THE WATER WHEEL

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WORLD WATER DAY
The answer lies in nature

ECOSYSTEM SERVICES
SA peatlands show their value

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WATER RESEARCH COMMISSION

WISA Water Institute of Southern Africa

2018

Cape Town, South Africa

Breaking Boundaries Connecting Ideas

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Bridging The Gap: Sustainable Finance For Improved Delivery

Pooling Together: Enabling Participation Through Good Governance

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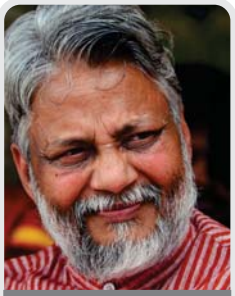

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A Water Research Commission - funded study has shed light on the distribution, characteristics and socio-economic value of peatlands in South Africa. *See page 14.*

FLUID THOUGHTS

WRC CEO, Dhesigen Naidoo

Day Zero on the back of drought in southern Africa – lessons for the future

Cape Town has become the latest poster child of drought in the southern African region. The dramatic declaration of Day Zero — the date on which the taps are turned off — has caught the attention of the world. Indeed, in light of this looming deadline, now set for July 7 of this year, the city is facing the implementation of unprecedented water restrictions, such as a daily limit of 50 ℓ of water per person; severe, mandatory decreases in water usage by agricultural users and commercial properties; and complete bans of unnecessary water usage, such as pools and washing cars.

But the Cape Town experience is not an isolated one: This development follows stark drought episodes in the broader southern African region on the back of the 2014 El Niño, which has been recognised as the most severe in 20 years. Even before El Niño, East Africa was ravaged by the severe 2011-2012 drought, which jeopardised food security there: Most acutely felt in Somalia, Djibouti, Ethiopia, Kenya, and Uganda, where collectively 10 million people were threatened with famine.

This food shortage and threat to agricultural security has continued to the present as a result of the erratic weather patterns. During the El Niño, severe droughts in South Africa's summer rainfall areas plunged five of its nine provinces into the realm of stagnating economic growth. A traditional grain exporter, South Africa has been forced to import staples. After-effects of drought are not just limited to food insecurity. For example, in 2017, Zimbabwe has been ravaged by post-drought flooding, resulting in both loss of lives and livelihoods.

Ashraf Hendricks/Groundup

In Cape Town the search for alternative water supplies continues, such as the drilling of additional boreholes.

Three factors that brought Cape Town to Day Zero

One of the primary difficulties in addressing water scarcity in Africa, and indeed the decreasing water security worldwide, is the continued conservatism of the current global establishment. We insist on trying to solve twenty-first century problems with twentieth century technology and solutions, using nineteenth century operating rules, standards and guidelines.

The water crisis in Cape Town illustrates this trend. Planners at city, provincial, and national levels, relied on the 2005 planning exercise that, at the time, indicated the city was water secure until 2022. This was when the next major water augmentation or major new water supply infrastructure would be required. These plans did not accommodate other scenarios, in spite of continuing major drought events in South Africa and its neighbours, which clearly indicated a shift in weather patterns.

A second factor is the city's over-reliance on traditional surface water sources, with limited investment in a sustainable groundwater strategy or other augmentation options such as desalination. The water demand management strategy was far short of what was required in the early 2000s to maintain water security up to 2022.

Third, there is limited enthusiasm from South African institutions and their international partners to embrace the array of new solutions and technologies. Cape Town and other South African cities are renowned, quite justifiably, as having some of the better water utilities in the world. This is a key factor in how South Africa has been able to ensure water security in one of the driest countries on Earth. It is also fair to say that we came out less than favourably when stress tested by this five-year intermittent, but extreme, drought episode.

A "new normal"—and its consequences

Core to every analysis of these drought episodes, and extreme weather events in general, is the phenomenon of a change in regional climate in southern Africa on the back of global climate change. There is a growing political acceptance of the concept of a *"new normal"*—a term that has found resonance in platforms like the African Union (AU) African Ministers Council on Water.

This *"new normal"* has precipitated changes that have had a profound impact **economically**, with direct and dramatic losses in earnings at many levels experienced by individuals, as well as countries' GDPs and growth rates.

The second impact of the new normal is **social**. Climate change events are directly reducing livelihood opportunities, with

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citizens eking out a living from a rapidly degrading environment in the short term. In addition, indirect repercussions, such as challenges of social upheaval in the medium to long term are also becoming evident. Indeed, two features of this emerging trend are social delivery protests in countries like South Africa and Ethiopia as well as the new phenomenon of what can best be described as 'climate change migration'.

This is an important outcome of the third impact which is **environmental**. Degradation of the environment and biodiversity loss is a graphic feature of a new drier and hotter regional climate. The new category of refugees is seeking asylum from economic, social, and environmentally depressed traditional locations on the back of droughts and floods precipitated by the changes in the Sub-Saharan climate in recent years.
This triumvirate of drivers will inevitably have a profound impact on the political stability and the security status of the region, inviting the somewhat inappropriate metaphor of a dark cloud hanging over this part of the world.

So, is there a silver lining?
At the same time as these dangers, we are also sitting on an unprecedented opportunity: Some of the highest levels of innovation in water in human history are being developed. We have an ability to revolutionise both water and sanitation in a manner that facilitates the targets of universal access to safe water and dignified sanitation, as expressed in the United Nations' Sustainable Development Goals. In addition, if we fully utilise the boons of recent scientific discovery and innovation, we can do this in a manner that vastly increases local and global water security. Thus, water can be available for economic growth, with increased opportunities for livelihood creation and entrepreneurship, food security, and concomitant health security. In the African context this will remove one of the core constraints in the realisation of the AU's Vision 2063 ambition for a more industrialised and prosperous Africa.

What makes this opportunity even more exciting is that the new science points to water-energy nexus solutions that, if engineered imaginatively, will provide combined water and energy solutions in a sustainable development paradigm. That will not only relieve the burden on existing water and energy grids, but because of their ingenuity, organise to engage and achieve this goals with lower carbon dioxide emissions—thus paving the way to a lower carbon future. These new solutions include new sanitation mechanisms epitomised by the Gates Foundation-led Reinvent the Toilet Challenge, and exciting new solutions to turn polluted waters like acid-mine water into potable water. New technologies can enable water-sensitive cities to not only have the ability to see to a significant percentage of the city's nutritional needs through urban agriculture, but to also develop inner-city artificial and enhanced natural wetland systems that radically decrease the city's ecological footprint and impact on surrounding rural areas.

The brightest part of this silver lining is that Africa, precisely because of its lower levels of development, is not as locked into the existing infrastructure as her neighbours in Europe and the Americas. Therefore, the continent has the best opportunity to leap frog with these new solutions, transforming into a water-secure continent, and pioneering the possibility of a water-secure world.

This article was published first by Brookings, https://www.brookings.edu/

WATER DIARY

Water business
April 15-17
Business meetings are at the heart of the Global Water Summit, happening in Paris, France. Every year, over 600 top executives come together to determine water's key role in sustainable economic growth and to meet with potential partners, suppliers and clients.
Visit: www.watermeetsmoney.com

Water loss
May 7-9
The IWA Water Loss Specialist Group, together with the City of Cape Town, will host the biennial Water Loss Conference and Exhibit at the Century City Conference Centre in Cape Town. The conference will be one of the world's largest water loss conferences and is expected to attract over 500 participants from more than 50 countries.
Visit: https://www.eiseverywhere.com/ehome/251759&internal=1

Aquatic science
June 24-28
The Southern African Society of Aquatic Scientists will be holding its 2018 congress in Cape St Francis Bay resort, in the Eastern Cape. The theme for the congress is 'Aquatic ecology in the Anthropocene'. Enquiries: Petrie Vogel (conference organiser); Tel: (012) 346-0687; Email: admin@savetcon.co.za;
Visit: www.savetcon.co.za

Water resource management
June 24-27 2018
The Water Institute of Southern Africa (WISA) is hosting its biennial conference at the Cape Town International Convention Centre.
Visit: www.wisa2018.org.za

World water week
August 26-31
World Water Week is the annual focal point for the globe's water issues. It is organised by the Stockholm International Water Institute. The theme is 'Water, ecosystems and human development'.
Visit: http://www.worldwaterweek.org/

Municipal engineering
October 31-November 2
The annual conference of the Institute of Municipal Engineering of Southern Africa will be held in Port Elizabeth with the theme, 'Innovative Infrastructure Solutions'.
Visit: www.imesa.org.za

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NEWS

South Africa's largest water conference coming to Cape Town

The Water Institute of Southern Africa (WISA) will host its Biennial Conference and Exhibition in Cape Town from 24-27 June 2018.

This is traditionally the biggest event on the South African water calendar.

The central theme of the conference – Breaking barriers, connecting ideas – seeks to address past, existing and future water resource challenges by promoting collaboration, cooperation and integration within the water sector, explains Jason Mingo, WISA 2018 Technical Committee chair and project manager in the Western Cape Department of Environmental Affairs and Development Planning. Amid growing concerns around the impact of climate change, and the threat of more extreme weather events, the southern African region faces increased uncertainty and vulnerability regarding water supply, he notes.

This makes the 2018 event all the more timeous, not least because the host city is facing its own drought and water security troubles. "The conference, while hosted every two years, is especially relevant given the attention and focus placed on water in terms of its scarcity across the southern African region," says Mingo. "The development of new technologies, processes and advancements in research during this time means that there has never been a more exciting time to be involved in the water sector."

The conference is targeting both water professionals and those persons interested and involved in some way with the sector. The conference features a diversity of forums, presentations and workshops to engage on new ideas, to enable the connection of such ideas to become a reality and drive positive change within the field.

"The event aspires to be the turning point in how the water profession within the region considers its role within the broader society and to address the need of better integrating and collaborating across sectors and disciplines," notes Mingo. "By promoting and supporting concepts linked with the theme, it is hoped that WISA 2018 will be the beginning of a new approach to the management of water."

Visit: www.wisa.org.za

Nation called on to conserve water amid drought

With a national state of disaster having been declared in three provinces, newly elected President Cyril Ramaphosa has appealed to the nation to continue to intensify efforts to use water wisely.

Ramaphosa made the appeal during his inaugural State of the Nation Address (SONA) as President of the Republic in Parliament in February.

"The country remains gripped by one of the most devastating droughts in a century, which has severely impacted our economy, social services and agricultural production. The drought situation in the Western Cape, Eastern Cape and Northern Cape has been elevated to a national state of disaster. This gives national government the authority to manage and coordinate our response nationally with support from all provinces.

"This will ensure that we also heighten integrated measures to support the provinces that are hardest hit. We are looking at activating the necessary extraordinary measures permitted under the legislation," said Ramaphosa.

With SONA being held in Cape Town due to the location of Parliament, the new President used the platform to commend the people of Cape Town and the rest of the Western Cape for diligently observing water saving measures. Level 6b water restrictions have been in effect from 1 February, which require all residents to drop their daily use to 50 litres per person per day or less.

SAnews.gov.za

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Groundwater brings relief to thirsty Kimberley school

Ongoing drought in the western parts of the Karoo have hit every water user hard, but when Middelpos Primary School was landed with a R18 000 water bill last year, a more sustainable plan had to be made.

Located in the small town of Middelpos, between Calvinia and Sutherland in the Northern Cape, the school and its hostel were subject to the water restrictions in the Hantam Local Municipality – but clearly could not afford the water it needed. Through a provincial Department of Education programme to alleviate the water crisis in schools, RE Construction was awarded the tender to provide a solution.

The company approached SRK Consulting to site a water-supply borehole within the school property to alleviate the water problem. "There is an existing borehole at the hostel, but due to numerous sewage pits in the vicinity, the water quality is unsuitable for human consumption," said Bernie de Jongh of RE Construction. "However, the school is upstream of the town and the likelihood of finding potable groundwater in this area is considered to be fairly good."

According to SRK principal hydrogeologist, Chris Esterhuyse, no prominent geological features linked to the occurrence of groundwater on the school property could be identified from satellite imagery. "However, detailed surface geological mapping of the area revealed a narrow joint system that intersects the property – and we selected a drill site there."

Borehole drilling was completed in the school yard on a single day. "We were pleased when fresh groundwater was intersected at 34 m below ground level with a measured drill stem blowout yield of 2.8 ℓ/s.

The borehole was completed to a final depth of 50 m below ground level ad a water sample submitted to UIS Analytical Services in Kimberley for quality analysis. A second borehole was completed to a final depth of 66 m below ground level, and also achieved a positive result.

The results from this investigation suggest that groundwater can be a quick, viable solution to improve water supply, especially in drought-stricken areas. Finding suitable drill sites was crucial, so the appointment of a hydrogeologist with the necessary expertise to conduct the investigations and select the borehole sites was invaluable," noted De Jongh.

Government intention to introduce a single CMA gathers momentum

The Department of Water and Sanitation (DWS) is powering ahead with efforts to collapse the current nine catchment management areas (CMAs) and establish a single catchment management agency (CMA).

The department has set itself a deadline of 2018/19 financial year to establish the single CMA. According to the DWS, the envisaged CMA will help manage water resources at a local level, facilitate inclusive water resources management and minimise costs. A number of internal and external consultations have been taking place in different regions in this regard.

Speaking at the consultative meeting at the Gauteng Provincial office, DWS Project Coordinator, Thivhonali Masindi, said the decision to establish a single CMA was motivated by concerns of costs associated with running multiple institutions. The department felt a need to rationalise and align existing institutions as a mechanism to unburden the state of burgeoning service costs.

According to Masindi, the creation of a single CMA would not impact the water resource management at catchment level. "The only change will be the governance structure of the CMA. Instead of having nine governing boards there will be only one governing board."

Added Masindi: "The single CMA will allow the nine water management area offices on the decision-making process at the local level and community participation will remain as central as stipulated in the National Water Act."

The nine water management areas will still be responsible for the development of their catchment management strategy. Visit, http://bit.ly/2n8YCgX, to read the business case for a single CMA.

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Planning cities to better manage rising temperatures

The CSIR has developed a modelling capability that can help municipalities adapt to climate change and associated rises in temperature.

This is done by combining information from temperature projections and detailed information of urban surfaces, such as roads and buildings, using the city spatial development plan in that region.

In addition to the challenge of rising temperatures, climate change risks facing cities in South Africa include more frequent heat events, heavy rain and droughts. This will put pressure on municipalities to provide infrastructure and services designed, developed and implemented to anticipate and respond proactively to these factors.

The modelling capability developed, though initially focused on the urban heat island, enables the interpretation and translation of key technical information into usable narratives that can be used by decision-makers to help them toward optimal decision-making in responding to climate change and developmental goals.

Researchers have found that South Africa's urban areas are at risk of the urban heat island effect, where temperatures in cities are warmer than the surrounding rural areas. This is caused primarily by the heat absorbed by building and built-up surfaces. More than half of South Africa's population lives in urban areas.

CSIR researchers found that warmer cities mean increased energy demand for cooling needs. In turn, this increases greenhouse gas emissions. Higher temperatures also put a strain on infrastructure such as roads, pavements and railways and ultimately have negative effects on human health and comfort.

The CSIR-developed model can be used to adapt any city by recommending key interventions that can mitigate the effects of the urban heat island effect, such as the use of reflective materials for roofs and pavements; and expanding green spaces in cities through green roofs and urban parks.

The science council is working with the eThekwini Municipality to apply the model for Durban.

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Water engineering fraternity loses a giant

The South African water engineering fraternity has lost another giant. Dam safety expert Dr Chris Oosthuizen, formerly of the Department of Water and Sanitation (DWS), passed away on 11 November at the age of 70 after a long battle with cancer.

Chris spent his career working in dam engineering, starting at the then Department of Water Affairs in 1974 at the construction of Vanderkloof Dam.

Chris was the Approved Professional Person for dam safety evaluations and/or remedial works of more than 300 DWS dams since the inception of South Africa's dam safety legislation in 1986, and he spent much of his career looking after the safety of the department's dams. He also served as the dam safety expert for two dams in Switzerland, and was involved in mentoring the dam safety and surveillance teams of dams in the Lesotho Highlands Water Project (Phase 1) as well as Cahora Bassa Dam.

Chris served on the advisory committees of the University of Cape Town (UCT) and UNISA and was an ex-Professor Extraordinaire at the Tshwane University of Technology. He also lectured post-graduate students at UCT and Stellenbosch University. Furthermore, he chaired the International Commission on Large Dams (ICOLD) Technical Committee on Dam Surveillance from 2012.

Chris was a very active member of the South African National Committee on Large Dams (SANCOLD), presenting papers and lectures, serving on the management committee for several years, as well as acting in the role of SANCOLD Secretary for a number of years.

Chris was awarded the SANCOLD Award in 2013 in honour of his exceptional contributions to SANCOLD and in the field of dam engineering in South Africa. In the accompanying photograph he can be seen receiving the award from SANCOLD Chair, Danie Badenhorst (left).

Chris was universally respected by all his peers and his contribution to dam engineering in South Africa was immeasurable. The South African water engineering fraternity has lost a great man.

Water ambassadors pledge to #SaveWater

The Department of Water and Sanitation with various stakeholders have launched the #SaveWater Ambassador Programme to foster responsibility towards saving water resources in the City of Cape Town and the rest of the country.

Launched at the Cullinan Hotel in Cape Town in February, the multi-stakeholder programme is an initiative that will serve as a platform to heighten communications among and between a variety of stakeholders, and especially communities to increase efforts to conserve water. The initiative saw different groups pledging to partner with the department to ameliorate the effects of the drought in the mother city.

Among the groups included Miss Earth South Africa, Operation SA, Tsogo Sun, South African Rugby Union, and the Muslim Judicial Council. During the launch, all partners echoed one another's sentiments, saying that there was a need to make sure that Day-Zero did not happen through their partnership and working together.

They said it was time the citizens led the way in finding solutions to the water challenge that is facing the country.

"The work of the initiative will not only be confined to the City of Cape Town as the most drought-stricken area, but will make its presence felt throughout the country in the face of the calamity that is quickly spreading to other provinces," the department said.

Source: SAnews

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GLOBAL

Increasing number of natural World Heritage sites affected by climate change

The number of natural World Heritage sites threatened by climate change has grown from 35 to 62 in just three years, with climate change being the fastest growing threat they face. This is according to a report released in January by the International Union for Conservation of Nature (IUCN).

The *IUCN World Heritage Outlook 2* – an update of the 2014 report – assesses, for the first time, changes in the conservation prospects of all 241 natural World Heritage sites. It examines the threats, protection and management of the sites, and the state of their World Heritage values – the unique features which have earned them their prestigious World Heritage status.

According to the assessments, climate change impacts, such as coral bleaching and glacier loss, affect a quarter of all sites – compared to one in seven in 2014 – and place coral reefs and glaciers among the most threatened ecosystems. Other ecosystems, such as wetlands, low-lying deltas, permafrost and fire sensitive ecosystems are also affected. The report warns that the number of natural World Heritage sites affected by climate change is likely to grow further, as climate change remains the biggest potential threat to natural world heritage.

"Protection of World Heritage sites is an international responsibility of the same governments that have signed up to the Paris agreement," says Inger Andersen, IUCN Director-General. "This IUCN report sends a clear message…climate change acts fast and is not sparing the finest treasures of our planet. The scale and the pace at which it is damaging our natural heritage underline the need for urgent and ambitious national commitments and actions to implement the Paris Agreement."

Retreating glaciers, resulting from rising temperatures, threaten sites such as Kilimanjaro National Park – which boasts Africa's highest peak.

"Natural World Heritage sites play a crucial role supporting local economies and livelihoods," says Tim Badman, Director of IUCN's World Heritage Programme. "Their destruction can thus have devastating consequences that go beyond their exceptional beauty and natural value. This adds to the urgency of our challenge to protect these places."

The broader findings of the report show further challenges to the World Heritage Sites. Other threats, such as invasive species, unsustainable tourism or infrastructure development, are also increasing. They affect ecological processes and threaten the survival of species within the sites. Invasive alien species are the most widespread of all the threats.

Visit, www.worldheritageoutlook.iucn.org to download the report.

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Scientists suggest way to predict the behaviour of invasive weeds

Is it possible to predict which non-native plant species will become invasive weeds and when? According to research featured in the journal, *Invasive Plant Science and Management*, the answer is 'hopefully yes'. And those predictions can lead to more effective and cost-efficient weed management.

Researchers say invasive species generally follow a three-phase development curve – from lag to expansion to plateau. The length and rapidity of expansion phase varies across species and determines how aggressively a plant spreads.

"Understanding the source of this variation can help us predict which non-native species become invasive," notes Pedro Antunes, who co-authored the paper with Dr Brandon Schamp, both of Algoma University in Ontario, Canada.

"The key is to take a best practices-based approach to gathering and comparing data about past invaders, their traits and preferred habitats."

Examples of the best practices the research recommends include using herbarium records as a data source for invasion curves; verifying the accuracy of the records and confirming the origin and taxonomic status of each specimen; and comparing invasion curves to determine which traits are linked to more aggressive growth and expansion.

"As our knowledge increases, we can make better-informed predictions about the likelihood of particular species becoming invasive and the timeline they will travel as they do,"Antunes says. "We can take advantage of the lag time before the plant population expands to intervene with appropriate management controls.

Visit, http://bit.ly/2DALxqZ, to read the journal article.

More trees would mean cleaner water, air for megacities – study

Planting 20% more trees in our megacities would double the benefits of urban forests, such as pollution reduction, carbon sequestration and energy reduction. This is according to a study published in *Ecological Modelling*.

The authors of the study, which was carried out at Parthenope University in Italy, say city planners, residents and other stakeholders should start looking within cities for natural resources and conserve the nature in our urban areas by planting more trees. In the study, the team used a tool called i-Tree Canopy to estimate the current tree coverage in cities and the potential for more urban forest cover, and worked out the benefits that would bring.

Nearly 10% of the world's population live in megacities (cities of at least 10 million people). "By cultivating the trees within the city, residents and visitors get direct benefits," explained lead author, Prof Theodore Endreny. "They are getting an immediate cleansing of the air that is around them. They are getting that direct cooling from the tree, and even food and other products. There is potential to increase the coverage of urban forests in our megacities, and that would make them more sustainable, better places to live.

To view the original article, Visit: http://bit.ly/2rzh1rZ

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THE WATER WHEEL

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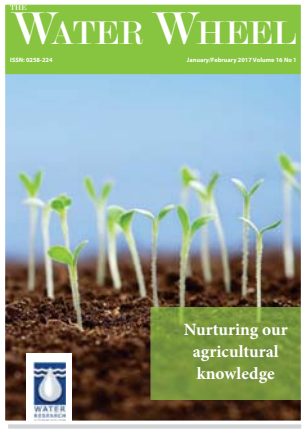

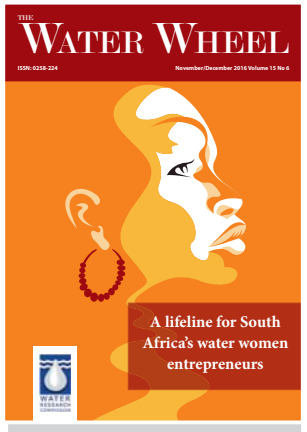

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WATER RESEARCH COMMISSION

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NEW WRC REPORTS

Development of a high throughput sequential phytoremediation system for sustainable water purification using endemic macrophytes

Overloading of wastewater treatment systems and the inadequate provision of sewerage in many rural areas can result in very poor quality surface waters containing high concentrations of emerging organic contaminants being released from water treatment facilities. These xenobiotics include pharmaceuticals and frequently also cyanotoxins where polishing ponds precede release. The released water typically also contains high levels of nutrients. The aim of this work was to validate the concept of a consortium of macrophytes in series to remove multiple xenobiotics while protecting those macrophytes that may be harmed by one or more of the xenobiotics.

Report No. 2367/1/17

Assessing aquatic ecosystem services value chains and markets in South Africa: Some case studies

We still have a limited understanding of the value chains, markets and the actual economic value of ecosystem services from aquatic ecosystems. Different studies have developed various approaches for determining the economic value of these benefits, and of the associated natural capital. This study focused on identifying key ecosystem services and their forward linkages, understanding how to improve market access to such services, and creating or improving the value chains in the South African context. The research is intended to help identify opportunities for improvements that benefit society more broadly. It is anticipated that the study will be useful to land use planners, designers of infrastructure and town planners.

Report No. 2341/1/17

Direct reclamation of municipal wastewater for drinking purposes

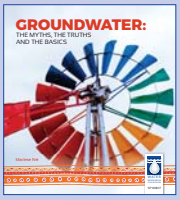
Existing water sources are increasingly coming under stress due to growing water demand on a global scale. Water resource managers and planners are forced to look at other, unconventional water sources such as water reuse. Water reuse has become an attractive option for water augmentation due to improvement in efficiency of treatment processes, reduced costs and the fact that this water source is readily available and in close proximity to the point of application. The overall aim of this study was to investigate and test the major factors that govern people's decisions towards the use of reclaimed water for drinking purposes; and develop strategies and tools to inform better information sharing and public engagement within the institutional decision-making process for introducing reclaimed water. The intention was to find ways to influence public perceptions through public knowledge acquisition and information flows, and to engage with the public in order to overcome resistance and build trust, so as to assist water institutions effectively to introduce and manage water reclamation schemes. Volumes 2 (Investigation into institutional and social factors influencing public acceptance of reclaimed water for potable uses in South Africa) and Volume 3 (Framework guidelines for public engagement on water reuse) of this study are now available. Volume 1, *Guidance on monitoring, managing and communication of water quality* (Report No. TT 641/15) was published in 2015.

Report No. TT 734/17 (Volume 2) and TT 735 (Volume 3)

Response of urban and peri-urban aquatic ecosystems to riparian zones land uses and human settlements: A study of the rivers Jukskei, Kuils and Pienaars

The negative impacts of land use on aquatic ecosystems have generated conditions that are conducive to the devastation of goods and services emanating from water resources. The use of sensitive riparian areas in urban and peri-urban areas has been due to high rates of urbanisation, which is driven by the community's need for socio-economic improvement, while municipal service provision is not increasing at the same pace. This study aimed to investigate the impacts of land use and human settlements in urban and peri-urban areas on aquatic ecosystems.

Report No. 2339/1/17



Groundwater: The myths, the truths and the basics

Groundwater forms an important part of the water cycle, and of the water resources landscape in South Africa, providing crucial water supplies to millions of people, especially in rural areas. This special publication from the Water Research Commission explores some basic concepts about groundwater in South Africa. This includes how groundwater moves, how groundwater can be polluted, and how to find and manage groundwater. The country also explores some interesting facts about groundwater in South Africa, particularly around the towns and cities that are dependent on groundwater for their survival. **Report No. SP 108/17**

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ECOSYSTEM SERVICES

Research project underlines the importance of South Africa's peatlands

A Water Research Commission (WRC)-funded study has shed new light on the distribution, characteristics and socio-economic value of peatlands in South Africa. Article By Sue Matthews.

The Malahlapanga wetland in the Kruger National Park contains a rare hot spring mire. A mire is a wetland that is actively accumulating peat.

It is the threat of climate change that has put peatlands on the global environmental agenda in recent years, because they store vast quantities of carbon that contribute to greenhouse gas emissions when these wetlands are damaged or destroyed. The Global Peatlands Initiative – launched at the 2016 United Nations Climate Change Conference (COP 22) – released a rapid response assessment report at COP 23 in November 2017 to raise awareness about the importance of the world's peatlands, and to encourage immediate action to protect them.

Previously, peatlands only garnered this level of international attention when the various 'bog bodies' were discovered. The most famous examples are the remarkably well-preserved Tollund Man, discovered in a peat bog in Denmark in 1950 and dated to 300–400 years BC, and Lindow Man – nicknamed Pete Marsh – discovered in England in 1984 and dated to 20–90 AD. Their existence perfectly illustrates what it is that sets peatlands apart from other wetland types, namely the extremely slow rate of decomposition of plant material and other organic matter. This is due to waterlogging that creates anaerobic conditions in the wetland, inhibiting bacterial decomposition processes.

Since waterlogging is a key feature of peatlands, they are primarily found in the 'wetter' parts of the world, such as the northern hemisphere's high latitudes and the tropics. As a semi-arid country, South Africa is not well-endowed with peatlands because most wetlands are seasonal, drying out during periods of lower rainfall and higher evapotranspiration. The peatlands that do exist are largely concentrated in the moist eastern and southern regions of the country.

The first national peatland ecoregion survey culminated in a report, published in 2001, and a database of likely peatland locations developed from a modelling exercise. This database

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was recently updated and refined as part of a WRC-funded project entitled ***South African Peatlands: Ecohydrological characteristics and socio-economic value*** (**WRC Report No. 2346/1/17**). Project leader, Dr Piet-Louis Grundling, who was a co-author of the earlier report, headed up a team of five researchers from various organisations and consultancies. When the project was awarded he was employed at WetResT, but he is currently the Deputy Director: Programme Implementation for Working for Wetlands, and is also affiliated to the University of the Free State's Centre for Environmental Management.

The project team conducted a literature review to find new records of peatlands published since the previous survey, and also put out a call to the wetland and soil science community to contribute information. Using this expert knowledge and the existing model, a geographic information system (GIS) map depicting areas where peatlands potentially occur was produced. An accuracy assessment using known peatland distribution revealed that the greatest accuracy (87%) was attained when the old and new models were combined.

This exercise resulted in 990 additional data points being incorporated into the South African Hydrogeology Database. However, only 116 of these qualified as peatlands according to the criteria that they must contain >30% organic material (dry mass) or 15-29% carbon over a depth of at least 300 mm. Although just 10 of these 116 points have been verified infield, they have all been added to the South African Peatland Database, which is compatible with SANBI's National Wetland Inventory. The database is hosted and maintained by ARC-Soil, Climate and Water, where Dr Althea Grundling – Piet-Louis' wife and a fellow member of the project team – is employed as Senior Researcher: Wetlands.

The updated database now contains 635 peat points, but they add up to only about 1% of the country's total wetland area. So how important are South Africa's peatlands in terms of carbon sequestration – the capture and storage of atmospheric carbon dioxide? The project team evaluated this by estimating the annual carbon accumulation rates and the current levels of carbon stocks, using physical data pertaining to various peatlands countrywide and extrapolating to other peatlands where such data were lacking. Not surprisingly, the climate regulation ability of South African peatlands is rather paltry on a global scale, but the amount of carbon accumulated per year is nevertheless equivalent to the average annual greenhouse gas emissions produced by between 1 900 and 34 000 passenger vehicles! In Rand terms, the sequestration value is estimated to be at least R5.6 million per year, and possibly as much as R19.8 million.

More important for a water-stressed country like ours, though, is the ecosystem service provided by peatlands in the form of water quality regulation. Peatlands not only remove contaminants from water flowing through them, but also trap sediments, so they play a natural water purification role. And like other types of wetlands, they act as a sponge, absorbing water in times of plenty – providing they are not completely saturated already – and then gradually releasing it. In so doing, they help attenuate floods and sustain water flows for human use and aquatic health. The cumulative value of such ecological services was estimated by the project team to be as high as R174 billion, expressed as an ecological infrastructure value. This means that for every R1 of carbon storage value, approximately R12 can be added for other ecosystem services.

Clearly, peatlands are worth protecting, yet only 35% of the 635 peat points in the database are in formally protected areas, and even those are not immune to damage. Fortunately, commercial extraction of peat, which can be used as a fuel, horticultural soil amendment, filtration medium and construction material, has been halted in South Africa as it is unsustainable, and activities that might affect wetlands of any kind require authorisation in terms of the Environmental Impact Assessment Regulations. Nevertheless, water abstraction, alterations of watercourses, encroachment of infrastructure, urban and industrial effluent, and agricultural land transformation are all causing degradation of peatlands, with knock-on effects for aquatic ecosystems downstream.

"Forestry plantations in northern KwaZulu-Natal are having a particularly severe effect," says Piet-Louis. "Peatlands there are able to cope with natural dry and wet cycles to some extent due to the peat surface oscillation effect. In dry years, when the water table starts to drop, water flows out of the pores of the peat fibre, which causes it to collapse in upon itself, and the whole peat surface subsides, allowing it to stay close to the water table and remain moist. When the system wets again, the pores fill up with water and swell, so the surface raises. But these processes can't happen if the water table drops for a long period of time, as in plantations where the trees are pumping out the water through transpiration."

Elephants, buffalo and other animals visiting the Malahlapanga wetland for water have damaged a 4 000-year-old peat dome, but rehabilitation measures are underway.

Althea Grundling

Desiccation due to the forestry plantation surrounding Vasi Pan probably increased the peatland's vulnerability to fire.

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"The amount of carbon accumulated per year in South Africa's peatlands is equivalent to the average annual greenhouse gas emissions produced by between 1 900 and 34 000 passenger vehicles."

One of the consequences of this inadvertent drainage by the plantations is that the peat is prone to burning as it dries out, so fires set for forestry management or livestock grazing purposes may result in underground fires that can burn for weeks or months. Between 2014 and 2016, the ***Zululand Observer*** regularly published articles about the impact of acrid smoke from plantation fires on the residents of Richards Bay, but more recently the problem has shifted further afield, where rural communities bear the brunt of the health effects. Fires like these are a feature of peatlands worldwide, hence the title of the Global Peatlands Initiative report mentioned earlier – 'Smoke on Water'. For example, peat fires in Indonesia in 2015 released more carbon dioxide than the total emissions of Japan for that year, and in August 2017 a massive wildfire attributed to burning peat was detected on Greenland's tundra via satellite imagery.

"At a peat seminar and workshop held in Pretoria on 2 February to mark this year's World Wetlands Day, the need for special training for firefighters likely to encounter subsurface peat fires was identified," says Althea. "We will also be starting a new WRC-funded project in April on the use of multi-platform remote-sensing tools for peat fire detection and monitoring."

Marvin Gabriel

In order to qualify as peatland, a wetland must contain more than 30% organic material (dry mass) or 15-29% carbon over a depth of at least 300 mm.

For the completed project, the researchers selected the following eight peatlands representing different geology, climatic conditions, hydrogeomorphic settings and land use to study the various processes and factors driving peat distribution and accumulation in South African wetlands.

Vazi North is a grass-sedge peatland forming part of the Vazi Pan within the Manzengwenya State Plantation in the Maputaland region of KwaZulu-Natal. The forestry plantation has probably contributed to the lowering of the water table during the drought, resulting in extensive peat fires and providing an environment favourable for invasive vegetation. Ownership of the plantation is being transferred to a trust representing the local community, who already use the pan and surrounds for livestock grazing and water supply purposes.

Malahlapanga wetland lies on the banks of a small tributary of the Mphongolo River in the north-eastern part of the Kruger National Park. It contains a globally rare hot spring mire – a mire being an active peat-accumulating wetland – with a number of small domes of reed-sedge peat. These have been damaged as a result of trampling by elephant, buffalo and other wildlife, so Working for Wetlands has begun assisting SANParks with rehabilitation measures.

Matlabas Mire, in the Marakele National Park, is situated in the headwaters of the Matlabas River, which flows into the Limpopo River. As such it plays a significant role in maintaining baseflows to ecosystems downstream. This is a high-altitude wetland in a steep-sided valley, and has a fast rate of peat formation – mostly grass-sedge peat – compared to other southern African peatlands. The system has been degraded from past land-use practices, but SANParks intends initiating rehabilitation measures with assistance from Working for Wetlands.

Lakenvlei, near Belfast in Mpumalanga, contains reed-sedge peat in the permanent zones of this valley-bottom wetland. The area supports high biodiversity, and in last year was declared the Greater Lakenvlei Protected Environment by the provincial government. Although it is in a healthy ecological state, it is affected by various impacts from mining, agriculture, forestry and infrastructure within the catchment.

Colbyn Valley peatland, located along the upper Hartbeesspruit in Pretoria East, is an urban open space providing opportunities for hiking, birding, environmental education and research. The reed-sedge peat is important for wetland filtration and flood attenuation, and thus helps improve the health of ecosystems downstream. Tshwane Metro and Working for Wetlands have supported the very active Friends of Colbyn Valley in undertaking erosion control work.

Gerhard Minnebron wetland, near Potchefstroom in the North West Province, is a karst wetland that formed as a result of dissolution of limestone in the dolomitic landscape. It is fed by several springs, including the Gerhard Minnebron Eye, from

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Gamtoos Irrigation Board

In an effort to protect the last remaining peatlands and palmiet wetlands of the Kromme River in the Eastern Cape's Langkloof, Working for Wetlands has funded a number of costly erosion-control weirs.

which water is diverted for agricultural use. The wetland contains abundant reed-sedge peat that was extracted until recently, and this – together with the diversion of water – has caused dehydration and desiccation of large areas of the wetland, with some parts subsequently destroyed by fire.

Kromme peatland is part of the much larger Kromme wetland complex between Joubertina and Kareedouw in the Langkloof of the southern Cape. It is a rare peatland type in that it comprises palmiet-sedge peat, formed due to the growth behaviour of the palmiet plant, which is endemic to South Africa. By spreading across watercourses, palmiet blocks channels, traps sediment and slows the flow of water, creating conditions conducive to peat accumulation, but also causing back-flooding of agricultural land and infrastructure. As a result, palmiet wetlands were often destroyed by farmers in the past, but many were also lost to erosion exacerbated by roads and other infrastructure.

Vankervelsvlei, situated in a forestry plantation near Sedgefield on the southern Cape coast, contains what is thought to be the country's thickest peat system – up to 12 m thick in places. The lower layer is about 40 000 years old, with a younger layer of sphagnum peat above it. The vlei lies in an interdunal depression and its surface is dominated by reeds and rushes. The peatland is largely undisturbed, but it is unknown how it will respond to changes brought about by the extensive wildfires in the area in June 2017.

Water flow measurements and isotope analyses conducted for the study confirmed that peatlands in South Africa are mostly dependent on groundwater for maintaining their condition and productivity, but that they primarily formed during the past 15 000 years, with the period of about 5000 before present being most favourable for peat accumulation.

"For the majority of points in the peatland database, though, somebody must still travel there, put in an auger to see how deep it is, determine the carbon content and age of the peat, and properly describe the system," says Althea. "That's a big need – to take the database forward and validate it – but it would require significant funding."

The research report concludes with a list of management recommendations provided by the project team for all the case study sites, some of which are already being addressed.

"We held a workshop during the Wetlands Indaba in October 2017, and it was decided there that the government departments should get together and try to coordinate action," says Piet-Louis. "Hopefully, if we pool our resources we can make more of an impact in addressing peatland degradation."

To order the report, ***South African Peatlands: Ecohydrological characteristics and socio-economic value*** (**WRC Report No. 2346/1/17**) contact Publications at Tel: (012) 761-9300, Email: orders@wrc.org.za or Visit: www.wrc.org.za to download an electronic copy.

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WATER AND AGRICULTURE

Resource use efficiencies in potato production

Can South Africa produce more potatoes with less water? A current study investigates. Article by AC Franke, JM Steyn, ATB Machakaire, and AJ Haverkort.

Potato, the most important vegetable crop in South Africa, is produced in many distinct geographical regions differing in climate, soils, production seasons, management practices and access to markets. These differences affect the amount of input resources required to produce potato as well as yields and crop value, and therefore the use efficiencies of inputs.

Potato production in South Africa takes place on about 50 000 ha, with 92% of the production area under irrigation. The availability of irrigation water is limiting potato production in almost all production regions, but especially in those areas relying on borehole water (e.g. in Limpopo, North West and the Sandveld).

While potato is a high-value crop and important to rural economies, its production in South Africa is associated with several sustainability issues. The crop requires a high input of water, nutrients and biocides and due to potato's shallow root system, its production entails a risk of high levels of water drainage and nutrient leaching. Moreover, potato is often produced in areas with a high biodiversity value (e.g. the Sandveld situated in the Fynbos region) and due to the long

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rotation farmers use to suppress pests and diseases, land use for potato production is much higher than the actual area under potato at any time.

The main potato production regions in South Africa.

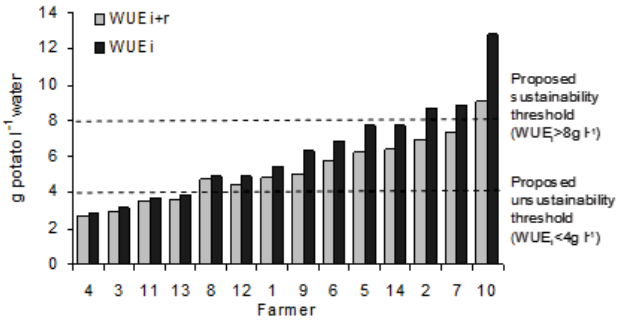
Resource use efficiencies, which are often expressed as the amount of yield produced for a certain amount of resource applied or consumed, are useful indicators of the ecological and financial sustainability of crop production. Comparing resource use efficiencies of farmers among each other can indicate the potential for improving efficiencies and help in identifying inefficiencies in the production system.

Moreover, relations between resource use efficiencies can help in unraveling the nexus between different sustainability indicators. Several projects, funded by Potato South Africa and the Water Research Commission, have contributed to assessing and understanding the variability in ecological resource use efficiencies achieved by potato farmers in South Africa and the impacts thereof on the environment. These projects conducted interviews with farmers and detailed measurements in the field.

Resource use efficiencies vary widely among farmers between regions but also within regions where farmers produce under relatively homogeneous agro-ecological conditions. For example, the observed water use efficiency achieved by farmers in the Sandveld varied from 2.9 to 12.8 g potato tuber produced for every litre of irrigation water applied. This wide variability within regions indicates a great potential for the majority of farmers to improve their resource use efficiencies. Moreover, the observed variability helps in setting sustainability norms where the best performers set a benchmark and indicate what is attainable when best crop management practices are applied.

As potato production regions in South Africa differ widely in climate, soils and production seasons, input use and resource use efficiencies also greatly differ between regions. In general, sandy soils (e.g. in the Sandveld) are associated with higher water use and lower water and nutrient use efficiencies due to the poor ability of these soils to retain water and nutrients.

In regions such as Limpopo and North West, where potato is irrigated with borehole water and pumping costs make up a main component of the production costs, water use efficiencies tend to be high. In general, the scarcer and more expensive a resource, the more efficient farmers tend to use it. The amount of irrigation water applied and water use efficiency are not related to each other. Some low yielding farmers achieve good water use efficiency due to low irrigation rates, while some farmers applying high irrigation rates also achieve good water use efficiency due to excellent yields.



Water use efficiency (WUE, g potato l^{-1} water) of 14 potato farmers in the Sandveld region, based on irrigation water only (i) and irrigation and rainfall (i+r). Proposed sustainability thresholds are based on the relative performance of the farmers.

Average amount irrigated and water use efficiency (WUE) achieved by potato farmers in different production regions of South Africa, estimated from interviews with growers.

Production region	Actual amount irrigated (mm)	WUE (g potato l^{-1} water applied)
Ceres	774	6.4
Eastern Cape (EC)	393	7.0
Eastern Free State (EFS)	121	7.0
Gauteng (GT)	513	8.6
Highveld (HV)	270	12.2
Kwa-Zulu Natal (KZN)	263	9.1
Limpopo (Lim)	454	11.1
Loskop Valley (LV)	475	9.9
Northern Cape (NC)	400	8.0
North Eastern Cape (NEC)	228	7.8
North West (NW)	440	10.5
Sandveld (Sand)	604	7.8
Southern Cape (SC)	250	9.3
South Western Free State (SWFS)	550	8.7

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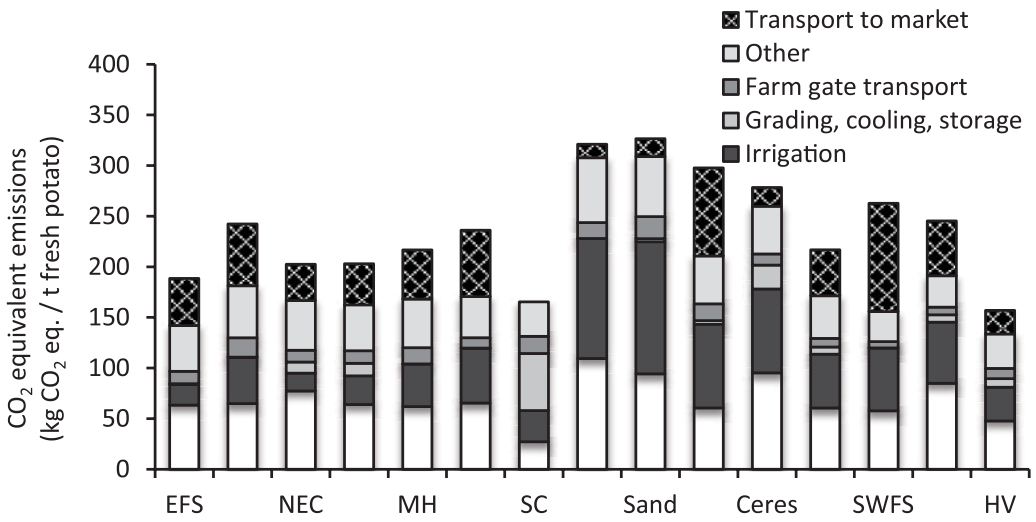
The carbon footprint of potato production indicated below, used as a proxy for energy use and expressed in CO_2 equivalents emitted per ton of potato produced, is made up of fertilizer-related emissions, the energy costs of irrigation, product cooling during storage, transport and other emissions. Fertilizer-related energy costs are high due to the high energy requirements to produce fertilizer, especially nitrogen-based fertilizers, and due to the N_2O emissions from the soil stimulated by N-fertilizer applications.

Energy costs for irrigation are also substantial, especially when farmers irrigate from boreholes. Energy costs for transport of produce to markets are high for those farmers that are situated far from the main urban markets. A potato tuber consists for 80% of water, making it a bulky product to move around.



Main contributors to the carbon footprint of potato (in kg CO_2 equivalents per ton of tuber produced), averaged per production region in South Africa.

Photo supplied

An eddy-covariance system measuring real-time evapotranspiration in a potato field.

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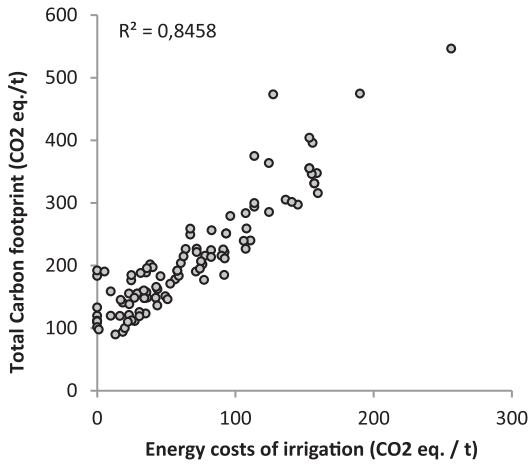
Photo supplied

Potato production in South Africa gives high yields and requires high levels of inputs.

Resource use efficiencies are often related to each other and in potato production in South Africa water tends to be the key resource that drives use efficiencies of other resources. For instance, the energy costs associated with irrigation are largely determined by the amount of irrigation water applied and the vertical distance (depth of the borehole) the irrigation water needs to be pumped. While energy costs for irrigation make up around 25% of the total energy use in potato production and transport, these costs explain a large proportion (85%) of the variability in total energy costs.

Energy costs for irrigation are thus closely associated with the other contributors to energy use in potato. For instance, farmers who irrigate more than crop demand, tend to have a low fertilizer use efficiency due to leaching of nutrients and therefore high fertilizer-related energy costs. Probably farmers who achieve a high water use efficiency are generally those farmers who are 'on top of the ball' and produce efficiently in general.



The relation between the energy costs for irrigation and the total carbon footprint of individual potato farmers in South Africa.

To unravel the detailed interactions between environmental resource use efficiencies, we initiated detailed field measurements in potato-based rotations in the western Free State and in North West, using lysimeters to assess drainage and nutrient leaching and eddy-covariance techniques to measure evapotranspiration. We observed that water and nitrogen use efficiencies in potato are generally on the low side. However, the crop that follows potato, especially in case it is a deep rooting crop such as maize, can recover some of the water and a large part of the nitrogen leached by the previous potato crop making up for the low nutrient use efficiency and high leaching potential of potato. It shows that the environmental sustainability of crops should be assessed as part of the larger cropping system.

In conclusion, the large variability in resource use efficiencies observed among potato farmers, even within regions with homogenous agro-ecological conditions, indicates a great potential for many farmers to improve efficiencies and reduce pollution from agricultural activities. Intensive, high-input farmers that achieve high yields are not necessarily more, or less efficient in the use of resources compared to low-input farmers aiming for moderate yields. Water is clearly a key resource in potato production that affects the use efficiency of other resources. The use of decision support systems, such as irrigation scheduling tools, is thus key to improve resource use efficiencies.

Further information:

Franke AC, Steyn JM, Ranger KS, Haverkort AJ (2011) Developing environmental principles, criteria, indicators and norms for potato production in South Africa through field surveys and modelling. ***Agricultural Systems*** 104: 297-306.

Steyn JM, Franke AC, van der Waals JE, Haverkort AJ (2016) Resource use efficiencies as indicators of ecological sustainability in potato production: a South African case study. ***Field Crops Research*** 199: 136-149.

WRC Project no. K5/2501, Quantifying and managing agricultural nitrogen and phosphorus pollution from field to catchment scale.

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WATER RESOURCE MANAGEMENT

Breede River environment plan taking shape

The Western Cape Department of Environmental Affairs and Development Planning (DEA&DP), mandated to achieve environmental sustainability in the Breede River Catchment, has embarked on a visionary new Environmental Resources Protection Plan (ERPP) to achieve it. Article by Leanne Seeliger, Annabel Horn and Wilna Kloppers.

Jason Mingo

The aim of this plan is to protect the ecological integrity of the 322 km-long Breede River that drains the catchment of 12 625 km^2 and drives the agricultural and tourism sectors of the province.

"The inspiration for our plan follows growing threats to the Breede River Catchment over time," says Zayed Brown, project manager. "One major, growing challenge has been the increase in invasive species that have been reducing water yield significantly. Experts calculate that as much as 30% of the water resource could be lost over 20 years."

Frequent fires in alien vegetation have contributed to soil erosion and subsequent sedimentation in rivers. It has been calculated that as much as 60 tons of soil per hectare is lost when fires burn in alien vegetation.

Water quality in the catchment continues to be under threat. The main contributors are nutrient enrichment from wastewater treatment work discharges, return flows from agricultural land enriched with fertilisers and stormwater flows from the informal housing sector.

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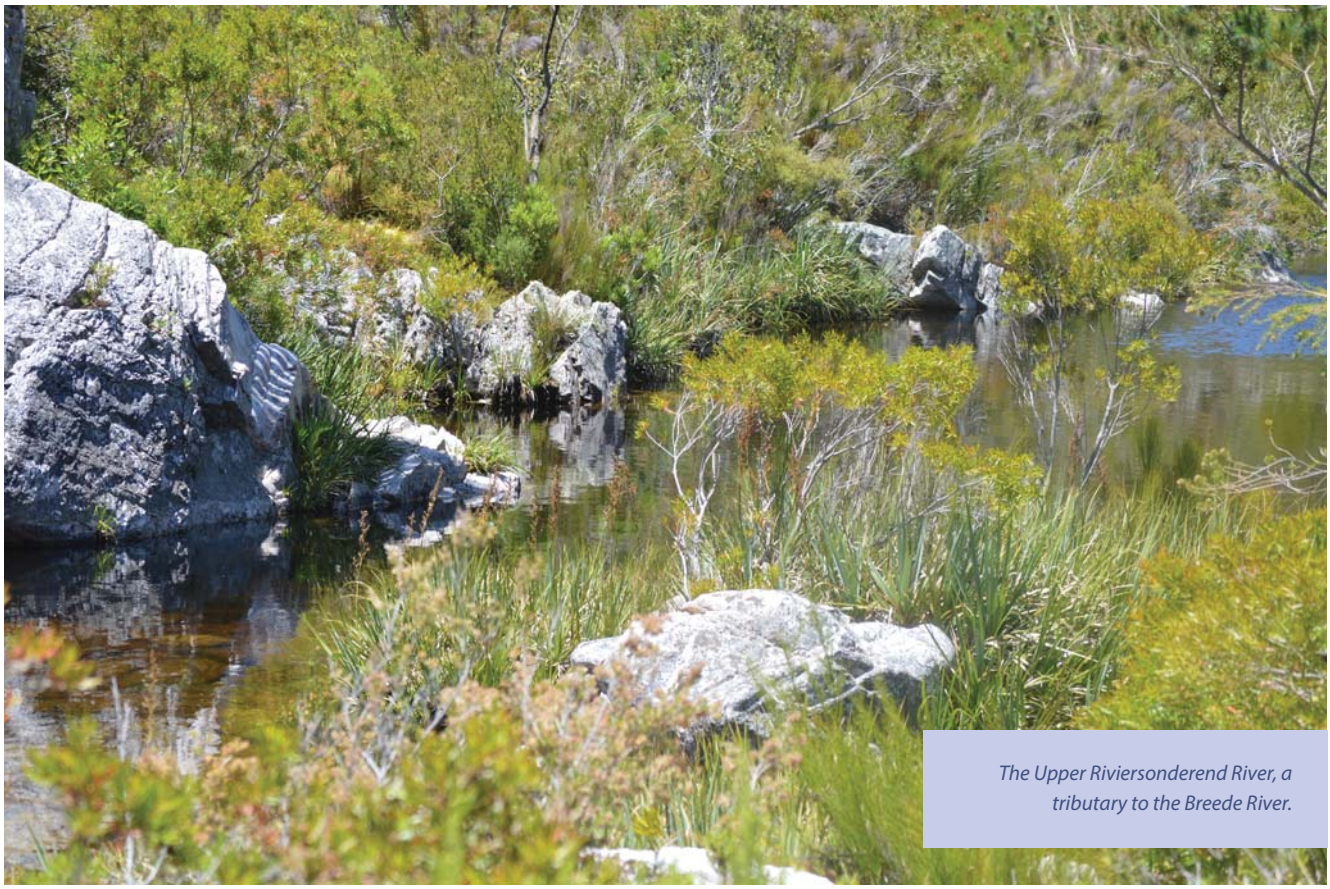

Annabel Horn

The Upper Riviersonderend River, a tributary to the Breede River.

"The invasion of alien species is severely impacting on the ecological sustainability of the Breede River catchment with about 70% of riparian areas in the Breede River catchment in a transformed state."

The 10-point strategy of the ERPP is visionary in that it calls for a collaborative approach to water governance in the catchment to address these challenges. It focuses on creating a partnership between the Department of Water and Sanitation, water user associations, the Breede Gouritz Catchment Management Agency (BGCMA), the Western Cape government, municipalities, universities and non-governmental organisations.

The rationale is that the complexity and the enormity of the problems affecting the catchment means that a single government cannot address all the issues at hand effectively. It will require the co-operation of many departments, as well as the leveraging of funding and resources from outside of government.

This collaborative partnership is to be supported by a water monitoring programme facilitated by ERPP that will enable the continuous evaluation of all Breede River catchment interventions and their impact on water quantity and quality. This programme adds to the water quality analysis of the BGCMA and municipalities in the area.

Water quality in the Breede River catchment is of serious concern, because it decreases downstream where there is intensive farming. Geological influences like the salt from the shales in the area and problems with urban stormwater drainage are other contributing factors.

The aim of the monitoring programme is to measure chemical parameters, selected metals within the sediment, pesticides, E-coli and to start biomonitoring at sites along the Breede River.

Several of the wastewater treatment plants in the Breede River catchment are already in need of urgent attention, because of, among other reasons, overloading in terms of design capacity with population increases in towns. It is common sense that this imposes a risk for downstream water users, including agricultural users.

There are a number of human settlement projects at an early stage of development in the catchment. The plan promotes the development and implementation of stormwater master plans and stormwater management plans for all the municipalities, including aspects of water quality as well as potential harvesting of storm water as a water resource. Municipalities will be consulted to identify strategic areas for sustainable bioremediation solutions to address the impacts of informal settlements on water quality.

The plan further calls for the agricultural sector in the Breede River catchment to look at methods by which water can be used more efficiently, while still maintaining production yield.

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Robertson Tourism

The Breede River serves as the backbone of the region's wine agriculture.

The plan aims to support international best management practice guidelines for agriculture in the Breede River catchment. These initiatives include water-use efficient technology and techniques, maintaining riparian buffer zones, and conservation agriculture.

The invasion of alien species is severely impacting on the ecological sustainability of the Breede River catchment with about 70% of riparian areas in the Breede River catchment in a transformed state. The plan identifies supporting existing riparian rehabilitation activities and implementing rehabilitation activities for priority wetlands within the Breede River catchment. The promotion of stewardship management plans and agreements with landowners is another priority.

Mountain catchments within the Breede River catchment are protected under the Mountain Catchment Act of 1970, and developments are limited to ensure quality water production by preventing soil erosion and protecting natural vegetation. The importance of the protection and proper management of these areas has been recognised by the National Water Resource Strategy II, promulgated by the Department of Water and Sanitation. Water source areas have been recognised as important where 8% of the land provides for 50% of the water.

The National Water Act of 1998 protects the water courses, while the National Environmental Management Act (NEMA) of 2008 protects the water resource if an activity triggers an Environmental Impact Assessment (EIA). Under the auspices of NEMA there is the Protected Areas Act of 2003, saying that if an area is declared as a protected area, then changes may not be made without authorisation. Land use is also protected by zoning, in that the land use can't be changed from open space without being rezoned, according to municipal bylaws and also by the national Spatial Planning Land Use Management Act (SPLUMA) Act of 2013.

"The economic focus stresses the importance of the agricultural sector, recognising the cost of pollution with regards to the potential loss of market"

There is an obligation to set fire breaks around these natural areas in the catchments, under the National Veld and Forest Fire Act of 1998. Then specifically the Biodiversity Act of 2004 states that permits are needed for the removal of threatened or protected species, such as ***Podocarpus elongatus***, commonly known as the Breede River Yellowwood.

In order to ensure the effective protection of the catchment areas, the plan will identify the priority rivers for alien fish eradication in liaison with Cape Nature and encourage universities to research the interaction between indigenous and alien species.

A focus on fire management is another priority. Fires in fynbos do not lead to erosion and sedimentation, but when it takes

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place in alien vegetation it can lead to excessive erosion and sedimentation impacts on rivers. Fire protection associations aim to reduce the impact of human interference in fire regimes and lobby for funding to remove alien flammable vegetation from priority areas.

The ERPP lays a strong emphasis on researching the economic drivers that govern future water use. While big towns like Worcester, Ceres and Robertson accommodate more than half of all people in the catchment, small towns like Greyton and Prince Alfred Hamlet have most recently experienced the highest growth. This calls for a spatial analysis of future development in relation to its impact on water resources in the catchment.

The economic focus stresses the importance of the agricultural sector, recognising the cost of pollution with regards to the potential loss of market, if polluted run-off from farmlands are not effectively managed. In support of this, it emphasises the danger of not upgrading informal settlements and allowing polluted effluent from these areas to continue to contaminate rivers downstream.

"The ERPP promotes ongoing payment for ecosystem services with the maintenance of natural infrastructure and ecosystems. Linked to this is the management of alien vegetation and fire regimes. It is considered that it is appropriate that the users of water should pay not only for the water used, but should also contribute to the maintenance of the natural infrastructure, such as the catchments, which maintains the provision of water," says Jeanne Gouws from Cape Nature.

A study of the Theewaterskloof Dam and other parts of the Breede River catchment is another priority. The plan calls for the measurement of water flows through hydrological modelling, as well as the value of the maintenance of these related ecosystem services to be investigated.

The tourism sector is highlighted as a key role-player in the Breede River Catchment that is directly reliant on the continued ecological integrity of the Breede River. The river serves as the backbone of the region's wine agriculture and the unique biodiversity that attracts visitors. The plan aims to use tourism promotion platforms to raise awareness of the ecological state of the Breede River and the river's importance to attract visitors to the area. It will link the tourism sector to conservation and protection initiatives.

A broad lack of awareness of environmental best practice across different sectors of society in the Breede River catchment is noted as a concern. A communication plan will therefore be developed that calls for community awareness engagements to be conducted in collaboration with ERPP partners. The main objective of the communication plan will be to restore the water quality to a level where its value for ecosystem services is recognised, and in doing so to promote growth and development and sustainable use of water for all the intended purposes.

The Kluitjieskraal Nursery, at Wolseley, provides indigenous plants to replace invasive alien invitation.

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WETLAND REHABILITATION

Pietersieliekloof wetland rehabilitation project – Investing in the future

A multimillion Rand wetland rehabilitation project has contributed to the conservation of endemic fauna and flora in the Agulhus Plain. Article by Heidi Nieuwoudt, Piet-Louis Grundling, Lana du Toit and Farai Tererai.

The main site before restoration: Headcut erosion degrading and draining the wetland and preventing fish migration.

All photographs supplied

The Agulhas Plain is an area of high biological diversity. More than 1 750 plant species are found on the plain, with many being endemic. The Agulhas Plain supports one of the largest areas of lowland fynbos and renosterveld habitats in the world.

A remarkably rich invertebrate fauna is also found in the area. The whole of the Agulhas Plain is considered an important bird area and is divided into three – the Overstrand, Overberg Wheatbelt and De Hoop Nature Reserve. Sixteen species of frogs have been recorded in and around Agulhas Plain, of which three are threatened. These are ***Amietophrynus pantherinus*** (Western Leopard Toad – endangered), ***Microbatrachella capensis*** (Micro Frog – critically endangered) and ***Xenopus gilli*** (Cape platanna – endangered).

Agulhas is further home to at least ten indigenous fish species, of which seven are marine and the remainder freshwater. A number of sub-catchments in the Agulhas area have been identified as Freshwater Ecosystem Priority Area (FEPA) fish sanctuaries, fish support areas (FSAs) or catchments important for fish migration. The Agulhas Plain is therefore a priority area for rehabilitation and conservation.

Current restoration work by Working for Wetlands focuses on

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The Working for Wetlands team at work constructing a chute-drop inlet.

the Pietersielieskloof wetland system, an unchannelled valley-bottom forming part of the broad Nuwejaars wetland complex. The Pietersielieskloof tributary rises as numerous branched mountain streams on the Bredasdorp Mountains. The mountain streams flow into typically unchannelled valley-bottom wetlands as they flow out of the mountains onto flatter ground. The Nuwejaars and many other wetlands in the Algulhas National Park have been identified as priority wetlands within the Agulhas Plain, being palmiet wetlands that are only found in South Africa. The system is located in quaternary G50B, and the Southern Folded Mountains aquatic ecoregion within the Overberg District Municipality, Western Cape.

These wetlands contain deep peat stores over which wetland vegetation grows, primarily palmiet (***Prionium serratum***), restios, sedges (such as ***Juncus lomatophyllus***), leucadendrons, ***Psoralea pinnata***, ***Pennisetum macrourum*** and ***Berzelia*** species. Sanctuary is provided for ***Sandelia capensis*** (Cape kurper), ***Pseudobarbus*** species (redfins), and ***Galaxias*** species (galaxiid). Fish found in the Pietersielieskloof wetland was identified as the critically endangered and endemic red-finned minnow, and the risk factor and rewards of the rehabilitation of these wetlands increased substantially.

A combination of inapt catchment land-use and wetland degradation by invasive alien plants, anthropogenic draining and road crossings has led to erosion and the subsequent rapid loss of peat from the Pietersielieskloof system over the past 12 years. Significant erosion occurred in 2006, and since then, many of the eroded areas have been invaded by alien vegetation. The wetlands have almost entirely lost their unchannelled valley-bottom characteristics. Headcut erosion caused the wetland to drain and prevented the migration of fish.

The Working for Wetlands project endeavoured to arrest erosion by building various structures, such as chute-drop inlets, to restore the wetland and regain ecosystem functions such as water and carbon storage, base flow maintenance and biodiversity conservation. Wetland rehabilitation is often constrained by poorly developed methodologies and associated high costs. This project presented a balance between innovation and cost optimisation.

Traditionally, huge and costly concrete or gabion structures with large construction footprints are used to address massive erosion gullies. Such big structural interventions take long to construct and cause considerable soil disturbance which provide invasive alien plants an opportunity to invade the area. This project applied the highly innovative "softer" and low cost interventions – chute-drop inlets to address big erosion head-cuts, with great success.

Unique methodologies were applied from planning and implementation, to monitoring and evaluation. Large interventions such as weirs, are known for fragmenting freshwater habitats, but this intervention maintained continuity. In light of limited resources for wetland rehabilitation and conservation it is envisaged that the experiences from this project may be applied elsewhere in the country in order to expand the Working for Wetlands rehabilitation footprint.

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Main site construction in progress.

This project made a valuable contribution to the environment and community alike. With an investment of about R2.8 million, it contributed to the protection of the endemic Palmiet peatland system and its associated rich biodiversity; in particular the future and survival of the red-finned minnow. Sustained base flow was restored to the benefit of the local communities towards the village of Elim, as well as farmers by protecting local water storage.

Improved water security contributes to ecotourism in the Agulhas National Park; and mitigation of climate change effects. The restoration has potential to enhance the carbon storage capacity of the peatland, thus contributing further to the mitigation of climate change effects. A total of 44 people from the Elim and neighbouring communities were employed and trained during the 7 898 person days of this project. The return on investment in providing water security to the people and land, and the contribution to the prevention of local extinction of the red-finned minnow – priceless.

The techniques developed here will also be rolled out in other palmiet wetland systems in South Africa. In particular in the Kromme and Gamtoos River Catchments where wetlands in these catchments are important in flood attenuation, base flow maintenance and sediment filtration upstream of large impoundments such as the Churchill Dam supplying water to the Nelson Mandela Metro (Port Elizabeth). This is of note given the Ramsar theme for World Wetlands Day 2018: Wetlands for a Sustainable Urban Future. We need to conserve wetlands in river catchments important to urban water supply.

The beginning of work to address two erosion headcuts just upstream of the main site.

Completion of work to address two headcuts just upstream of the main site – SUCCESS!

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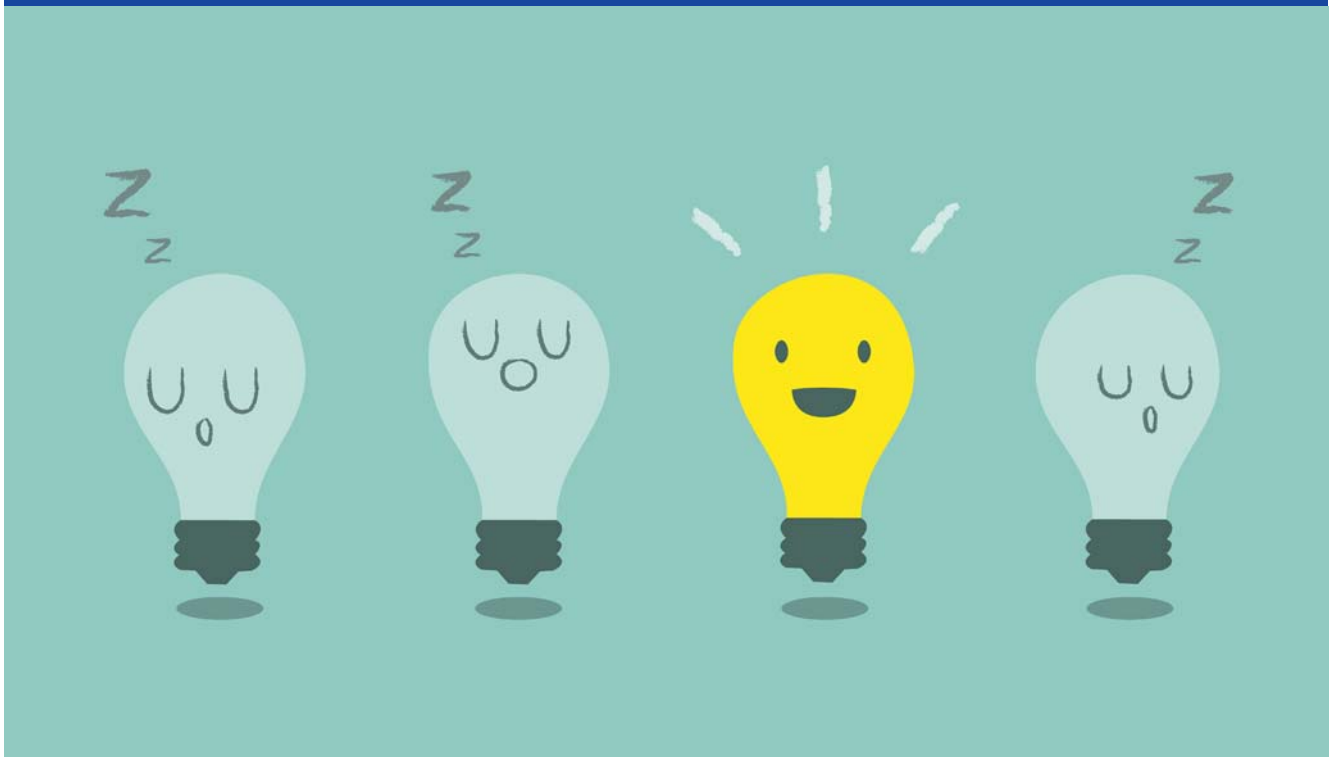
WATER PERSONALITY

Leading the charge towards innovation – Valerie Naidoo

In order for South Africa – and the region – to overcome its massive water challenges will require creativity, innovation and persistence in the water research, development and innovation field. Leading the charge is Dr Valerie Naidoo, current Chair of the Water Institute of Southern Africa (WISA).



Have you ever watched Star Wars and wondered about how a light sabre or a moisture vaporator might be manufactured and brought to market? Or mulled over the biological processes that treat wastewater so that it can be used for fertiliser or bioplastics?

No? Well, fortunately for us and our sustainable living on this planet, there are people thinking about – and working towards – these sorts of solutions all the time. Current chair of the Water Institute of Southern Africa, Dr Valerie Naidoo, is one of them.

"I love futuristic movies. They have all these innovation principles that get me thinking about what the next world might be and how we might live in it. What sorts of gadgets will we need and how would we do things differently?"

Not content to simply wonder about these things, Valerie has made it her life's work to unpack sustainable living practices and then make them a reality. Now working as the Executive Manager of Business Development and Innovations at the Water Research Commission (WRC), Valerie's background is in the sciences.

As a child, Valerie preferred science over other subjects, but the environmental angle was an early interest inspired by her health problems. "I stayed in South Durban basin in between two oil refineries. It was a highly polluted area, and I suffered from respiratory problems, so I was very aware from quite a young age that pollution was actually accelerating some of these symptoms. I might not have fully understood the whole concept of sustainability at that age, but I was certainly aware that the

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unchecked use of resources can lead to negative impact."

And what her early education in science revealed to her was how systems need to be balanced and in equilibrium. "You get some sense that the environment is really important – and that we are part of the environment. The more I read about it, the more I started to understand the environment around me and the value of our role in protecting it."

RESEARCH CAREER

Driven by her curiosity in the sciences, a love for reading, and her solutions-seeking nature, Valerie's studies veered towards deep research in microbiology and chemical engineering, finally seeing her complete her Masters and then her PHD in water treatment systems. At the urging of her professor at the University of KwaZulu-Natal (UKZN), Valerie took up a two-year PhD data collection position at the Paris research unit of French water company Suez-Lyonnaise-des-Eaux.

The opportunity gave her exposure to a completely different environment – and a significant realisation: "Quite clearly when you go there, you think 'First World' and 'developed' and they obviously have better facilities and funding. But you start to understand that South Africa, especially at that stage, was quite well ahead on the biological nutrients process and had contributed substantially to scientific literature in that area. It was less a case of being taught by the French who were doing the teaching and more a case of collaboration."

After finishing up in France, Valerie joined the Pollution Research Group as UKZN as a project coordinator before moving into the private sector with Unilever as the Research and Development Manager in the Africa, Middle East and Turkey regions.

"For me this was an interesting step away from research and analytical spaces of life. This was a deliberate decision. I looked at the academic environment and, to some extent, found it very slow, with limited opportunities to change quickly. After all, that's just the nature of the way these organisations are structured. But I thought I'd spend some time in the private sector to see where I fit in."

WISA Chair, Dr Valerie Naidoo, in action at the Water Research Commission Symposium in 2017.

into a very good management training programme at Unilever. Different management skills are important even if you're purely specialising. You're always going to have to manage something whether it is budgets, research programmes or teams. So getting an understanding of business principles and how to manage and understand finance to some extent is the useful addition to growing a knowledge base and it all comes together in the end.'

And where it all came together for her was with her appointment to the WRC.

RESEARCH AND INNOVATION

Valerie's first six years at the organisation was in research. "But as someone who's always looking for solutions, I needed to do more than just research. Innovations provide solutions to challenges so if you really want to solve something you have to take on innovation."

"We need to consider marketable products that can either then be used by the public sector or the private sector, from households to communities and governments. But there are some big gaps in this process and considerations that are very different from the pure private sector."

In 2013, the WRC was restructured for just this purpose. "There are areas we're playing in now where we are learning as we are doing. We're asking: "How do you take this research and make it impactful?" We're looking at the different mechanisms and models and new ways of partnering. It's exciting because I suppose to some extent it's new and risky and you have to think on your feet."

According to Valerie, the water sector needs to push the envelope in terms of the way it looks at innovations and economic growth, industrialisation and business development, while spanning both the public and private sectors. "'There are a lot of unknowns here, and this is the part where the curiosity in the excitement in trying to find those solutions is interesting to me from an innovation point of view."

INSIGHT INTO THE PUBLIC v PRIVATE CONVERSATION

Anyone in the innovation space will know that although ideas may be many, taking those ideas through a development process and then to market is a whole other ball game. "In our case, we need to consider marketable products that can either then be used by the public sector or the private sector, from households to communities and governments. But there are some big gaps in this process and considerations that are very different from the pure private sector."

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On air with SAFM.

One of the big considerations is the extra step of having to convince government authorities that new implementations and products are viable. "Due to the huge red tape around the Public Finance Management Act, the Municipal Finance Management Act and Treasury rules, most public sector officials are risk-averse. And nobody wants a failure that the newspapers will say is a waste of public funds. People almost need to quadruple-check everything, taking a lot longer to make decisions and only doing so when they feel like the chance of failure is very low."

Although there are the usual methodologies and mechanisms to test new initiatives and lower risk, this is where another gap in the public sector is highlighted. "The chance of failure gets lower if you have a highly capable society, because almost any innovation can be fixed if you have the right minds, if you're nurturing the right kind of excellence in your own system.

"But the problem is that we have an issue of capacity in the municipalities. If you don't have the right people when you introduce new outputs, the guys that are used to routines are unable to take calculated risks on the offering or adjust, think and analyse to adapt your technology to the environment."

Nurturing the right kind of minds then is what Valerie sees as a foundational necessity to encouraging innovation in South Africa and the rest of the continent. "If Africa is to grow and create its own economic base, it needs to know where to prioritise and what to prioritise. We can't compete with the US; we can't compete with China. But we can figure out what areas we want to work in, which people to invest in and what instruments and infrastructure we need to accomplish this."

Valerie believes this means funding the basics: understanding the value of and building capability around engineers, physics, mechanics, electronics, robotics and IT and investing in schools and colleges around manufacturing and assembly. "This is a long-term thing; this isn't a short-term, five-year programme from the government. But it must happen if we're to become part of the global society and competitive."

INNOVATION BY AFRICA, FOR AFRICA

Despite these fundamental requirements, Valerie believes that water scarcity issues faced by South Africa and the rest of the continent is a point of possible strength when it comes to innovation. After all, physical scarcity demands a solution. "If we push ourselves and ask ourselves tough questions – for example, in a resource scarce environment is it worthwhile doing things like flushing water down the toilet – we offer ourselves the opportunity to leapfrog, not to copy. We have the opportunity to do things where, while we may not create the Rolls-Royce of the US or European markets, we can create the kind of technologies and opportunities that actually work in this kind of environment."

It's why Valerie believes it's worth investing in the innovation culture of encouraging people to think differently and to try out new things, to test them and to look for opportunities to do things differently. "It's this kind of mindset that will drive other things. If you do come up with a worthwhile technology, for instance, it drives multiple agendas for the government from jobs to new products to export markets to the opportunity to provide services… So you see, multiple benefits come from looking at some of these tough questions just a little bit differently."

Apart from education, Valerie believes that another part of the solution lies in building entrepreneurs and enablers for innovation. "We need people who are curious and looking for new things. These are the people disrupting the status quo and effecting change. This is the basis of life – continuously improving by looking for new and better ways to do things."

LEADERSHIP DRIVING INNOVATION

Leadership is of utmost importance. "[Leadership] is the heart of innovation or innovative thinking in organisations. It provides a route that gives people a forward-thinking approach to the different initiatives and strategies that are being driven," notes Valerie.

Leaders who embrace innovation leave room to fail, she believes. And in the public sector, where there's a microscope over everything a public official does, there are very few pockets where visionary leaders are strong and daring enough to convince counselors to look forward to the future.

This is not only not a problem for the likes of Valerie, it is part of the challenge and excitement of her role in driving innovation. "I don't look at life in terms of what obstacles there may be. I look at what I want to achieve and then find the different pathways to get there. As you grow older, you realise that what you can achieve on your own is actually easy because it's in your control. The bigger challenge is what you can achieve through others – what can you influence, who you can motivate, or what vision you can create that people buy into and support."

As climate change continues to affect the already strained resources facing South Africa and the continent, answers to the crisis will be found with people like Dr Valerie Naidoo whose passion for exploration and solutions will bravely drive change and lead us into the next world.

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WATER SUPPLY

Are icebergs a realistic option for augmenting Cape Town's water supply?

With Cape Town staring down the barrel of the taps running dry, the question of the use of icebergs as an alternate freshwater source has once again begun to raise its head, around dinner tables, on street corners and in the press. But is this a viable water augmentation option? Article by Neil Malan.

Photo supplied

That icebergs attract this kind of attention is perhaps not surprising, given the enormous size of the polar freshwater resource – a single large (in the order of 10 km long) berg contains enough water to supply Cape Town for a couple of decades

Towing icebergs is not a new phenomenon, the idea crops up pretty much any time a major coastal city is beset by water-supply issues, as a series of feasibility studies by both US and Australian authorities (and most recently Abu Dhabi) in the second half of the twentieth century can attest.

That icebergs attract this kind of attention is perhaps not surprising, given the enormous size of the polar freshwater resource – a single large (in the order of 10 km long) berg contains enough water to supply Cape Town for a couple of decades. So, is it as simple as grabbing some free freshwater, or is this just the tip of … er … iceberg?

One can go pretty deeply into this topic, but some frequently asked questions are summarised below:

Can we get it there?

The short answer:
Maybe… Probably.

The long answer:
Icebergs are large, and heavy. Therefore, in order to get a decent-sized (say 20 km-long) iceberg it is estimated that some twenty large oceangoing tugs would be needed to move the

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Neil Malan of SAEON.

iceberg the 6 000 odd km from the Southern Ocean to Cape Town. This would be done at a speed of approximately one knot, thus making a journey of 250 days to reach the Cape and losing about 40% of its mass along the way.

With this class of tug being in limited supply, they cost around $250 000-$500 000 a day to charter. If one includes the need for each tug to be refuelled three times during the tow, you get to a cost of at least 2.5 Billion USD (to put this into perspective – this exercise would burn around 100 000 tons of fuel).

Despite being mathematically and theoretically possible, it has been these physical constraints which, in the some 200-year history of 'let's go get us an iceberg', has kept anyone from actually trying it. Although possible methods have evolved over the last 50 years and use of ocean currents or kites for propulsion, and shields to slow down the melting of the ice have been put forward, none of these are able to change the fundamental physical scale of the task. Small-scale experiments have proved that the instability of icebergs, due to their ever-changing centre of gravity as they melt, makes the use of alternative propulsion methods very difficult.

It has also been proposed that the natural drift of the iceberg with ocean currents could be harnessed to direct it towards its destination. However, while this looks easy on schematic diagrams, in reality the ocean is a cauldron of turbulent currents (which we do not entirely understand at small scales) and in order to get to Cape Town, the iceberg would have to cross the Antarctic Circumpolar and Agulhas Currents, two of the most energetic ocean currents on the planet, as well as an area aptly known as the 'Cape Cauldron'.

As a marine engineering exercise this is a fascinating problem – how does one attach the tow cables, what do you do when the iceberg rolls over, how long will it take to get moving (several days actually), how does one steer it around other icebergs? Despite pitfalls, humans are creative when confronted with great challenges, and perhaps we do have the technological ability (given an unlimited budget) to transport an iceberg, but the bigger question remains, would we want to?

How do we harvest it?

The short answer:
Not as easily as you might think…

The long answer:
Once an iceberg has arrived in Cape Town waters, it then has to be melted and transported to land. This would have to be done either by pipeline or tanker ship. The elephant in the room here is depth. An iceberg of the size needed for water supply will have a depth of at least 200 m. This depth requirement results in the iceberg having to be placed around 50 km offshore, and thus increases the cost and difficulty of transporting the water to shore. In addition to this is the challenge of keeping the water uncontaminated by salt and pollution during the melting process.

What are the consequences?

The short answer:
How long is a piece of string?

The long answer:
One can divide the consequences of iceberg harvesting into two main categories – the practical and the environmental (although some overlap between these is inevitable). Environmentally, the effect on local weather patterns and ocean currents would have to be quantified.

However, the presence of such a large, cold input of freshwater near the coast would undoubtedly have an effect on the coastal water circulation, which makes the ocean off Cape Town one of the most biologically productive in the world's oceans. This biological productivity is reliant on the upwelling of cold, nutrient-rich water from deep, which supports a staggering array of life, including most of the country's large commercial fisheries. A cap of cold, fresh meltwater could reduce the efficiency of this system, causing a regime shift to an alternative, and far less productive, ecological state.

Of more immediate impact and interest to most of Cape Town's citizens would be the effect of a large iceberg sitting offshore of the city on local weather patterns. One argument which could be made is that the cold air descending above the iceberg would result in a localised high pressure. The contrast of this with the warm land during the summer months could result in an acceleration of the South-Easter. An increase in these winds, even if only 10% or so, could have some fairly catastrophic consequences on the buildings of the city and has the added downside of deflecting rainfall from cold fronts southwards, away from the city and its catchment areas.

While there are many of this type of environmental consequences, which would have to be thoroughly explored through computer modelling simulations, there is a more immediate practical consideration to consider. Icebergs melt, and will do so at some speed in the mid-latitude climate of the Cape. In addition, they do not melt quietly and calmly. As they melt and are eroded by the wind and waves, their weight distribution changes, until such a point as they are off balance. What happens then is that the iceberg will turn over – which,

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with the amount of weight involved, is not a trivial event. Think of the largest ship you can imagine capsizing, then add a few orders of magnitude.

These turnover events could also result in 'mini-tsunami' wave events which could prove a hazard to both shipping and coastal structures. However, the real danger here is that when an iceberg melts and turns over, it also splinters, resulting in the production of smaller icebergs and their pint-sized cousins, growlers and berg bits. These may sound cute, but each of them has the power to send a ship to the bottom. Hence, in mooring an iceberg off the coast of Cape Town, one of the world's busiest shipping lanes will become littered with floating hazards (most people have seen Titanic and can deduce what happens when ship collides with ice).

Is it legal?

The short answer:
No.

The long answer:
Under the Antarctic Treaty (the body which essentially governs how we treat Antarctica and its resources), activities related to the removal of mineral resources are not allowed. The loophole here is that icebergs are difficult to categorise (e.g. is it a solid mineral or a liquid water resource). However even if one wriggles through that loophole, the use of icebergs under the law of the sea would be subject to an environmental impact assessment.

Based on the key role which Antarctica and its ice play in driving the global overturning circulation, this would be difficult. Whilst water supply to populations in dry areas of the world can be seen as important, preserving the mechanisms which maintain our entire climate system (yes, the same system that allows human existence on earth at all) must surely be seen as a greater priority. It would therefore be difficult to see the decision to allow the harvesting of icebergs to be a moral one.

This article was first published by SAEON (www.saeon.ac.za).

Response to article – Iceberg harvesting IS a possibility
Dr Olav Orheim, initiator of the ship-bore iceberg observation programme under SCAR, Georges Mougin, Director of Water and Power from Iceberg, and Capt Nicholas Sloane, Director of the Resolve Marine Group disagree with Neil Malan's view. In a letter to SAEON they write: "we believe that the question of 'Ice to the Cape' is possible and shall become a reality if this concept receives serious evaluation."

They disagree with Malan's view of a 'decent-sized' iceberg. According to the letter writers, a realistic towable iceberg is 1.0 x 0.5 km in above-water dimensions. "This size could provide Cape Town with 200 000 m^3 of freshwater daily, for about a year.

They also point to the particular nature of the large Antarctic icebergs as compared to Arctic icebergs. "These Antarctic icebergs are flat 'tabular' slabs of ice, and although many have internal flaws and therefore may break up, they do not roll over until their horizontal dimensions are reduced to about the same as the vertical dimension, which is generally around 250 m.

According to the authors, a 'small' tubular iceberg would not affect ocean circulation and local weather as it will be stranded many kilometres offshore. Thus its impact on local air and water temperatures would only be discernible immediately around the iceberg, with minor impacts on the local ecosystem.

"The article asserts wrongly that it will be illegal to tow icebergs from the Southern Ocean, and refers to the Antarctic Treaty. The Treaty does not discuss ice harvesting, which most likely is not covered by the Environmental Protocol under the Treaty. In any case, any towed iceberg would be picked up far north of 60°S, i.e. north of and outside the boundary of the Treaty. It would be an object floating in the High Seas, slowly melting on its eastward passage around the southern oceans, or awaiting to be harnessed by the first who could do so."

There are at any time around 200 000 icebergs floating in the Southern Ocean. While 20 km-long bergs are very rare, approximately 20 000 of the icebergs have lengths of over 0.5 km. Of course, a very small proportion of these will have the suitable position, size and strength for towing towards Cape Town.

The authors also caution the estimated cost of towing an iceberg to Cape Town. "The article states that the cost of towing a huge iceberg near to the Cape would run into billions of US Dollars. We estimate that towing, or guiding, realistic icebergs into the Benguela Current and making a landfall north of Cape Town offshore of St Helena Bay, would be less than the cost per cubic metre of desalinated water schemes presently approved by the Western Cape Government. We believe that with venture capital, the concept of 'Ice to the Cape' will become a reality in the near future, and certainly within the next five to ten years!"

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WATER AND BIODIVERSITY

Ensuring the future of Kamfers' flamingos

Phetole Peter Ramollo from the Northern Cape Department of Environment and Nature Conservation reports on government efforts to ensure the future of the Lesser Flamingo at Kamfers Dam, and ecotourism site in the Northern Cape.

All photographs courtesy Peter Ramollo

Kamfers Dam is one of only six known breeding sites for Lesser Flamingos in the world, and is the only one in South Africa. The pan extends across about 500 hectares, and is located 5 km north of Kimberley, in the Northern Cape. The pan also supports Greater Flamingos and other water birds.

Over the past 40 years Kamfers Dam has been changed from an ephemeral to a permanent pan due to the constant influx of effluent and stormwater. The Homevale Wastewater Treatment Plant pumps both treated and untreated sewage water into Kamfers Dam. Together with other effluent and stormwater released into Kamfers Dam by Sol Plaatje Municipality, a total of about 30 - 40 Ml flows into the pan daily.

The permanently inundated pan provides a suitable saline environment that promotes the growth of spirulina, a major food source of flamingos. This endorheic pan accordingly provides (geographically and ecologically) a suitable habitat for flamingos and other water birds, while also playing a role in nutrient cycling. Conversely, when too much poorly treated or untreated sewage is pumped into the system it can increase the risk of disease outbreaks like avian botulism, putting the flamingos and other water birds' lives at risk.

In 2006, a breeding island and nests were built with clay to stimulate flamingo breeding. After the creation of this artificial island, an estimated 24 000 Lesser Flamingo and 100 Greater Flamingo chicks hatched on the island between 2007 and 2011. Sadly, due to the unregulated influx of stormwater and sewage effluent the island was flooded in over the 2010/11

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period, and some of the chicks drowned. The flooding event was followed by an extremely dry and warm period, together with the breakdown of sewage water-supply pipelines from the Gogga Pump station, which left the pan dry by September 2016. Flamingos and other water birds abandoned the pan, leaving only catfish skeletons visible in the pan.

"With the development of suitable bird viewing infrastructure at Kamfers Dam it can become an even more popular birding locality, attracting more eco-tourists and bird photographers. "

During January 2017 rainfall brought some relief, and the former pan residents started to return in numbers. At the same time, the municipality secured funds to fix some of the broken pipelines. This enabled the release of treated sewage water into the pan again. By the end of October 2017, the flamingo population reached an estimated ten thousand. This time the birds not only built nesting (turrets) sites, they also successfully bred along the south-western edges of the pan, not on the island! It was not the first time they were building nests along the water edges, but it was the first time the birds successfully bred there. This was the first breeding event not facilitated by human intervention, something the provincial Department of Environment and Conservation were hoping for. While the reasons for the sudden successful breeding is uncertain at this stage, it is still valuable towards the conservation of the species, and is a historic event for South Africa and, specifically, the Northern Cape.

With the development of suitable bird viewing infrastructure at Kamfers Dam it can become an even more popular birding locality, attracting more eco-tourists and bird photographers. Former unsuccessful breeding attempts were ascribed to disturbances caused by stray dogs, photographers and other people walking too close to the nesting areas. It is accordingly inferred that the biggest threats to the flamingos at Kamfers Dam include water quality (and associated changes in algae composition), water quantity (volume released into the pan system) and human-related disturbances.
Apart from the importance of Kamfers Dam in terms of species conservation (ecological value) the flamingos are also considered to be iconic, contributing towards ecotourism revenue (economic and cultural value. Many places in Kimberley derive their names from the flamingos, like the Flamingo Race Course and Flamingo Casino. The flamingo also features on the logos of the Sol Plaatje and Frances Baard District Municipalities. With people already coming from all over the country to view and enjoy the amazing congregation of flamingos at Kamfers Dam an economic opportunity presents itself. With the development of suitable bird viewing infrastructure at Kamfers Dam it can become an even more popular birding locality, attracting more eco-tourists and bird photographers.

Currently, the endorheic pan is not formally protected, and might be facing complete collapse if collaborative action and adaptive management is not implemented. The population of Kimberley continues to increase, which implies in an increase

An abandoned chick.

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Declining water levels are causing flamingo parents to abandon their nests.

in the volume of sewage water released into Kamfers Dam. It is feared that if the Homevale Wastewater Treatment Plant is not upgraded it would not be able to cope with the future volume of raw sewage potentially being released as untreated raw sewage into the pan.

Consequently, toxic algae blooms (toxin-producing cyanobacteria was first recorded in 2012 in Kamfers Dam) probably would result in large bird mortalities, as recorded in Kenya and Tanzania. If housing development is allowed on the periphery of the pan the presence of human activities and noises would disturb the flamingos and they will migrate as seen at Kamfers Dam and around McDougals bay. With the primary eco-tourism attraction gone the eco-tourism revenue will be lost for Kimberley.

One the one hand there are those who ask for Kamfers Dam to be proclaimed a nature reserve or to be managed under a stewardship programme. For them such action will ensure the protection of flamingos (and their breeding) while also boosting ecotourism and the local economy. Others argue that even though is declared a conservancy as long as the poor water quality and high volumes of water are not addressed the problems will remain unsolved.

At the time of writing, some of the flamingos were still breeding and it was expected that they might breed until the end of March depending on the water level. Once again, we are facing a situation where declining water levels are threatening the success of flamingo breeding, with several eggs and small chicks already been abandoned as the adults and juveniles follow the residing water edge. There are several abandoned turrets with eggs on the south-western side. With the receding water level, the flamingos continue building new nests towards the water edge while abandoning the outer nests, irrespective if they contain unhatched eggs and/or small chicks. The water level in the pan should be maintained at least until all the eggs have hatched and the chicks are mature enough to fly and feed on their own.

Discussions are underway between the Sol Plaatje Municipality, Department of Water and Sanitation, and the provincial Department of Environment and Nature Conservation to improve the responsive management of the water levels at Kamfers Dam to secure the successful completion of this historic breeding event. We hope that the estimated 10 000 to 15 000 chicks and juveniles in the crèche become fully fledged, being more mobile and able to search for other suitable habitats.

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WATER AND THE ENVIRONMENT

Threatened KZN wetlands offered a lifeline

The outcome of several scientific investigations have revealed on-going declines in water levels in Northern KwaZulu-Natal.

Technical director and geohydrologist at JG Africa engineering and environmental consulting, Mark Schapers, was invited to share his experiences working on groundwater projects in rural areas to assist in developing a workable solution for the declining water levels in northern KwaZulu-Natal. This includes the Vazi Pans peatland wetland system.

The workshop was held at Isibusiso Esihle Science Discovery Centre earlier this year, and brought together a number of stakeholders, including community leaders, municipalities, state departments, scientists and industry. It was held under the banner of the KwaZulu-Natal Wetlands, and supported by the South African Environmental Observation Network (SAEON), as well as JG Afrika.

Schapers alerted the Water Research Commission (WRC) and SAEON to serious declines in water levels in the Vazi-wetlands three years ago, based on JG Afrika's ongoing operations in the northern coastal flats aquifers. His findings complemented those of SAEON, which has been focusing on understanding the relative impacts of climate and land use on the groundwater table and the wetlands system.

Outputs from several scientific studies concur that forestry plantations in the region are having a significant impact on the water resources. Additional stressors include a prolonged drought and increased levels of abstraction for human consumption. The latter, however, has had a minimal impact compared to those of forestry and drought. Superimposed on this is the threat of climate change impacts on the area.

Exacerbating the problem is the burning of the peatlands, which are important stores of carbon and which, by acting as a sponge, help hold up the water table.

The declining water table has led to the drying out of the peatlands with the earliest reported incident of severe burning in Vazi-North in 1998. In 2017 fires broke out again in some of the peatlands resulting in an increased loss of peat that has taken thousands of years to accumulate and with it the release of greenhouses gases, such as methane and carbon dioxide.

The declining water levels are also having a dire influence on the livelihood of the rural community in the area who, for many years, have been aware of the threat that the pine and blue gum trees pose to their small farming activities.

Sue Janse van Rensburg, SAEON Grasslands-Wetlands-Forests Node Coordinator, is encouraged that all stakeholders have now agreed on the issues and there is a commitment to work together to find water sustainable options for livelihoods, economic growth and job creation.

"These are important steps that will ensure an outcome that emphasises climate resilience. Moreover, the day ensured a collective understanding of the severity of the situation, but also provided a road map to explore alternatives and solutions proposed by experts. It requires a bottom-up approach to ensure ownership, and complemented by integrated research that spans various relevant fields, ranging from environmental monitoring to resource economics," Janse Van Rensburg says.

Schapers concurs that the workshop was a sound starting point, considering that there is now beneficiary buy-in and the relevant authorities understand the need for action. He says that his experience in groundwater projects clearly shows that there is a greater chance of success when there is increased interaction between the technical, political and social components.

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A formal proposal is now being drafted and, importantly, it focuses research into ways of replacing the existing resource-based economy in the area with sustainable alternatives. It will include suggestions made by resource and environmental economists, who were also invited to share their insights at the workshop.

This plan will be used to apply for funding from various sources, such as the Green Climate Fund, to assist in the development of a document that will guide the implementation of a strategy for the Vazi wetlands.

Janse Van Rensburg notes the need for urgent action, and points to research undertaken by Schapers and his team of groundwater and surface water specialists at JG Afrika concerning the greater area around the Vazi wetlands and, in particular, the Lake Sibaya system.

Their work has revealed a significant drop in the water table as early as 2000, while changes in climate and low rainfall levels in the area have compounded the situation.

After monitoring efforts came to a halt in 2014, when water tables fell below gauging stations, the SAEON, working with the DWS, and Schapers intervened to ensure real-time data was available to capture the continued declining trend.

As she notes, "good data is our life blood, and even sophisticated models rely on ***in-situ*** data".

The combined impact of forestry and below average precipitation in the area is evident by the extremely low levels of Lake Sibaya. Located in the iSimangaliso Wetland Park, water levels of the largest fresh water lake in South Africa are at the lowest ever recorded.

A combination of current below average rainfall trends and continued forestry operations will result in the rapid deterioration of water levels at the Vazi wetlands. Further research is required to determine whether changes in land use, rainfall levels and climate will reverse the decline.

Groundwater recharge in the area is under investigation. While previously thought to be a simple function of rainfall, Schapers explains that studies into the recharge of groundwater are further complicated by high-energy events, such as cyclones, as well as flooding on the Pongola River. There may be further consequences for the entire system should these dynamics change.

Covering about 19 000 ha, the Manzengwenya and Mbazwane Plantations are located in Mhlabuyalingana Municipality within the uMkhanyakude District, and affect three traditional councils, including KwaTembe, KwaMbila and KwaMabaso.

The forests are part of a major state-driven land redistribution programme in the area, and the plan will, therefore, also propose ways of substituting existing and future employment opportunities created in the forestry value-chain.

Janse Van Rensburg says that many of these jobs could be supplemented by developing the significant eco-tourism potential in the area.

Schapers emphasises that a long-term solution to the declining water levels in the northern coastal flats aquifers is dependent upon the accurate capture and interpretation of information by relevant and experienced scientists. This will assist in the identification and interpretation of trends, as well as in forecasting the eventual complete depletion of water levels.

He also advises the authorities to increase expenditure in the area to assist in the development of a formal implementation plan, including familiarising politicians and local contractors with the latest standards and protocols.

Deterioration at surface water ponds throughout the area has confirmed the sheer extent of the challenge that lies ahead.

For example, JG Afrika's research has revealed an estimated 3,5 m drop in the water table level at the Giba Pan in Mnqobokazi. Water loss from the groundwater system is between 450-million m^3 and 900-million m^3, equating to between 3 200 and 6 400 litres per person annually for the entire uMhlabuyalingana Local Municipality.

"The area that was investigated is about 1 500 km^2 in size, with an average porosity range varying between 10% and 20%. Taking a conservative estimate of only 5% porosity, the groundwater system in the northern coastal flats has declined by at least 225-million m^3. This is a very serious loss of water from the system, and is showing no signs of recovery," Schapers says.

He thanks the National Research Foundation, WRC and SAEON for the opportunity to participate in an initiative that has already received such a favourable response from all stakeholders and that is expected to have a profound positive impact on the Vazi-wetlands.

Stakeholders have gathered to find a workable solution to declining water levels in the Vazi Pans Peatland Wetland system.

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Water KIDZ

Tshwane kids get up close and personal with unique urban wetland

Learners conducting miniSASS – identifying aquatic invertebrates that can indicate river health.

Located just 5 km from the Union Buildings, and flanked by the N4 and N1 highways, the Colbyn Valley wetland, in Pretoria, is a unique asset. On 10 February, children from all over the city got the chance to experience this special urban wetland for themselves.

The wetland, which covers an area of about 15 ha, is formed by backflooding of the Hartbeesspruit as it flows through a poort between two quartzitic ridges, along with the contribution of groundwater and subsurface drainage from seeps upstream. This has also created favourable conditions for the accumulation of peat, a rare occurrence in South Africa. Peat forms when low-energy flows and permanent waterlogging enable partially-decomposed plant material to accumulate.

In a special event in celebration of World Wetlands Day, more than 170 children visited the Colbyn Wetland Nature Reserve in Pretoria to learn about wetlands and their role in sustaining our lives and livelihoods. This is an annual event hosted by the WESSA-affiliated Friends of Colbyn Valley and the Agricultural Research Council's Institute for Soil, Climate and Water. This year the organisers were assisted by BirdLife Northern Gauteng, Cripsis Environment, and WetResT Centre for Wetland Research and Training, and sponsored by Ocean Breeze Food Merchants.

A number of environmental professionals and students also volunteered as leaders and facilitators at the event, including, among others, the Tshwane University of Technology Green Arcadia students, BSc Soil Science students from the University of Venda, and specialists from the national departments of Environmental Affairs and Water and Sanitation.

The event was aimed at children aged 7 to 13 years old, drawn from various school and youth groups across the city. In addition,

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the non-governmental organisation SOAPKidz facilitated the attendance of vulnerable children from two of the city's community development centres.

The day's activities were designed to create awareness about the value of wetlands, how they are formed, how they function, and how to protect them. Participants were taken on a wetland discovery walk; built a simple model to show how wetlands work; walked the 'catena' (a sequence of changing soil conditions down a slope) to look at the soils and plants that indicate the presence of wetlands; and became 'citizen scientists' by performing miniSASS to classify the water quality of the Hartbeesspruit. MiniSASS or 'mini stream assessment scoring system' is a simple tool which can be used by anyone to monitor the health of a river. You collect a sample of macroinvertebrates (small animals) from the water, and depending on which groups are found, you have a measure of the general river health and water quality in that river.

Wetlands are important areas for supporting bird diversity, and the day kicked off with some extreme close-up bird watching – bird ringers from BirdLife Northern Gauteng set their mist nets in the reserve before dawn, allowing visitors to see how the birds were caught, measured, ringed and released, and explaining how the practice of bird ringing contributes to avian science and conservation. Colbyn Valley has been described as the 'best birdwatching spot in Pretoria' and around 150 bird species can be found here.

In addition, several animal species depend for at least part of their lifecycle on the wetland or surrounds – notable sightings over the years have included genets, duikers, hedgehogs, elephant shrews, water mongooses, and even the threatened red rock rabbit.

Though it is vulnerable to a number of impacts due to its urban location, the Colbyn Valley Wetland remains a valuable biodiversity and water resource, as well as offering residents a unique educational and recreational site. The wetland is conserved within the Colbyn Wetland Nature Reserve, proclaimed in June 2014 by the City of Tshwane.

Children arrived at 6 am to see what had been caught in the BirdLife Northern Gauteng ringers' nets.

Crossing the Hartbeesspruit on the wetland discovery walk.

Suretha Botha explaining that different plant species are found in seasonal vs permanently wet conditions.

Sandiso Dlamini from TUT Green Arcadia guiding his group in building a simple wetland model.

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HIPPO ROLLER DONATION BOOSTS FOOD PRODUCTION

The Water Institute of Southern Africa (WISA) through its Water Sciences Division's Women in Water programme, has facilitated the donation of hippo rollers to a number of urban food garden cooperatives in Gauteng. While water issues can impact anyone, the greater burden is placed on women; the role of women in rural areas as the primary water collectors is well known. The Women in Water programme aims to address these challenges and make a difference in the lives of women. At the second annual Women in Water Conference, organised by the Water Sciences Division and held in October last year, conference attendees were requested to sponsor hippo rollers for needy recipients. The Paper Manufacturers (PAMSA) and Recycling (PRASA) associations of South Africa met this call by sponsoring ten hippo rollers, which were then donated to Food and Trees for Africa, a social enterprise that addresses the issues of food security and environmental sustainability.

One roller was handed over to Paul Maluleke of the Alexandra Greening route for their garden. Food and Trees for Africa will hand over the remaining rollers to other beneficiaries that they are supporting in both urban and rural areas. The Hippo Roller Company donated three rollers which were handed over to World Vision, Violet Bhala at the Molobanyane Cooperative in Alexandra and the Modimo Oteng Cooperative – the latter is a newly-established food garden in Alexandra. Finally, Aqua Resources donated ten rollers which were handed over to World Vision, which primarily focuses on supporting children. They have identified communities in the Eastern Cap where 55 children will directly benefit from the roller donation.

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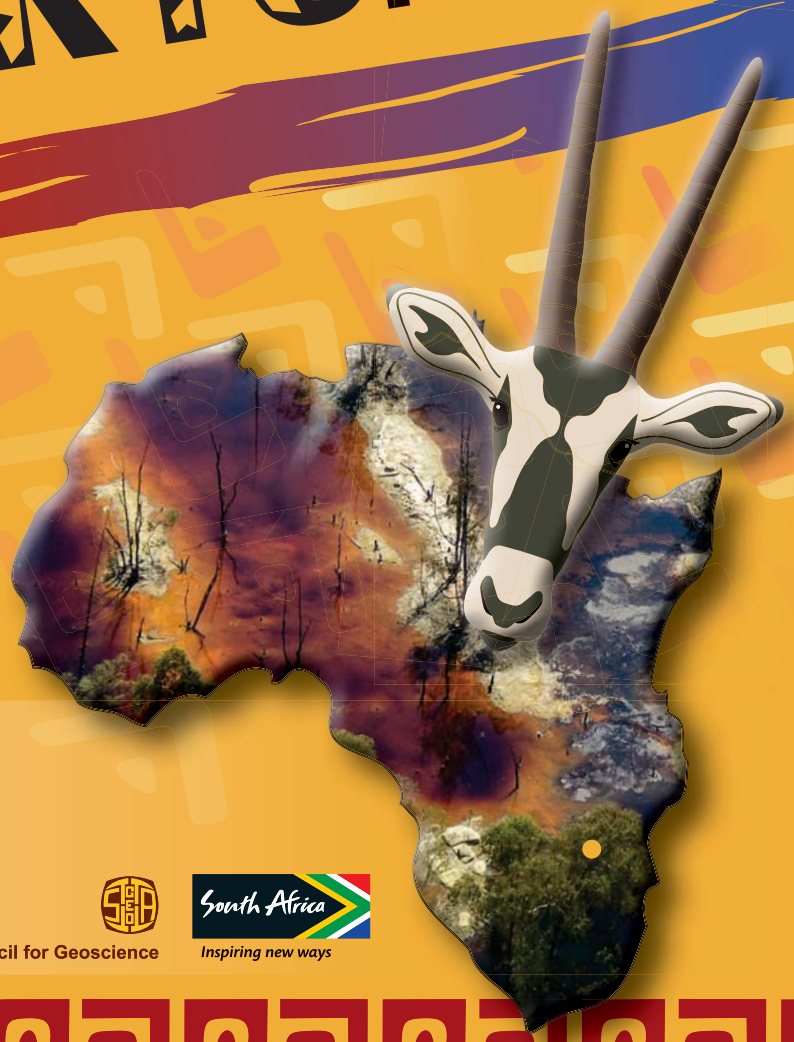

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