA project delivered the country's first systematic conservation plan for freshwater ecosystems. "The atlas highlighted that freshwater resources are conservation priorities in their own right," lead author, Dr Jeanne Nel, said.

At the time, the priority areas were identified based on a range of criteria dealing with the maintenance of vital ecological processes as well as the conservation of ecosystem types and species associated with rivers, wetlands and estuaries.

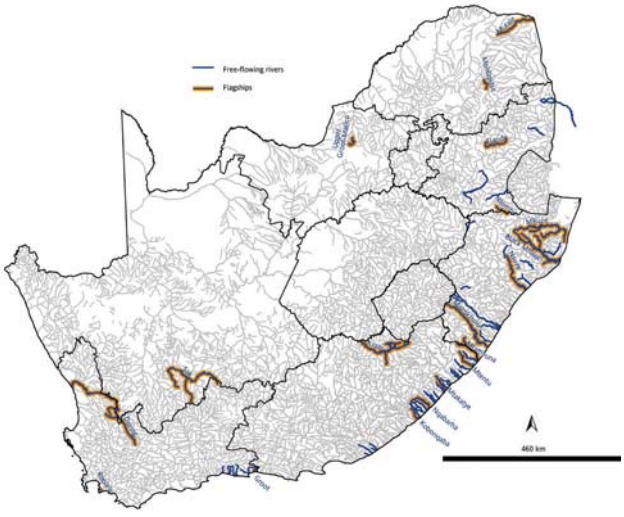
"One goal was to identify freshwater ecosystems, such as rivers and wetlands, that should be prioritised for biodiversity protection," Nel explained. "Another was to promote the adoption of co-produced outputs by relevant agencies."

The project was a joint effort between the water and biodiversity sectors to incorporate freshwater ecosystem goals into water resource planning and management. The project was run by a project team comprising both researchers and managers. They incorporated the expertise of over 100 stakeholders in this project.

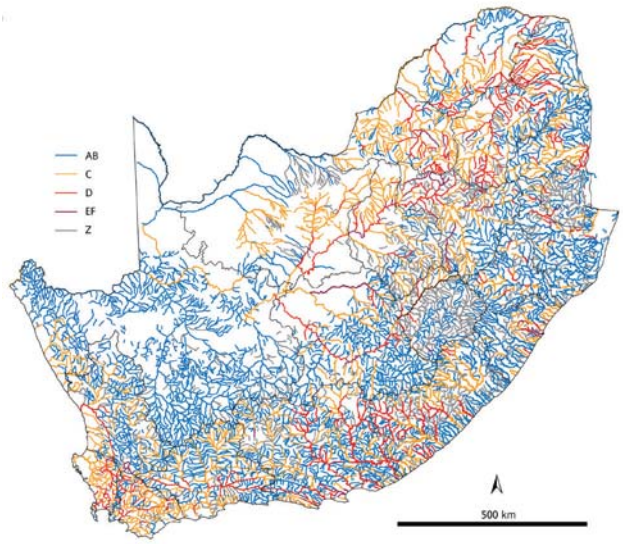
Spatial data informed the selection of the priority areas which were reviewed in a series of workshops. The map products were designed with user needs as well as the relevant policy and legal contexts in mind, Nel explained.

"The project supported efforts to ensure that healthy ecosystems continue to form the cornerstone of our water resource classification system and the development of catchment management strategies," Nel said. "The maps generated have informed planning and decisions about land use and the expansion of the protected area network, among others"

The maps also informed water resource planning and management at a primary to sub-quaternary catchment scale.



The NFEPA project identified South Africa's large free-flowing rivers.



River condition in South Africa as identified by NFEPA, with blue indicating unmodified, natural rivers and red and purple indicating largely and seriously modified rivers, respectively.

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The Sabie River is one of the most biologically diverse rivers in South Africa.

"These visual tools provided context for decision-making at the local and site scale," freshwater ecologist Nancy Job from SANBI indicated.

The atlas has since been well embedded in relevant freshwater assessments, including in national and provincial strategies and planning processes, and by consultants in environmental assessments, Job highlighted.

There have also been applications of NFEPA by different departments. The Department of Water and Sanitation is, for instance, working on actions to declare strategic water source areas as well as critical groundwater recharge areas. Strategic water source areas for surface water cover about 10% of the country. These areas provide 50% of South Africa's total mean annual runoff and most of its groundwater recharge, sustaining most of the perennial rivers.

Efforts are also underway to implement resource directed measures in main stem rivers of the Berg, Breede and Gouritz, as well as middle and upper water management areas. These efforts were outlined by Yakeen Atwaru from the Department of Water and Sanitation's chief directorate responsible for water ecosystems.

Unpacking NFEPA's shortfalls

NFEPA received several "constructive criticisms" based on the accuracy and omission of some ecologically sensitive areas, Nel indicated.

There has been good application of the freshwater priority areas in biodiversity planning and land-use planning and decision-making processes. However, there has been limited improvement in the monitoring and management of these areas. This is partly due to the ongoing absence or reduction of scientific staff in key institutions and funding issues.

"Some institutions have raised concerns about the lack of confidence of the wetland priority area maps – these need to be a key priority for the updated version," Job said. "The river freshwater priority areas have, in contrast, been quite reliable in the first version of the atlas. They received quite extensive expert review. The National Biodiversity Assessment 2018, however, noted that some of our information is still based on data last collected in the field in the 1970s."

Dr Albert Chakona from SAIAB noted that dedicated surveys are needed in some provinces for freshwater fish. Availability of credible fish data, where the species identification is validated with voucher samples and genetic data, is a challenge. The Western Cape and parts of the Eastern Cape are the only provinces with extensive updated data. There is a need for dedicated resources that allows for fine-scale geographic sampling and taxonomic verification. In some provinces, information has not been updated since the 1970s. The identification of priority areas is, therefore, based on, at times, outdated data.

Despite the momentum that NFEPA generated, the impetus seems to have declined between 2016–2018, primarily as a result of declining funds at national and provincial departments. This negative trend in funding had a negative impact on staff appointed to do the implementation and monitoring, as well as operational costs to facilitate monitoring, Job pointed out.

2020 and beyond

New knowledge has been generated over the last decade, including updated information on wetlands and freshwater species generated for the National Biodiversity Assessment 2018 and about Ramsar sites. These sites are recognised as wetlands of global importance.

There is also updated information available about the country's protected area network, taxonomic updates of fish species, and DEFF's environmental impact assessment screening tool guidelines for ecosystems and species.

The process of translating national-scale products to finer scales has been relatively well done for rivers, inland wetlands, important fish areas, but not yet for water resource classes. Findings of the need to establish climate change buffer areas must also be considered. The reconciliation of the overall class of a catchment and the local scale information also needs consideration, participants highlighted.

"The next version of the atlas could consider a hierarchy of important freshwater sites, starting with sites with legal protection," Job said. "It could also approach prioritisation with estuaries and catchments in mind and include an update of wetland classification and condition."

Updating the wetland priority areas is considered a vital component of this planned review. Job said: "The river priority areas have, in contrast, been quite reliable in the first atlas. However, longer-term priorities include refining the river ecosystem classification and riparian zone mapping."

The next version must also be aligned with the protection of the strategic water resource areas through various efforts, said Pamela Kershaw from DEFF. "These areas form the foundational ecological infrastructure on which a great deal of built infrastructure for water services depends," she said. "They are also an important mechanism for long-term adaptation to the effects on climate change on water provision, growth and development."

Yet the National Biodiversity Assessment 2018 showed that

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freshwater ecosystems and species need more management and protection. "These areas, part of working landscapes across the country, should be integrated into planning, oversight and governance," Job emphasised. "In light of predicated global and regional changes in weather patterns and ever-increasing resource pressures, we should protect the remaining areas that are still intact and functioning. It is crucial to develop a long-term collaborative framework of work focusing on priority freshwater areas, with partnerships for monitoring and evaluation," she said.

The management of national freshwater ecosystem priority areas requires a balance between protecting them and the ecosystems services they provide, and continued human activities. Due to low levels and uneven distribution of protection, they are highly vulnerable to inappropriate development.

Maintenance, restoration and rehabilitation of ecosystems, ecological processes and biodiversity are the most cost-effective ways to guarantee the water quantity and quality flowing from strategic water source areas, Kershaw added.

There remains a gap between the tools, implementation and a measurable impact in alleviating the key identified pressures. These gaps will require a substantial investment of human and financial resources, both by the government and the private sector.

Skumza Ntshanga, DEFF's chief director of biodiversity and conservation, said South Africa has a comprehensive suite of spatial planning tools available which should be used to secure freshwater priority areas. There currently is not a silver bullet for protection. All legislative avenues should be used, she said.

Dr Boyd Escott from Ezemvelo KZN Wildlife proposed that water resource management should be embedded into the Spatial Planning and Land Use Management Act (No. 16 of 2013). This approach is needed to prevent unregulated developments at the expense of priority freshwater areas, he said. Currently, the zoning of such areas has not made allowance for water resource management.

"Town planners need spatial management tools including guidelines to inform actions that take strategic water source areas into consideration," Escott said. "We need a (data) layer specifically developed for spatial planning purposes that can help town planners which specifies what can be done and where."

"A new phase of research is required," Nel added. "Research for this new phase should be linked to implementation activities, for science to inform policy."

- Both the atlas and implementation manual are available from the WRC or can be downloaded from http://bgis.sanbi.org.

Our threatened aquatic ecosystems

- Estuaries and wetlands are the most threatened and least protected ecosystems in South Africa.
- Freshwater fishes are the most threatened species group in the country.
- Estuaries have the highest proportion of threatened ecosystem types (86%), followed by inland wetlands (79%) and rivers (64%).
- Rivers and inland wetlands have the highest proportion of types in the critically endangered category (42% and 61% respectively)

Source: SANBI's National Biodiversity Assessment (2018)

Healthy rivers are essential to the conservation of biodiversity in South Africa.

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WATERBORNE DISEASE

Billharzia and its snail vectors under the spotlight in current study

A Water Research Commission funded project is looking into the distribution and endemic knowledge of bilharzia in South Africa, particularly considering the potential increase of this waterborne disease due to climate change. Article courtesy Lizaan de Necker.

Nico Smit

Project leader, Dr Lizaan de Necker, with fellow postdoctoral fellow Dr Hannes Erasmus and Honours students Nobukhosi Sithole and Herman le Roux conducting field work for the bilharzia research project

Climate change and its predicted associated changes to rainfall patterns and air temperatures is one of the most important threats that aquatic ecosystems face in the 21st century. Freshwater ecosystems are some of the most at-risk habitats, particularly where these systems are already exploited by humans (UNU-EHS 2016).

The most prominent predicted ecological consequences of climate change include modification to water quantity and quality, aquatic species distribution and ranges, and increased waterborne and vector-borne diseases (see Dallas and Rivers-Moore 2013 for a full review). Climate change also poses a great threat to human health, and it is predicted that by 2030 sub-Saharan Africa will carry the greatest burden of mortality due to impacts of climate change (WHO 2009).

Climate change can severely impact human health directly by increasing the frequency of severe weather and climatic events such as flooding, droughts and extreme temperatures, and indirectly through environmental changes that affect food security, air quality and the distribution and occurrence of various diseases (Nhamo and Muchuru, 2019). Within the interior of South Africa, it is predicted that mean annual air temperatures will increase by 3-3.5°C while the coastal regions will experience a 1.5-2.5°C increase. In summer rainfall areas the mean annual rainfall will increase by 40-80 mm per decade while this will

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decrease by 20-40 mm per decade in the winter rainfall areas. Limpopo, Mpumalanga and Kwa-Zulu Natal (summer rainfall regions) will therefore experience hotter and wetter conditions in summer and autumn, while the Western Cape and southern parts of the Eastern Cape (winter rainfall regions) will experience hotter and drier winter conditions (Dallas and Rivers-Moore 2013).

Schistosomiasis, commonly known as bilharzia, is a disease caused by parasitic trematodes (flatworms) of the genus ***Schistosoma*** that affects both humans and animals and is classified as a neglected tropical disease by the World Health Organisation (WHO). The parasitic larvae (cercariae) are transmitted to humans and animals through contact with waterbodies that contain the intermediate snail hosts (vectors) contaminated with the parasite (Adenowo et al. 2015).

The disease is found in approximately 78 countries worldwide, including South Africa, and is most prevalent in tropical and subtropical areas, particularly in poor and rural communities (WHO 2016). An estimated 166 million people are infected with the disease in sub-Saharan Africa while at least 5.5 million people required treatment for schistosomiasis in South Africa in 2018, according to the WHO. Individuals most vulnerable to schistosomiasis are children, women and those working in close contact with freshwater habitats (Adenowo et al. 2015; Sacolo et al. 2018).

Three aquatic snail species are known vectors of the parasitic trematodes causing schistosomiasis, and three of the five ***Schistosoma*** spp. that have the potential to infect humans and animals are found in South Africa. The snail ***Biomphalaria pfeifferi***, serves as vector for ***Schistosoma mansoni*** which causes intestinal schistosomiasis. ***Bulinus africanus*** and ***Bulinus globosus***, are the vectors ***of S. haematobium***, causing urinary schistosomiasis in humans, and ***S. mattheei,*** causing schistosomiasis in cattle and sheep (Day and de Moore 2002). Although effective treatment for schistosomiasis exists in the form of the drug praziquantel, re-infection through continued exposure to infected water occurs frequently in endemic regions (Kalinda et al. 2017).

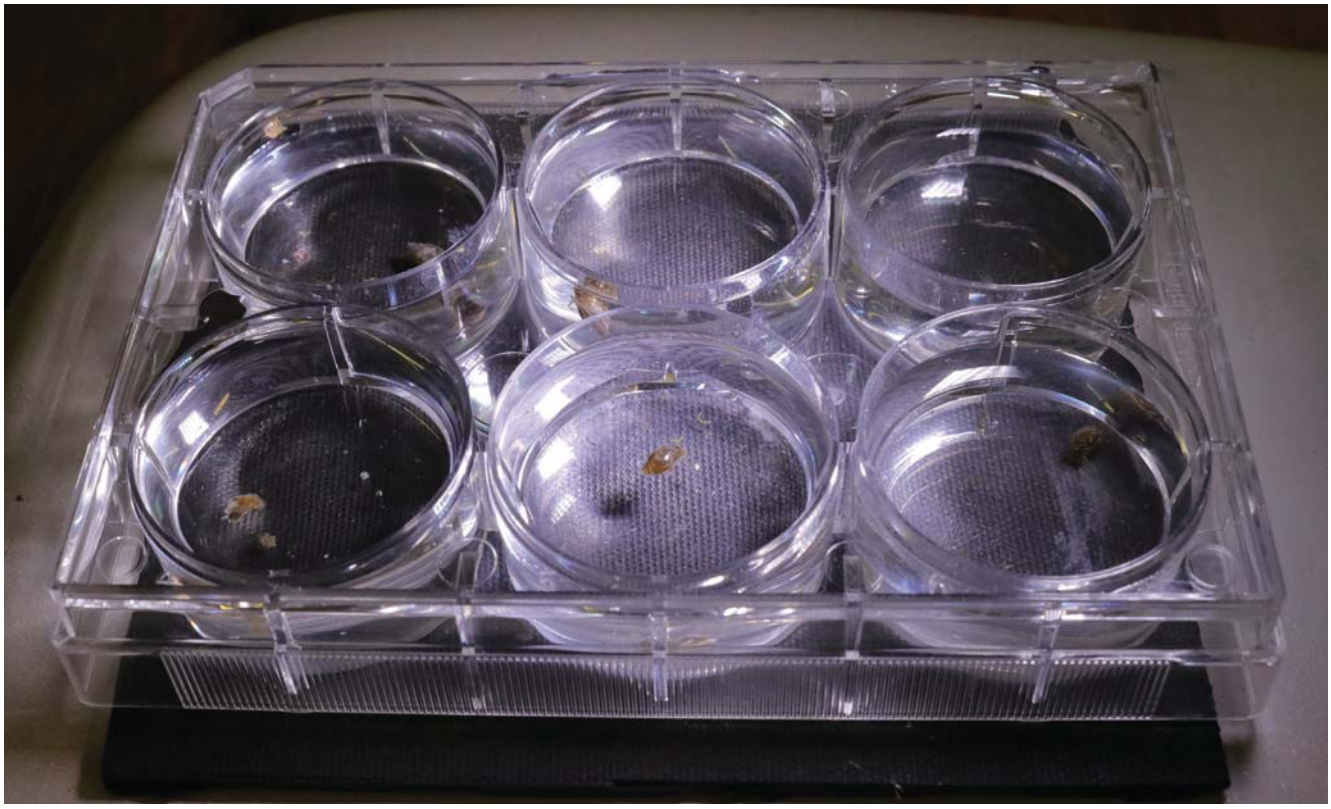
Chronic infection with schistosomiasis and resistance to praziquantel treatment pose long-term health threats to humans and animals. This is particularly true for rural, poverty stricken areas where access to effective medical care and treatment is limited. Chronic effects of schistosomiasis in humans and animals includes liver fibrosis, anemia and weight loss, while ***Schistosoma mansoni*** (intestinal bilharzia) also causes undernutrition and growth stunting in children (King et al. 2008).

"A better understanding of perceived health risk could inform public health policies and actions and influence mitigation and adaptive responses."

Nico Smit

The snails prefer vegetated aquatic habitats located in areas close to human and animal activity

Lizaan de Necker



Snails are placed under a light source to stimulate shedding of the parasitic cercariae

Chronic infection with ***S. haematobium*** (urinary bilharzia) leads to chronic granulomas in the bladder that can result in bladder cancer or Female Genital Schistosomiasis. This causes greater susceptibility to sexually transmitted diseases and, if left untreated, can lead to infertility, miscarriage and other birth complications (Kukula et al. 2019). Infected humans and animals also have reduced immune responses and are more susceptible to other parasites and diseases. Infected snails are therefore a threat to both humans and livestock in South Africa (de Kock and Wolmarans 2005).

The snails and parasites are found predominantly in areas with relatively mild to warm air temperatures and high rainfall. In South Africa, the disease is largely confined to the northern and eastern parts, including Limpopo, Mpumalanga and the coastal parts of KwaZulu-Natal. However, isolated populations are found in the upper parts of North-West, Gauteng and the Eastern Cape (de Kock et al. 2004).

The eggs of ***S. haematobium*** are transmitted from humans to water through urine and these parasites most frequently occur in summer in regions where people play and swim in the water. The eggs of ***S. mansoni*** and ***S. mattheei*** are transmitted to waterbodies through the faecal matter of humans and animals, respectively. These two parasites therefore most often occur in regions where there are farmlands (both subsistence and commercial) and rural and informal settlements close to waterbodies. In many cases, people in these areas do not have access to adequate sewerage systems and are highly dependent on nearby water sources for both domestic (drinking, irrigation, washing and fishing) and recreational (playing and swimming) activities (Wolmarans et al. 2006).

Continued human population growth along with future predicted climate changes could alter the ranges of the snail vectors and their parasites, thus leading to changes in the presence and prevalence of schistosomiasis. Warmer temperatures may cause greater spread of the disease in endemic regions while areas that were too cold for the disease before may become new areas of infection. Changes in annual average precipitation may also alter disease transmission with greater infection occurring in areas with increased rainfall and reduced transmission in areas will decreased rainfall. Increased frequency and intensity of heatwaves may lead to outbreaks of the disease in regions that were previously low or zero transmission areas. Changes in river flow and flooding regimes due to droughts or extreme floods could also cause the establishment of snails in new regions and/or temporary or permanent removal of snails in endemic regions (McCreesh and Booth 2013). It is thus essential to understand if and how future predicted climate change may influence the transmission of schistosomiasis in order to protect public health.

At present, we do not have a clear indication of the distribution of schistosomiasis transmitting vectors and parasites in South Africa as the most comprehensive snail distribution studies occurred in the 1950's to 1960's as part of the collections for the National Freshwater Snail Collection (NFSC) of South Africa. Local studies have also assessed the prevalence and distribution of schistosomiasis in humans in rural communities in the Eastern Cape (Meents and Boyles 2010), North-West (Wolmarans et al. 2006), KwaZulu-Natal (Manyangandze et al. 2016) and Limpopo (Samie et al. 2010) provinces. These studies provide valuable insights into the prevalence of schistosomiasis in humans in South Africa but do not provide a holistic indication of the

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present distribution and abundance of the vectors, parasites or what the potential future distribution of schistosomiasis may be. Given how human population has grown in the past 60 years, along with changes in temperatures and rainfall patterns, the distribution of schistosomiasis transmitting vectors and parasites may have changed already, particularly in regions that were on the distribution fringes.

Since schistosomiasis mainly affects poor, rural agricultural communities, it is important to understand how affected communities experience climatic and environmental change and how these changes impact their health, well-being and livelihoods. An understanding of the physical environment, and the broader social environment in which people live and work is necessary to fully understand vulnerability to schistosomiasis infection (Kukula et al. 2019).

A better understanding of perceived health risk could also inform public health policies and actions and influence mitigation and adaptive responses, as perceptions can drive health related behaviours. Designing effective response programs requires an understanding not only of changes the distribution of schistosomiasis vectors and parasites, but also the existing knowledge, attitudes, perceptions and practices (KAPP) surrounding schistosomiasis in endemic communities (Sacolo et al. 2018).

Models that predict the potential effects of climate change on schistosomiasis distribution can provide valuable information regarding areas that will become suitable for transmission in the future (McCreesh and Booth 2013). These models need to be carefully designed with specific parameters for each study region, intermediate hosts and parasites in question as these can vary greatly. Although such models have been created and tested in several African countries including Ethiopia (Kristensen et al. 2001); Uganda (Stensgaard et al. 2006) and Zimbabwe (Pedersen et al. 2014), this has not been undertaken in South Africa.

Through a combined field and desktop based study approach Dr Lizaan de Necker and her fellow researchers (Nisa Ayob, Ncobile Nkosi, Farina Lindeque, Dr Wynand Malherbe, Dr Dirk Cilliers, Dr Roelof Burger, Prof Nico Smit and Prof Victor Wepener) aim to address the lack in knowledge about the present distribution of schistosomiasis in South Africa. Their project entitled 'Current status and future predicted distribution patterns of bilharzia transmitting snails and implications for vector-borne diseases in South Africa' is funded by the Water Research Commission (**Project No. C2019/2020-00151**) and is a collaboration between the Water Research Group of North-West University, the South African Institute for Aquatic Biodiversity and University of Limpopo. The overarching aims of the study are to determine whether the ranges of schistosomiasis vectors and parasites have changed in the past half-century; how it could change in the future given predicted climate change and how communities in endemic regions perceive and experience the disease.

Using climate modeling techniques, historic distribution data collected for the NFSC and a specific set of environmental conditions from the past 60 years', decadal maps will be created to show the estimated spatial distribution of schistosomiasis vector snails in South Africa. These maps will be used to identify areas as localities where the range of schistosomiasis has potentially extended into. Field collection will then occur in these areas to determine if the snails and parasites are indeed present and so verify the predictive capabilities of the created model. These results will then be used to adjust the model where necessary and applied to determine potential new distribution ranges of schistosomiasis in relation to future predicted climate change.

Surveys will be conducted with local communities in endemic schistosomiasis areas to gather information about how the people experience climatic and environmental change and assess community KAPP surrounding schistosomiasis. At the end of the project, workshops will be held with the community to provide information on schistosomiasis and the threats of exposure to this disease. The project will also create a digital version of the Bilharzia Atlas of South Africa to provide information on the distribution of schistosomiasis in South Africa which will be accessible to the general public through a web-based platform.

More about Schistosomiasis

- Schistosomiasis is an acute and chronic disease caused by parasitic worms.
- People are infected during routine agricultural, domestic, occupational, and recreational activities, which expose them to infested water.
- Lack of hygiene and certain play habits of school-aged children, such as swimming or fishing in infested water, make them especially vulnerable to infection.
- Schistosomiasis control focuses on reducing disease through periodic, large-scale population treatment with praziquantel; a more comprehensive approach including potable water, adequate sanitation, and snail control would also reduce transmission.
- Estimates show that at least 290.8 million people required preventive treatment for schistosomiasis in 2018, out of which more than 97.2 million people were reported to have been treated.

Source: WHO

FRESHWATER AND ECOSYSTEMS

Embracing biodiversity stewardship to help protect SA's unique frogs

Efforts are underway to target research and conservation action for South Africa's most threatened frogs, and using biodiversity stewardship agreements as one of the tools to help ensure their survival. Article by Jorisna Bonthuys.

Jeanne Tarrant

South Africa is home to almost a tenth of all known species of birds, fish and plants in the world, as well as 6% of mammal and reptile species. It is a mega diverse country, hosting some of the most unique biodiversity on the planet.

The country's extraordinary diversity of fauna and flora is also one of the most threatened. Many of South Africa's frog species are in dire straits. As part of a new area of focus for its threatened amphibian work, the Endangered Wildlife Trust (EWT) recently launched a research project in the Western Cape. The organisation is zooming in on some of the most threatened frogs in the province.

The need to conserve threatened frogs remains critical, according to Dr Jeanne Tarrant. She heads up the EWT's threatened amphibian programme. "Many of our frogs and their habitats are in trouble, and urgent interventions are needed to turn the tide," she says.

Globally, around half of all amphibian species are declining.

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More than 40% are threatened, making amphibians the most threatened vertebrate group in the world. Habitat loss and degradation, climate crisis, trade and a deadly fungal disease all play a role in their demise.

Since 2012, the EWT's amphibian programme has aimed to build resilience for amphibian populations in a changing landscape. It currently implements five projects across the Eastern Cape, Western Cape and KwaZulu-Natal. These three provinces are home to the country's most threatened frogs.

"We look at threatened species as flagships for improved protection and management of important freshwater habitats," Tarrant says. "Our team then prioritise species based on threat status, existing conservation work and level of endemicity."

Looking in new spots for frogs

Although still in its infancy, the EWT's frog research in the Western Cape has already yielded promising results. The work is done in partnership with Bionerds, supported by the Whitley Fund for Nature and the Amphibian Survival Alliance.

The researchers focus on priority species that occur from the Agulhas Plain, through the Overberg and on the Cape Peninsula. These include the rough moss frog (***Arthroleptella rugosa***), the micro frog (***Microbatrachella capensis***), and the newly described moonlight mountain toadlet (***Capensibufo selenophos***) – all critically endangered.

"We also included the Cape platanna and the western leopard toad into our survey work. These two endangered species are often found in the same area as the micro frog," Tarrant says.

Using distribution prediction modelling and survey techniques, the researchers have already confirmed at least two new localities for the endangered Cape platanna (***Xenopus gilli***). Fieldwork only started in July on the Agulhas Plain and within the Nuwejaars wetland special management area near Botrivier in the Overberg. This knowledge expands the known range for this acidic, black-water habitat-specialist, according to a recent press release.

The rough moss frog has a tiny range of 0.9 km^2, making it extremely vulnerable to threats such as alien and invasive plants and fire.

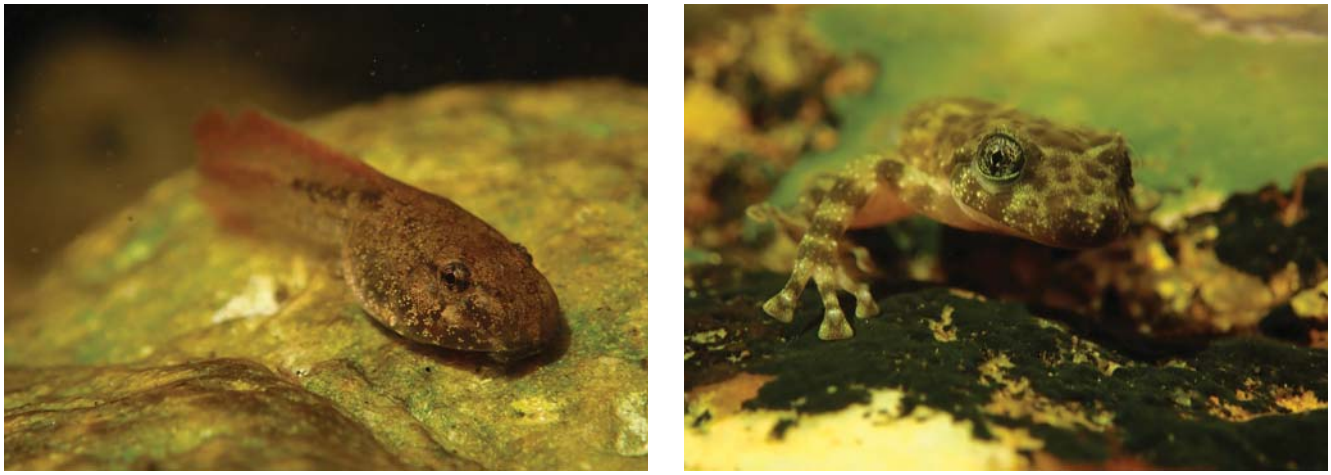
The distribution of the micro frog, found in just four localities across 7 km^2, is highly fragmented and affected by urbanisation, agricultural expansion, the spread of alien invasive plants, and drainage of breeding habitats.

At this stage, the distribution of the newly described moonlight mountain toadlet is not well understood. "Given the vulnerability of these species and their limited range, targeted efforts and effective management of key conservation sites will benefit

Werner Conradie

Almost 30% of South Africa's 135 frogs are considered threatened.

Jeanne Tarrant



A Table Mountain Ghost Frog tadpole (left) and an adult (right). This rare and elusive frog species is endemic to Table Mountain in the Western Cape

all three species," Tarrant says. "Frogs are generally sensitive creatures. Some are generalists and can tolerate a wide range of environmental variables, including temperature changes."

But will they be able to survive pressures to their habitat amid climate change? Scientists already predict conditions getting hotter and drier in the Western Cape over the next few decades. "This could edge many amphibian species closer to the edge of extinction," Tarrant warns.

More research is needed to improve scientific understanding of the threshold of many of these species to inform conservation efforts. Tarrant says: "We need to collect baseline data for the future."

The EWT is compiling a 10-year research and conservation strategy for South Africa's frogs.

Unlocking biodiversity stewardship for frogs

South Africa's legislation allows for the protection of habitat through mechanisms including biodiversity stewardship sites and servitudes.

Over the past two decades, there has been a shift from land purchase towards stewardship projects to secure threatened ecosystems. Between 2008 and 2016, 68% of the country's protected areas were established through biodiversity stewardship programmes. Several organisations now work both inside and outside reserves and parks to expand the protected area network.

This mechanism of habitat protection relies on agreements with landowners that remain in place in the long term – at least 30 years, and 99 years for the highest level of protection status (a nature reserve).

Landowners can enter into one of several types of voluntary stewardship agreements. Under the highest level of stewardship, a property is declared as a privately-owned nature reserve. At the other end of the scale is a non-binding, voluntary agreement to conserve the biodiversity on a property.

The EWT promotes biodiversity stewardship agreements for important freshwater environments, with threatened frogs as their flagship. "These agreements offer cost-effective solutions to achieve targets for protected area expansion in key areas, and improving the environmental management of the broader landscape," Tarrant says.

But using stewardship sites as a tool to protect threatened amphibians is a complicated and long-term process. "Landowners must be supported on their stewardship journey. Management of these sites must be adequate to ensure long-term benefits for both nature and people," Tarrant says. "It takes time to build relationships. There are all sorts of variables at play. It is an intricate process."

In the Eastern Cape, the organisation is working with the Eastern Cape Parks and Tourism Agency. Together they aim to secure up to 30 000 ha of privately-owned grasslands in the Amathole region, including through stewardship agreements. This mountainous region, considered one of the Eastern Cape's most crucial strategic water source areas, is also home to the critically endangered Amathole toad (***Vandijkophrynus amatolicus***).

In Kwazulu-Natal, the EWT works in partnership with the provincial conservation authority Ezemvelo KZN Wildlife to ensure amphibians survive outside existing protected areas. Here Tarrant and her team focus on the endangered Pickersgill's reed frog (***Hyperolius pickersgilli***), found on communal land in a semi-urban area within the eThekwini municipality. Much of its former habitat has been drained for agriculture (sugarcane and tree plantations) or completely lost due to urban development (housing) and industrial activity (mining).

Together with traditional leaders of the Sobonakhona Traditional Authority in Adams Mission south of Durban, they are exploring a communal stewardship agreement to protect this species. The land belongs to the Ingonyama Trust Board, who recently gave its support to this approach. The 500 ha wetland system, the largest intact wetland site in the greater Durban area, is under pressure from unregulated development in the area, especially in its buffer zone.

"It is an exciting project that we could replicate elsewhere on

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communal land in the province," Tarrant says.

Ghosts of the mountain

In the Western Cape, the EWT partners with South African National Parks (SANParks) to ensure the survival of the Table Mountain ghost frog (***Heleophryne rosei)***. This species is found within the Table Mountain National Park, in an area of only 9 km^2. Its habitat is affected by streamflow changes, alien vegetation, siltation and path erosion.

Despite occurring almost entirely within a protected area, the species is considered to be "poorly protected". As a result, the species remains under serious threat.

Tarrant says: "Although its habitat is already under formal protection, it is not necessarily managed specifically for the species and the freshwater systems that support them."

The EWT launched a project in 2019 in collaboration with the South African National Biodiversity Institute (SANBI) and SANParks, supported by the Table Mountain Fund, to understand more about this species and its requirements. This cryptic, secretive species typically occurs in inaccessible ravine habitats. Information on its habitat requirements, breeding activity, life history and population size remains limited.

"Without a specific focus on threatened amphibians, it is possible that the frogs' habitat could be affected by invasive plants or inadequate fire management. The management of a stewardship site remains key, whatever the conservation status," Tarrant says.

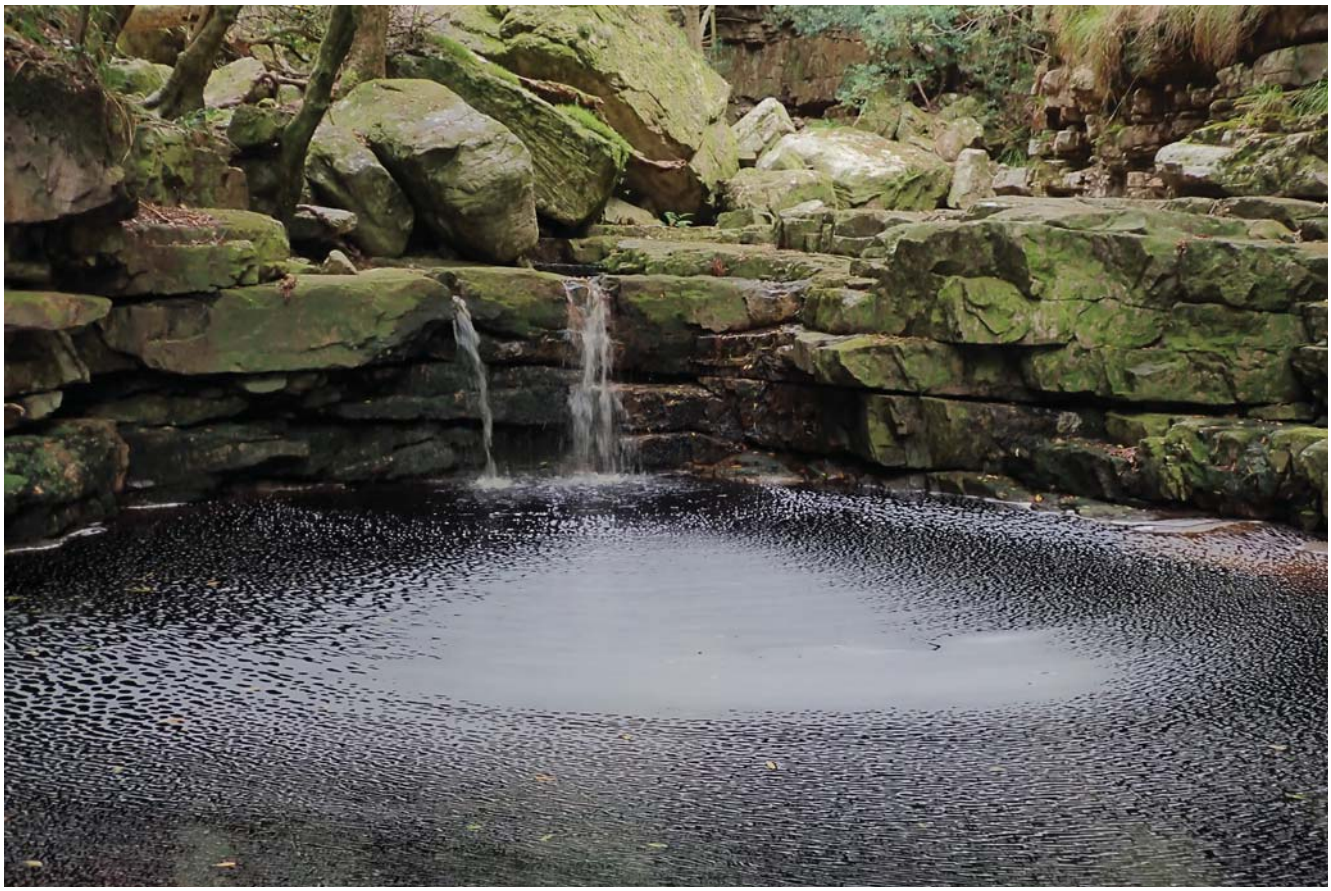
The EWT is carrying out research to support the necessary management interventions. "Our role is focusing on the frog, which relies on the functional freshwater stream environment. We help provide the research evidence and recommendations for their survival. But this information must become part of the management plans for this nature reserve."

Keeping the chorus alive

Over the years, the EWT has collected many hours (over 700) of frog call data, including through the use of passive acoustic monitoring. "Each species of frog has its own unique call," Tarrant explains. "A frog's call is an excellent aid in frog identification, and enables us to tell which species are present in an area."

Three postgraduate students at the University of KwaZulu-Natal will now analyse these recordings. "They will search for acoustic signals to use in machine learning and help inform our management efforts, thus feeding into stewardship sites," Tarrant says.

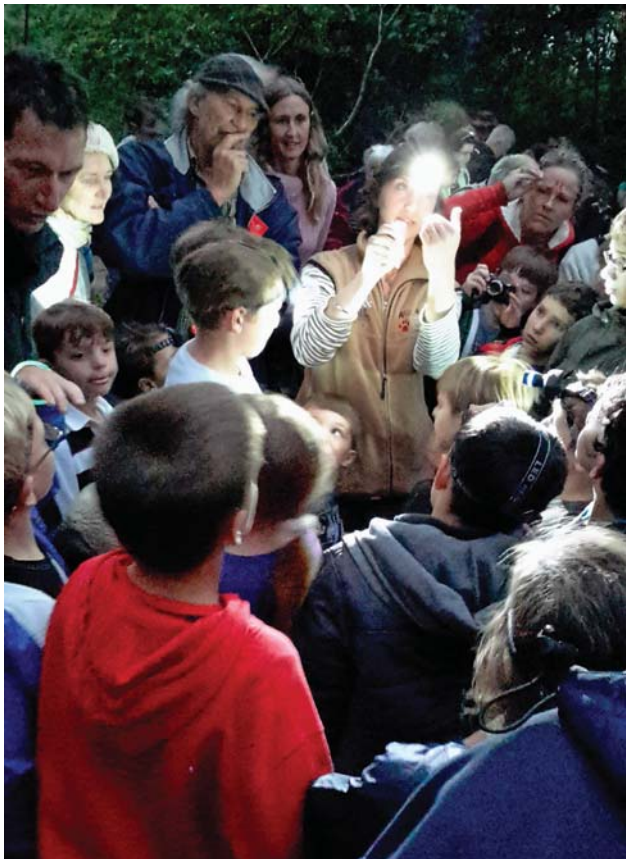
If frogs are disappearing, we need to ask ourselves what does that mean about the state of our natural resources, especially freshwater? "Frogs represent the aquatic system and are great indicators of the ecological health of freshwater systems. If you look at the value of our freshwater resources – it is pretty much a free or very cheap service that is provided to us by nature.



Jeanne Tarrant

The Table Mountain Ghost Frog is found within the Table Mountain National Park, in an area of only 9 km^2

Photo supplied



Education plays an important role in the conservation of South Africa's frog species

Globally, this resource is literally trillions of dollar worth, and we get it for free," notes Tarrant.

"Frogs also play an important role in pest control; they eat things like mosquitos and flies. They are also important in the food chain – lots of things are eating them. "If we lose our frogs that would also disrupt our food chain. Yet many people undervalue their value in nature.

She adds that in South Africa, we also have lots of superstitions about frogs – most of them are negative. "Many people are genuinely afraid of frogs, and we know public perceptions of frogs affect our conservation efforts. "There are also myths associated with frogs in some cultures. Some people associate frogs with curses and witchcraft. Others believe they shoot lightning out of their mouths. A key part of our work is to get people to understand and appreciate that these little creatures have huge value."

The race is on to prevent amphibian losses, and secure their freshwater habitats.

Scientists are now also exploring rehoming some endangered species, including the Pickersgill's reed frog**.** "We are working with wetland specialists and the Johannesburg Zoo that breed these frogs in captivity.

"We can already reintroduce captive-bred frogs back into the wild, which may allow a species to return to a healthy population. But it makes no sense to re-establish populations in systems that are degraded or not well-managed.
"In the meantime, our primary aim remains to protect the remaining populations in the wild," Tarrant concludes. "We need to know where they are and secure the wetlands and streams they depend upon."

Wetland, streams and frogs

- South African wetlands and river systems are in a critical state, with over 65% reported to be damaged and 50% estimated to have been destroyed.
- Of all ecosystems, wetlands are considered to be one of the richest in terms of ecosystem services provided. These 'services' are defined as the benefits that humans derive from nature. Wetlands and streams offer crucial habitat for many of South Africa's threatened amphibian species. Yet, the complexity of wetland ecology has resulted in them being studied the least.
- Almost 30% of South Africa's 135 frogs are considered threatened.
- Two-thirds of South Africa's frogs are endemic, meaning they are found nowhere else on Earth. Of these, the highest proportion of endemic frog species can be found in the Western Cape (with at least 40 species found only in this province).
- Amphibians are reliant on freshwater for their survival. Without water to moisten their highly permeable skin, most frog species would be unable to survive. It is also crucial for them to complete their lifecycle – most species' larval stage develops in or close to water.

Source: www.wrc.org.za; www.sanbi.org.za.

Did you know?

- There are 8 221 known amphibian species of which 7 252 are frogs and toads, 755 are newts and salamanders, and 214 are caecilians.
- New species are discovered every year. The most recently described species in South Africa include two new rain frog species (the Ndumo and Phinda rain frogs), three new mountain toadlets, and several dainty frogs.
- South Africa's smallest frog is the northern moss frog (Arthroleptella subvoce). It is 14 mm in length. This species is known only from the Groot Winterhoek Mountains in the Western Cape. It is also one of our most threatened species.
- South Africa's largest frog is the giant bullfrog (Pyxicephalus adspersus), which gets up to 25 cm and 1.4 kg. They are found throughout central southern Africa but occur predominantly in Gauteng.
- Amphibians are the oldest land vertebrates. Ichthyostega was an amphibian species that lived in Greenland 362 million years ago.
- Frogs can leap, on average 30 times their body length.
- A South African Cape river frog called "Santjie" holds the world record for frog jumping. This frog (5 mm in length), covered the longest distance covered in three consecutive jumps at 10.3 m. This jump, made in 1977, is listed in Guinness World Records.

Source: www.ewt.org.za; www.amphibiaweb.org

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AGRICULTURE AND INNOVATION

Soil and scheduling – Study tests farmer appetite for technology

There are a myriad of technologies available to farmers to improve agricultural output, but do they actually use them? And what motivates the use of some technologies over others? This is what a recent study by researchers at Stellenbosch University set out to find out. Article by Marlene de Witt and Willem de Clercq.

The Breede River flowing through orchards and vineyards just outside of Bonnievale.

When one considers the newest technological developments at agricultural shows it is clear that developers are aiming to enable farmers to do everything on the farm from their smartphones. Sensors, satellite imagery and automated drones exist that allow farmers to press a button and get their fields sprayed, switch irrigation on and off and identify problems, and provide detailed pictures of their fields. The rate of technological development in agriculture is astounding.

Of course, monetary cost plays a significant role in the adoption of these technologies. But is cost the main factor standing in farmers' way to become fully automated? Do they really want to sit in their offices and farm from behind a smartphone?

There aren't nearly as many studies looking at the uptake of technology as there are new tools on the market. Yet, a misunderstanding of local market needs and wishes may be a key barrier to the realisation of agricultural water savings in our catchments. There is little value in the development of new products if farmers are not using the innovative products already available to them.

It is a logical assumption to make that South African farmers would turn to technology to improve their water efficiency, so they can remain profitable with less water. Particularly in the Western Cape where the recent droughts cost farmers dearly. There is a myriad of local and international irrigation efficiency

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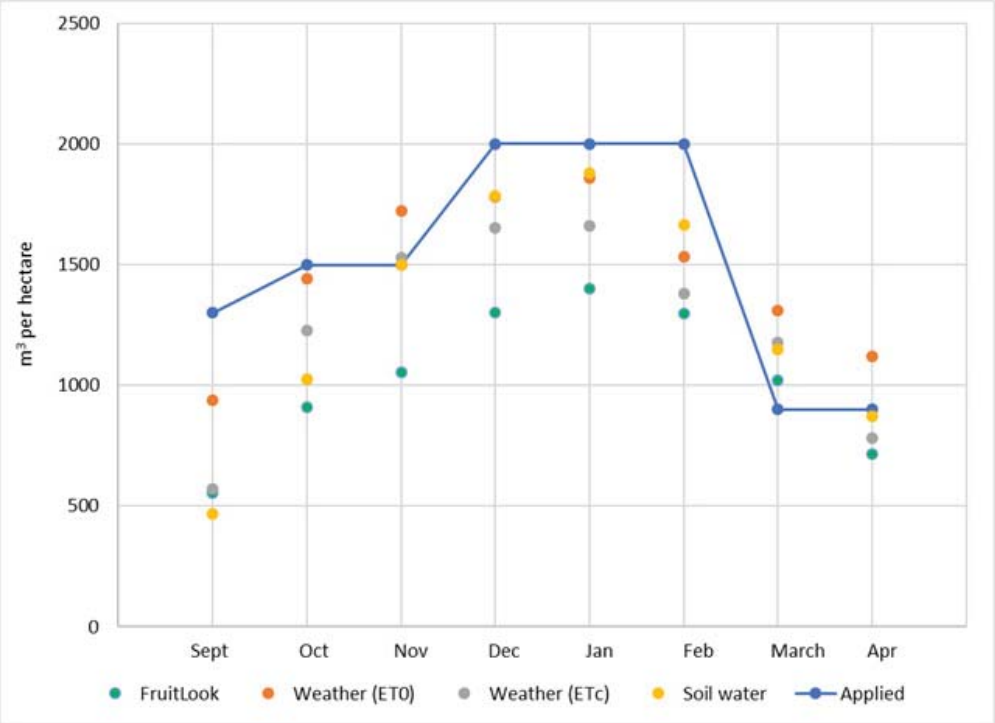

This graph shows the monthly water requirements as determined by the soil water probes, FruitLook and the weather station. The line shows the water the farmer applied in these months. The values provided by FruitLook are approximately 30% lower than the amounts applied, meaning that according to FruitLook the farmer over-irrigated by 30%. This is most likely caused by the effect of shade netting on the satellite service. The farmer irrigated close to weather station water requirement estimates.

technologies available to South African farmers, and Western Cape farmers also have access to the free, government-funded, remote-sensing product, FruitLook, which reportedly can save farmers up to 30% of water (for more information go to www.fruitlook.co.za)

Given the impact of the recent drought, and with extensive access to technological developments, including a free remote-sensing service, the Western Cape is a good area to investigate if farmers use the technology at their disposal to inform their irrigation decision-making. This is what researchers from the Stellenbosch University Water Institute set to find out in a recent Water Research Commission (WRC) study (**project no. 5/2788//4**) in the greater Robertson area.

The study investigated whether farmers use technology available to them, what drives them to adopt technology, and what the limitations are that prevent them from adopting new technology. These questions focused on irrigation scheduling, in particular, as scheduling is one of the most important methods to irrigate efficiently. Scheduling is the process of determining the water requirement of crops and applying irrigation as and when the plants need it. Furthermore, farmers were asked whether they've heard about or used FruitLook – since it is a free service, monetary cost is not a barrier to its adoption, therefore its use or non-use would shed light on other limiting factors.

The Stellenbosch team conducted this research as part of an international project called "OPERA" (Operationalising the increase of water-use efficiency and resilience in irrigation). OPERA is one of the first projects of the European Commission Water-JPI (Joint Programming Initiative) projects of which South Africa was part. The Water-JPI aims to promote collaboration between research institutions globally to tackle water challenges. In the OPERA project, Stellenbosch partnered with institutions in the Netherlands, Italy, France and Poland. Each country conducted interviews with stakeholders to examine technology uptake for irrigation scheduling.

Time is money

The research team interviewed 29 farmers, aged 28 to 79 years. Twenty-four of them (83%) use some form of technology to schedule their irrigation. This is a promising figure, as in 2006 a study by Stevens (2008) showed only 18% use of technology. Interestingly, younger farmers are only slightly more interested in exploring new technology than older farmers, but there is no relationship between the actual use of scheduling technology and age. Farm size also plays no role.

The two things farmers in all five countries mentioned as the main factors preventing them from investing in more technology, are cost and administrative issues. In South Africa these mean the cost of the new technology, as well as the cost of having to change existing infrastructure in order to achieve further gains in efficiency (i.e. to make a block more water efficient, one might have to change the layout of the block and hence its entire irritation system, to make it more aligned to soil types).

The administrative barrier in South Africa is the lack of storage dams. Without storage dams, the farmers have to use the water as and when they receive it from the irrigation scheme. "Farmers have the fear that 'if I don't use it, I'll lose it'; they will rather use their water out of fear that it will be taken away," one farmer said.

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Only when they have storage dams will it make financial sense to invest further in technology that will enable them to apply more discretion in their scheduling to optimise water use.

Because monetary cost is not a factor with the uptake of FruitLook, the conversations about its use or non-use were very interesting. Although 25 out of the 29 farmers had heard about FruitLook, only three have used it. It turns out the time-cost is as important, if not more important, than monetary cost of a product. Most farmers said it was too time-consuming to set up their fields in FruitLook so they didn't complete the task. The programme also does not provide advice, which means the farmer has to spend time to interpret and apply the information. Farmers said they want products that interpret data for them, providing them with simple management advice on how to address the identified problems. As one farmer put it: "We need an app in which you can put all your information and it throws out a solution for you… the ***why*** and ***how*** is needed."

Another perceived drawback of FruitLook was the delay in receiving information – because it's a satellite service, farmers get weekly information. "If something went wrong, FruitLook shows you a week later, then the damage has already been done," said one farmer. "You can only look in hindsight with FruitLook and make changes accordingly. But our irrigation system uses 12 computers, it will be half a day's work to make slight adjustments to the entire schedule if FruitLook shows something's wrong," said another.

Information is everything – or is it?

"***We take it, as a given, that the more information decision-makers have, the better off they are. But what does the Goldman algorithm say? Quite the opposite: that all that extra information isn't actually an advantage at all. In fact, that extra information is more than useless. It's harmful. It confuses the issues***." — Malcolm Gladwell, Blink

A key barrier to technology uptake that emerged from the conversations, is the amount of information farmers deem to be useful to them. Although 83% of the farmers use technology for scheduling, they all use only one type – soil water measurement – and three quarters of them use the same product. They use this product mainly because of its perceived accuracy, and because it has an easy-to-use management interface that visually tells them what is happening in their fields on an hourly basis.

Farmers are unlikely to use many different technologies to help them with the same decision-making process. While they believe that having information to inform their decision-making is important, having too much information is not practical and too time-consuming, because they will need to take time to compare all the data and advice before taking their decision. Using a new technology means having an additional dataset that needs interpretation. They struggle to see how they can connect all the bits of information from different products into a logical decision-making framework. Therefore, many of the farmers said that they will only use FruitLook, or any other innovative new technology, if the information somehow links to their existing technology (soil probes).

For technology developers, this means either creating a product that will replace the need for the technology farmers are currently using, or creating something that complements and directly speaks to the data generated by their existing technology.

Data integration

Based on farmers' desire to have data from different technologies and platforms integrated, the researchers explored whether it is possible to compare the outputs of the farmers' probes and FruitLook for a holistic picture of their plants' water requirements. Since there are numerous weather stations in the area that farmers can subscribe to at a relatively low cost, this data was also added to the comparison. Seeing the datasets of all three technologies in one document or graph could provide the farmers with an opportunity to cross-check the results to ensure accuracy and, as such, contribute to water saving.

The comparison was made between the soil water loss profile as captured by a soil water probe in a block of plums; evapotranspiration (ET; evaporation from soil plus transpiration from plant) as captured by satellite imagery in FruitLook for the block in which the probe is located; and ET measured by the closest weather station – all measured in mm. These values were aligned in Excel.

Although much work is needed to refine the approach, the results showed that soil water readings, weather station data and remote sensing data could in fact be aligned and compared. The comparison showed fair correlations between all values, but FruitLook's reported water requirements were much lower than the weather station's and the probe's. Which means if the farmer used FruitLook only, he would probably have applied too little water. This finding can most likely be attributed to the fact that the block studied is situated under nets, illustrating that remote sensing cannot be used as a reliable estimate with shade netting. This is problematic seeing as the use of nets as water saving effort, is growing rapidly in the province.

The independent assessment of technology uptake in this study showed that while farmers are interested in trying new technology and uptake is certainly much higher than a decade ago, efforts should be made to integrate the information offerings of different products. Farmers' time plays an equally important role as monetary cost when it comes to their decision to use or not use a new technology. And while developers try to develop products to allow farmers to farm from their cell phones, the interviewed group of farmers are resolute in their view that they still want to go out into the field every day, not losing their traditional way and relying on their experience of their farms.

- To download the report, ***Operationalising the increase of water-use efficiency and resilience in irrigation (OPERA)*** (**WRC Report no. 2788/1/20**) Visit: https://bit.ly/37Qu0Jr

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MUNICIPAL SERVICE DELIVERY

New water tech forum to boost municipal service delivery

The South African Local Government Association (SALGA) together with the Water Research Commission (WRC) have launched a Water Technology and Innovation Forum aimed as a sharing platform for how technological innovation can solve today's and future challenges of clean water and improves sanitation services delivery.

The forum is set to provide a collaborative platform for municipal partners to share their innovation needs, mobilise partnerships to jointly conceptualise programmes, projects and funding towards matters related to safe water and sanitation.

"Through these platforms we are re-imaging the delivery of water and sanitation to our communities. We are creating a different paradigm shift in our approach to water management. We acknowledge that the world is moving into a fourth industrial revolution and such requires all of us to adapt or become irrelevant hence these platforms anchored by Science, Research, Technology and People together under one roof." So said SALGA President, Councillor Thembi Nkadimeng at a two-day forum on 28 and 29 September to launch the initiative.

The event brought together technology and water thought leaders from the three spheres of government, research institutions and state entities, who shared their insights on the management of water and sanitation services through technology.

Nkadimeng made reference to a WRC study, ***Drivers for wastewater technology selection – Assessment of the selection of wastewater treatment technology by municipalities in relations***

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To watch a recording of the launch go to, https://www.youtube.com/watch?v=gFN6pcoZIFA

to the management capability and legislative requirements (**WRC Report no. TT 543/12**), which painted a worrying picture on the role of local authorities in the wastewater treatment sector.

"Research undertaken by the WRC in collaboration with SALGA paints a worrying picture in relation to application of appropriate technology at municipal level. The findings of the report indicate that there is no shortage of technological solutions. However, there are major challenges in the application of such in municipalities. To this end, relevance and cost effectiveness of our technology choices are a key feature and integral part of this initiative we are launching today," she noted.

However, Nkadimeng expressed confidence in the newly established forum and its ability to find water-tight solutions to these challenges "Further, it seeks to safeguard the interests of the water sector and municipalities through creating an enabling environment for municipalities to seek technical guidance before employing technological solutions, secondly to select proven and vetted technology by water sector experts."

Minister of Cooperative Governance and Traditional Affairs, Dr Nkosazana Dlamini Zuma, said that the forum would do well in paving the way towards the roll-out of the new District Development Model (DDM), an operational model for improving cooperative governance aimed at building a capable, ethical developmental state.

"We believe that the establishment of this forum will contribute to the implementation of the district development model, which seeks to strengthen local government by utilising the districts as a landing strip for all the spheres of government," said Dr Dlamini-Zuma.

"Through the DDM, we'll also see the acceleration of technology and innovation initiatives."

Chief Executive of the WRC, Dhesigen Naidoo said of the ambitious forum: "The local government water and technology innovation forum…is a critical intervention. This partnership-led forum seeks to set up and expand a network of test beds for ground breaking water and sanitation technologies emanating from South African laboratories."

Naidoo added that the endpoint of the forum would ensure that South African citizens receive improved water supply and sanitation. "We want South African districts, villages and towns to be among the leaders in sustainable water and sanitation solutions in the world. We want our citizens to be the beneficiaries of the best water supply, the best water treatment and state of the art sanitation," he said.

Department of Water and Sanitation ministerial advisory committee chairperson Jurgen Kogl, who addressed the virtual launch on behalf of Human Settlements, Water and Sanitation Minister Lindiwe Sisulu, proposed that the forum should provide regular feedback on progress review reports. "We propose that the forum provide quarterly or twice-yearly presentations to all stakeholders on what work has been done and what projects can be implemented in a financially sustainable manner," he said.

Further, the Department of Water and Sanitation proposed, in partnership with the departments of Cooperative Governance and Traditional Affairs and Human Settlements, as well as the National Treasury and Salga, that a water sector leadership group be established under Salga. "Our view is that the Blue Drop, Green Drop and No Drop programmes be reactivated with vigour. We need all the water works in every municipality on the system, regardless of the level of vandalism of malfeasance, to improve the management of water."

In addition, given the expected impact of climate change, the country needs to prepare and plan for the future and ensure that it uses what it has appropriately and in a financially responsible way to ensure that the country can ensure that water security and living standards can be met over the next 50 years, said Kogl.

There is significant academic and technical capacity in South Africa in the water and sanitation sectors and it has the support of international partner countries.

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WOLWEDANS - DAM WITH A DIFFERENCE

DWS

Wolwedans Dam during construction

The Wolwedans Dam on the Greak Brak River near Mossel Bay was completed in 1989. It was constructed mainly to supply water to the Mossgas plant that converts oil from the natural gas reserves below the ocean bed. This dam was the fifth dam in the country constructed with roller compacted concrete (RCC), and one of the world's first two RCC arch-gravity dams, the other being the Knellpoort Dam in the Free State.

The dam was designed and constructed by the then Department of Water Affairs. The dam contains close to 200 000 m^3 of rollcrete, placed over 14 months between 1988 and 1989.

With a downstream slope of 0,5 (horizontal) to 1 (vertical) the dam has to rely on arch-action for stability. Shrinkage of the rollcrete and the associated cracks would therefore pose serious problems especially if they are not grouted. A groutable system of induced crack joints was developed to overcome this problem.

Interestingly, environmental considerations played a major role in the planning, design, construction and operation of Wolwedans Dam. The dam site was chosen after thorough investigations, which included a comprehensive environmental impact report. There was some concern over the potential impact of the dam on the Great Brak estuary and, after an intensive study led by the CSIR; it was decided to reserve 1 million m^3 of water/year for the estuary from the dam's yield. The capacity of the Wolwedans Dam's outlets was also designed in such a way as to allow for the river mouth to be washed out by a release from the dam whenever necessary (and when water is available).

Wolwedans Dam statistics

Type	Rollcrete arch/ gravity
Height above lowest foundation	70 m
Gross capacity of reservoir	24 million m^3
Crest length	270 m
Arch radius	135 m
Total volume of RCC	178 000 m^3
Total volume of mass concrete	22 500 m^3
Total volume of reinforced concrete	9 800 m^3
Type of spillway	Uncontrolled ogee
Spillway capacity	1 920 m^3/s
Surface area at full supply level	110 ha

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DEEPLY ROOTED IN SOUTH AFRICA WATER SOCIETY

www.wrc.org.za

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

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

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

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THE POWER OF KNOWLEDGE TO THE PEOPLE