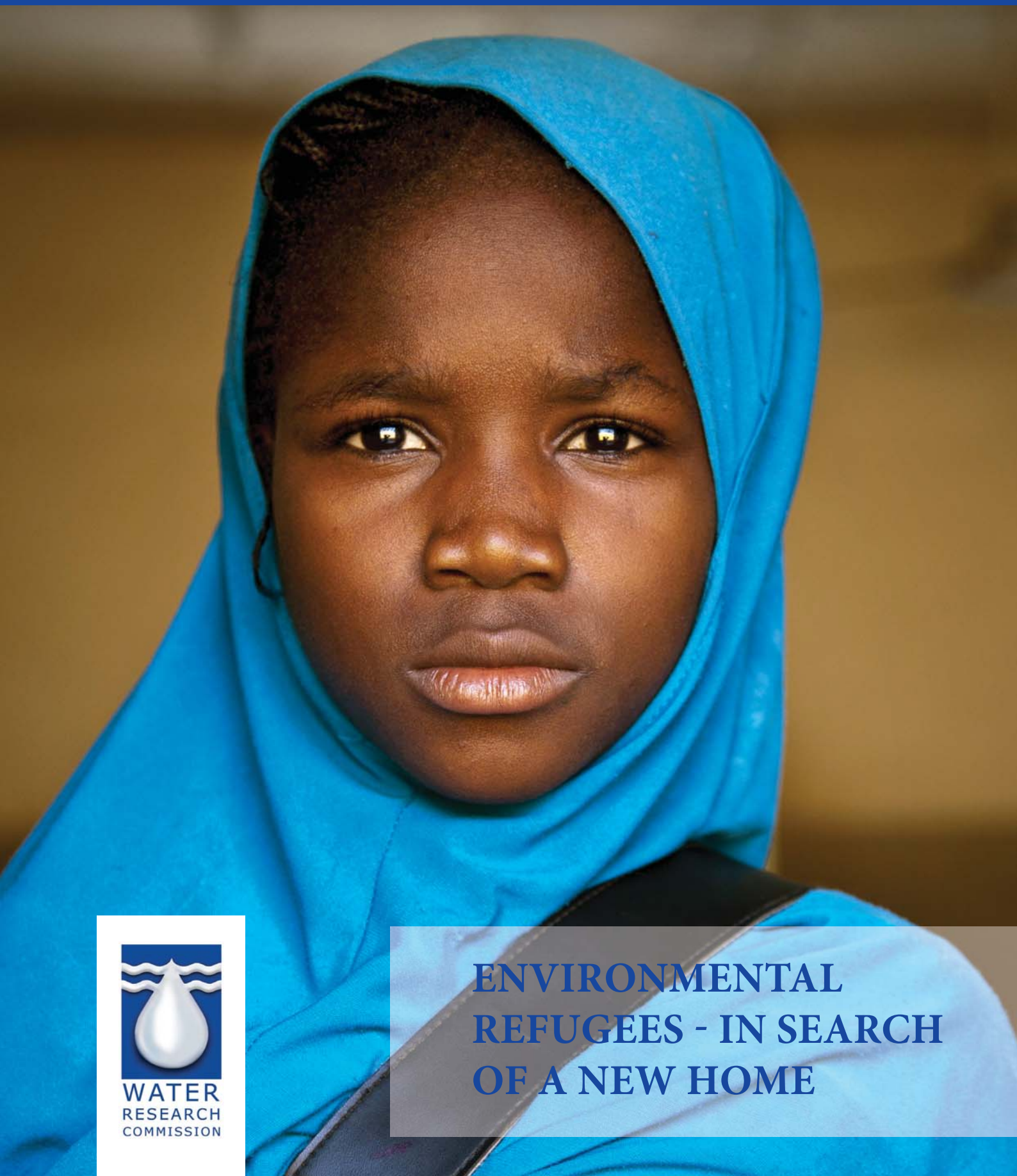
THE
WATER WHEEL

ISSN: 0258-224

July/August 2017 Volume 16 No 4



WATER RESEARCH COMMISSION

ENVIRONMENTAL REFUGEES - IN SEARCH OF A NEW HOME

14TH INTERNATIONAL WATER ASSOCIATION (IWA) SPECIALIST CONFERENCE ON WATERSHED AND RIVER BASIN MANAGEMENT

to be held 9 – 11 October 2017,
in the beautiful Skukuza Camp, Kruger National Park, South Africa.

ABOUT THE CONFERENCE

The conference will be hosted by the IWA Watershed and River Basin Management Specialist Group, in partnership with the Water Institute for Southern Africa (WISA) and IWA-South Africa (IWA-SA), and will address cutting edge issues related to sustainable watershed management, with a special focus on emerging issues related to climate change.

PAYMENT DEADLINE

16 June 2017: Early Registration (including speakers & accommodation)

1 August 2017: Normal Registration (after this date, no accommodation will be available at Skukuza camp)

Please also keep these deadlines in mind when paying through your employer and with a purchase order.

HIGHLIGHTS

Excellent programme - a diverse programme comprising of various sessions related to watershed and river basin management ranging from technical approaches and assessment tools for improving water resource management, to the water-energy-food nexus, to lessons learned in the South African context. Sessions comprise of a balance between local and international presentations as well as natural and social sciences. Additionally, a fourth parallel session provides the opportunity for topic-specific workshops.

World renowned keynote speakers - Leading international practitioners and academics such as **Professor Aaron Wolf** (transboundary water conflict and cooperation specialist and professor of geography at Oregon State University), and **Dr Brian D'Arcy** (biologist and catchment planning specialist and one of the leading people in the UK encouraging rural BMPs, and developing the Sustainable Urban Drainage Systems philosophy and approach) **Click for more info...**

Technical tours - a selection of highly relevant and context-specific technical tours are arranged such as the Sabie River and catchment tour, and the Inyaka Dam and Catchment Tour. **Click for more info...**

Fun social programme - seeing as this is a destination conference, the conference provides the opportunity to immerse yourself in the South African bushveld, from bush braais, to evening safaris and not forgetting local entertainment.

REGISTRATION AND FEES

For registration categories and costs **CLICK HERE**

CONTACT DETAILS

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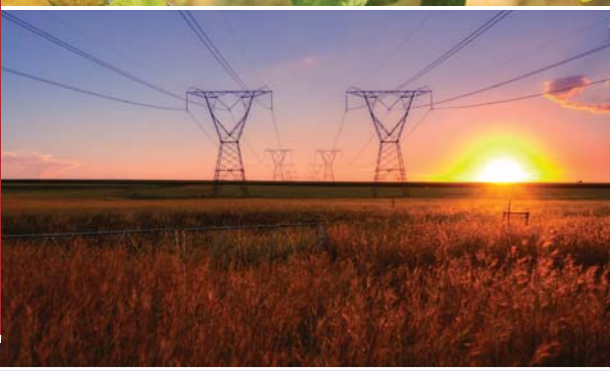

Contents

THE WATER WHEEL is a two-monthly magazine on water and water research published by the South African Water Research Commission (WRC), a statutory organisation established in 1971 by Act of Parliament.
Subscription is free. Material in this publication does not necessarily reflect the considered opinions of the members of the WRC, and may be copied with acknowledgement of source.

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The Water Research Commission, in collaboration with research partner, the CSIR, has launched a new project to investigate the impact of environmental refugees in southern Africa. Read story on page 12. (Cover photography courstey UN Photo/ Marco Dormino).

Fluid Thoughts

WRC CEO, Dhesigen Naidoo

Water and sanitation industrialisation – the promise of IPAP 2017

South Africa as a country, and southern Africa as a region, are emerging from the world's highest impact el Niño event in twenty years.

"a very important risk in the water and sanitation landscape is the absence at scale of a vibrant water private sector in South Africa."

At home, we have been through one of the worst droughts in recent history, and for the Western Cape, the worst since 1904. We will require three consecutive years of reasonable rainfall to effect a full recovery. In addition, South Africa's water balance continues to be at risk, with most models predicting a supply deficit of around 1 billion cubic metres by 2035 if our current high demand patterns continue unabated in spite of a supply increase of more than 16% on current and planned augmentation projects. This combined with the fact, that even in non-drought years, South Africa ranks 148 out of 180 countries with respect to water availability per capita, offers a very sobering picture.

Futureproofing South Africa's water security is a multidimensional task. This includes a sound demand management and water conservation strategy running concomitantly and interactively with a supply diversification strategy. The National Water and Sanitation Masterplan, currently in development, will provide the blueprint for these. But, a very important risk in the water and sanitation landscape is the absence at scale of a vibrant water private sector in South Africa. Because of this we are moving toward and increasingly negative technology balance of payments in this domain. This is not restricted to the commodities domain, where already, the market in sanitaryware, small-scale pipes, fittings and pumps relies quite heavily on imports. This extends further into provision of bulk services in water, wastewater and sanitation. A scaled-up private sector, beyond consulting services, will help to stimulate not only a move to domestic self-sufficiency. There is the huge promise of an export market for South African goods and services as the global demand rapidly increases worldwide.

An important stimulus in this direction has come in the form of the Industrial Policy and Action Plan (IPAP) 2017. The plan has, for the first time this year, a water and sanitation focus. Minister of Trade and Industry, Rob Davies, in his launch of the IPAP, pulled out water and sanitation as a point of special focus, recognising not only the opportunity for adding to South Africa's industrial base an important sector, but since water security is in the top five of most global risk registers, the increased local water security on the back of new private sector development helps mitigate the water risk for the entire industrial landscape. The key action programmes will be the development and roll-out of the Water Industrial Development Plan, the acceleration of the Innovative Desalination and Water Manufacturing Programme, the Next Generation Sanitation Cluster Development Programme, and, the Modular and Advanced Wastewater Technologies Manufacturing and Capability Build Programme. All run in the 2017-2020 timeframe.

One of the big investment issues is expected to be that of scale. The South African market, while significant, may not be large enough to encourage investments in new manufacturing lines for non-consumable commodities. A quick glance at the African and further global opportunity shows the opportunity vividly. The 2013 UN figures indicates a global backlog of 780 million in clean water access and an incredible 2.5 billion without improved sanitation. This number increases every year as the world contemplates the strategies and investments required to meet the SDG targets of universal access to clean water and safe, improved sanitation by 2030. Further, the growth trends in Africa indicate that the water services needs will more than double in that same timeframe. The opportunities are vast. The IPAP prioritisation of water and sanitation industrialisation comes with industrial development support. It is time to unlock our individual and collective entrepreneurial spirit and build a vibrant and successful water, wastewater and sanitation private sector in South Africa.

Minister of Trade and Industry, Rob Davies, pulled out water and sanitation as a point of special focus in his launch of the IPAP earlier this

BACK TO TOP

Water Diary

Catchment management
October 9-11
The International Water Association in association with WISA is hosting a specialist conference on watershed and river basin management at Skukuza camp, Kruger National Park.
Visit: www.rbm2017.com

Groundwater
October 14-18
The Groundwater Division of the Geological Society of South Africa will be hosting its Biennial Conference at Spier Hotel, outside Stellenbosch with the theme 'Change, challenge, opportunity'. Contact: Deidre Cloete; Email: deidre@iafrica.com;
Visit: www.gwd.org.za

International water
November 13-14
The International Water Association (IWA) Development Congress & Exhibition will be held in Buenos Aires, Argentina.
Visit: http://www.iwa-network.org/news/save-the-date-iwa-water-and-development-congress-exhibition-2017/ for more information.

Service delivery
November 26-29
The Water Research Commission, together with the Water Institute of Southern Africa is hosting the Second International Peri Urban conference, to be held at the Century City Conference Centre, in Cape Town. The theme of this conference is 'Shaping development and sustainability in peri-urban environments'.
Visit: www.wisa.org.za

Young water professionals
December 10-13
The eight International Young Water Professionals conference will take place in Cape Town under the theme 'Building leaders and making impact'. The conference brings together 450 water, environment and related young professionals from across the globe and showcases how the young water professionals are making impact across the sector as well as offering capacity development and training sessions to further skill our future water leaders to tackle the demands from the water sector.
Visit: http://iwaywpconference.org/

Water loss
May 7-9. 2018
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

BACK TO TOP

News

Departmental budget vote focuses on unserved communities

Water and Sanitation Minister, Nomvula Mokonyane, says government will go all out to ensure that previously unserved communities get access to water and decent sanitation, whilst ensuring water security for all South Africans.

The Minister said this during her department's Budget Vote Speech in Parliament in Cape Town in May. She added that to enhance water and service delivery to the nation, the empowerment of designated groups in society will be prioritised.

"The 2017 Budget Vote is, amongst others, about serving the unserved, creating new industries in the water sector, promoting the participation of women, youth and blacks within the sector, and providing water and sanitation services as catalysts to economic development and growth opportunities in our country."

The Department of Water and Sanitation's R15.1 billion budget for the 2017/18 financial year will, amongst others, ensure water security through building, maintaining and refurbishing water and sanitation infrastructure.

Some of the main infrastructure projects for this financial year include the Mzimvubu Water Scheme, Phase II of the Lesotho Highlands Water Project and the Vaal Gamagara Water Project. In order to increase water supply, the following augmentation schemes will be undertaken: the continuation of raising the Clanwilliam Dam Wall, raising of Tzaneen Dam, Lower Thukela Regional Bulk Water Scheme and Hoxane Water Treatment Works, among others.

In addition to the bulk water-supply projects, the department plans to eradicate some 52 300 buckets in formal settlements. This will be undertaken in partnership with the Department of Cooperative Governance and Traditional Affairs (COGTA) and the Water Research Commission. "The restoration of the dignity of our people is a commitment by this government. We can now confirm that the following provinces no longer have buckets in the formal areas namely Mpumalanga, Gauteng, KwaZulu-Natal, Limpopo and the Northern Cape," noted Minister Mokonyane.

Source: SAnews.gov.za

Limpopo learners to represent South Africa at international youth and water competition

Three learners from the Lebeko School in Phalaborwa, Limpopo, will represent South Africa at the Stocholm, Junior Water Prize Competition to be held in Sweden in August.

The learners, Kutalo Mmola, Thma Mokgotho and Wayne Luka, all in Grade 11, beat the South African finalists with their project titled 'Water wastage – a thing of the past'.

Apart from the prestigious all-expenses-paid trip to Sweden, the learners also won laptops and bursaries from the Department of Water and Sanitation (DWS) to study any water-related course at a university of their choice.

The South African Youth Water Prize competition is a DWS initiative aimed at encouraging development of new technologies that can be used to solve challenges in the water sector and to urge young people to consider careers in the water sector.

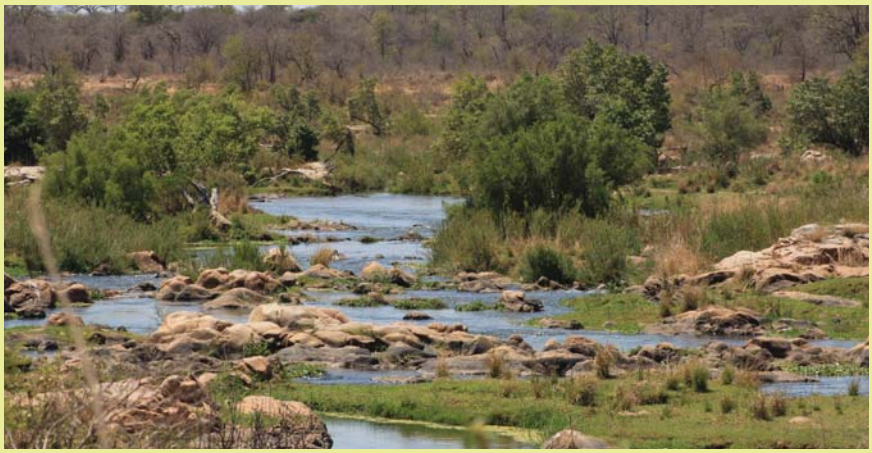
Each year, thousands of participants in over 30 countries from all around the globe join national competitions in hopes of earning the chance to represent their nation at the international final held during the World Water Week in Stockholm.

The national and international competitions are open to young people between the ages of 15 and 20 who have conducted water-related projects of proven environmental, scientific, social or technological significance. The projects range from local or regional to national or global topics.

The winner of the Stockholm Junior Water Prize receives a USD $15,000 award, a blue crystal prize sculpture, a diploma as well as the stay in Stockholm.

BACK TO TOP

Scientists assess invasive alien plant control in Kruger



Along with urban and agricultural encroachment and pollution mitigation, managing invasive alien species is a key intervention needed to protect biodiversity.

In order to find out whether the historical measures undertaken at the Kruger National Park in South Africa have been effective and optimised, researchers led by Prof Brian Wilgen of Stellenbosch University assessed the invasive alien plant control operations in the protected area over several decades. Their findings and recommendations are published in the open access journal *Neobiota*.

While the first invasive alien plants in the national park, which stretches over two million hectares, were recorded in 1937, it was not until the mid-1950s that attemps at controlling them began. By the end of the century, the invasive alien plant control programme had expanded substantially.

However, the scientists found out that despite several invasive alien species having been effectively managed, the overall control effort was characterised by several shortcomings, including inadequate goal-setting and planning, the lack of a sound basis on which to apportion funds, and the absence of any monitoring of control effectiveness.

Furthermore, the researchers report that over a third (40%) of the funding has been spent on species of lower concern. Some of these funds have been allocated so that additional employment could be created on-site, or because of a lack of clear evidence about the impact of certain species.

As a result of their observations, the team recommends three major strategies when navigating invasive alien control operations, as set out in their article.

Firstly, a thorough assessment of the impact of individual species needs to be carried out prior to allocating substantial funds. On the other hand, in case of a new invasion, management needs to be undertaken immediately before any further spread of the population and the subsequent rise in control costs.

Monitoring and assessments have to be performed regularly in order to identify any new threats that could potentially be in need of prioritisation over others.

Secondly, the scientists suggest that the criteria used to assign priorities to invasive alien species should be formally documented, so that management can focus on defensible priorities. They propose using a framework employing mechanisms of assessments used in the International Union for Conservation of Nature's Global Invasive Species Database.

The authors also point out that re-allocating current funds to species of greater concern is needed for species that cannot be managed via less expensive solutions, such as biological control. Taking care of alien plant populations living outside the park, but in close proximity, is also crucial for the prevention of re-invasions of already cleared areas.

To access the original article, Visit: http://neobiota.pensoft.net/articles.php?id=12391

Researchers test nifty way to save water in informal settlement

A partnership between the University of Cape Town, Stellenbosch Municipality and the Western Cape government is turning an abandoned water treatment facility in Franschhoek into a centre for water reuse research and innovation.

The goal of the Water Hub, as the project has been named, is to demonstrate how effectively natural water systems can clean stormwater runff.

"One of the things that we have done badly across all of Africa…is to deal with the surface runoff," said Dr Kevin Winter of the University of Cape Town and Director of the Water Hub. In South Africa, in particular, these processes are especially lacking in informal settlements, according to Dr Winter. "While these settlements have basic services of public tap stands, communal toilets and laundry stations, the drainage infrastructure is limited, often dysfunctional."

At the Water Hub, Dr Winter plans to treat water runoff from Langrug informal settlement, making its way into the Stiebeuel River, which runs through the site and into the Berg River system. Because of its positioning and Langrug's poor drainage infrastructure, Stiebeuel is laced with rubbish, greywater and sewage. "It is quite a significant river system, and we are now going to slowly start to rehabilitate," noted Dr Winter.

The project is viewed as a pilot for larger operations aimed at both conserving water and cleaning it naturally.

Source: www.groundup.org.za

BACK TO TOP

Global

Study highlights benefits and costs of action and inaction on drought

Significant progress has been made over the past decade in improving understanding of droughts and their impacts. However, several questions remain, including the real costs to a country's economy, and whether the price of preparing for droughts is worth it. A new study released by the World Meteorological Organisation (WMO) and Global Water Partnership seeks to answer these questions.

The working paper reviewed an extensive range of literature on the benefits of action and costs of inaction of drought mitigation and preparedness. It was prepared for the Integrated Drought Management Programme as part of efforts to support the development of more proactive drought policies and better predictive mechanisms.

"Unlike floods and tropical cyclones, drought is a slow onset disaster. But its impact is just as devastating in terms of human suffering and loss of livelihoods. We need to move away from the traditional piecemeal, crisis-driven response and adopt modern tools, in the form of integrated drought management policies, to increase climate resilience," noted Robert Stefanski, WMO's Head of the Integrated Drought Management Programme Technical Support Unit.

The paper reviews economic drought impact assessments and describes the main obstacles and opportunities facing the transition from crisis management to risk management. Presently, many available estimates of drought costs are partial and difficult to compare. Too little is known about the costs of indirect and longer-term drought impacts because of lack of data.

The countries that are most vulnerable to gross domestic product losses due to droughts are in eastern and southern Africa, South America, and South and Southeast Asia, according to one study cited in the working paper. It features a case study on Brazil, where droughts, especially in the northeast, are expected to increase in frequency and intensity as a result of global climate change.

Drought preparedness and risk mitigation helps lower the eventual drought relief costs. For example, the US Federal Emergency Management Agency estimated that the US would save at least two dollars on future disaster costs from every dollar spent on drought risk mitigation, the study shows.

"Given the scale of the issue and the likely drought trends under climate change, it is essential to have a well-defined strategy for mitigating the impacts of drought and enhancing drought preparedness, conclude the paper's authors, Nicolar Gerber and Alisher Mirzabaev.

To access the working paper, Visit: http://www.droughtmanagement.info/literature/IDMP_BACI_WP.PDF

Soil pollution comes under scrutiny

Soil pollution, due mostly to human activities that leave excess chemicals in soils used to grow food, took centre stage at the 5th Global Soil Partnership (GSP) Plenary Assembly held at FAO headquarters in June.

Excess nitrogen and trace metals such as arsenic, cadmium, lead and mercury can impair plant metabolism and cut crop productivity, ultimately putting pressure on arable land. When they enter the food chain, such pollutants also pose risks to food security, water resources, rural livelihoods and human health. It is estimated that around one third of the world's soils are degraded, due mostly to unsustainable soil management practices. Tens of billions of tonnes of soil are lost to farming each year. One cause is soil pollution, which in some countries affects as much as a fifth of all croplands.

"Soil pollution is an emerging problem, but, because it comes in so many forms, the only way we can reduce knowledge gaps and promote sustainable soil management is to intensify global collaboration and build reliable scientific evidence," said Ronald Vargas, a FAO soils officer.

"Combating soil pollution and pursuing sustainable soil management is essential for addressing climate change," added Rattan Lal, President of the International Union of Soil Sciences, in his keynote address to the Plenary Assembly. "Tackling human caused problems through sustainable practices will mean more change will happen between now and 2050 than during the 12 millennia since the onset of agriculture."

The Plenary Assembly endorsed three new initiatives aimed at facilitating information exchange: the Global Soil Information System; the Global Network of Soil Laboratories; set up to coordinate and standardise measurement across countries; and the International Network of Black Soils, launched to increase knowledge about the world's most fertile agricultural soils, which are also known for their high carbon content.

BACK TO TOP

Biodegradable microbeads aimed at reducing water pollution

Scientists and engineers from the University of Bath have developed biodegradable cellulose microbeads from a sustainable source that could potentially replace harmful plastic ones that contribute to pollution.

Microbeads are little spheres of plastic less than 0.5 mm in size that are added to personal care and cleaning products, including cosmetics, sunscreens and fillers to give them a smooth texture. However, they are too small to be removed by sewage filtration systems and so end up in rivers and oceans, where they are ingested by birds, fish and other marine life.

It is estimated that a single shower can result in 100 000 plastic particles entering the ocean, contributing to the eight million tonnes of plastic that enter the ocean every year. It is feared that the particles could enter the food chain, harming wildlife but also potentially ending up in our food.

Now a research team from the Bath University's Centre for Sustainable Chemical Technologie, has developed a way of producing a biodegradable renewable alternative to plastic microbeads in a scalable, continuous manufacturing process.

The beads are made from cellulose, which is the material that forms the tough fibres found in wood and plants. In this process the scientists dissolve the cellulose to reform it into tiny beads by forming droplets that are then 'set'. These microbeads are robust enough to remain stable in a bodywash, but can be broken down by organisms at the sewage treatment works, or even in the environment in a short period of time. The researchers anticipate that they could use cellulose from a range of 'waste' sources, including from the paper-making industry, as a renewable source of raw material.

Dr Janet Scott of the centre said: "Microbeads used in the cosmetics industry are often made of polyethylene or polypropylene, which are cheap and easy to make. However, these polymers are derived from oil and they take hundreds of years to break down in the environment.

"We have developed a way of making microbeads from cellulose, which is not only from a renewable source, but also biodegrades into harmless sugars. We hope in the future these could be used as a direct replacement for plastic microbeads."

You don't need hot water to wash your hands

Water temperature doesn't make any difference when it comes to removing harmful bacteria from your hands, a new study suggests.

"People need to feel comfortable when they are washing their hands, but as far as effectiveness, this study shows that the temperature of the water used doesn't matter," says Prof Donald Schaffner, extension specialist in food science at Rutgers University-New Brunswick.

For the study, published in the *Journal of Food Protection*, high levels of harmless bacteria were put on the hands of 21 participants multiple times over a six-month period before they were asked to wash their hands in water of varying degrees and various volumes of soap.

"This study may have significant implications towards water energy, since using cold water saves more energy than warm or hot water," Prof Schaffner explais. "Also, we learned that even washing for 10 seconds significantly removed bacteria from the hands."

While the study indicates that there is no difference between the amount of soap used, more work needs to be done to understand exactly how much and what type of soap is needed to remove harmful microbes from hands, says co-author Jim Arbogast, Vice-President of Hygiene Sciences and Public Health Advancements for GOJO.

"This is important because the biggest public health need is to increase hand washing or hand sanitising by the public before eating, preparing food, and after using the restroom."

To access the original study, Visit: https://www.ncbi.nlm.nih.gov/pubmed/28504614

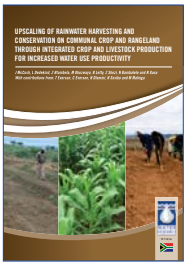
BACK TO TOP

New WRC reports

Evaluation of the risks associated with the use of rooftop rainwater harvesting and groundwater for domestic use and livestock watering

South Africa has a mixture of developed and developing regions, with at least 9.7 million (20%) of the people that do not have access to adequate quality water supplies. Rooftop rainwater harvesting (RRWH) has recently been considered to be one of the most promising alternatives for supplying freshwater in the face of increasing water scarcity and escalating demand. Although rainwater harvesting is being practised in a number of areas, the technology is not fully utilised in rural communities. Although the general public perception is that RRWH is safe to drink, the presence of potential pathogens, such E.coli, Salmonella, Legionella, and Giardia among others, have been reported in these water sources. The overall aim of this project was to evaluate the risks associated with the use of RRWH for domestic use and in homestead food gardens, and groundwater for potable use and livestock watering. The final product has been published as two volumes. Volume 1 deals with microbial quality of rooftop rainwater while Volume 2 considers the chemical quality of groundwater for potable use and livestock watering.

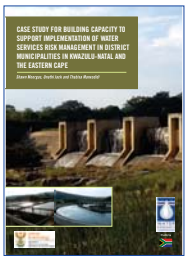
Report No. 2175/1/16 and 2175/2/16



Upscaling of rainwater harvesting and conservation on communal crop and rangeland through integrated crop and livestock production for increased water use productivity

Rainfed agriculture dominates world food production and thus rainwater harvesting and conservation (RWH&C) has the potential to provide significant social, economic and environmental benefits. This is particularly relevant in sub-Saharan Africa where 93% of farmed land is rainfed. Micro-catchment RWH&C is a subset of rainwater harvesting techniques and includes the systems and practices which concentrate rainwater from a larger area to a smaller area within a specific field and stores this runoff in the soil profile. Water conservation systems that enhance the productive use of harvested rainwater are considered important complementary practices that should be applied when in-field RWH&C systems are established. It is in this context that this research project was conducted. The overall objective of this project was to review and demonstrate rainwater harvesting and conservation methods for integrated crop and livestock production at field scale for increased crop and livestock water use productivity at selected sites in communal areas of South Africa.

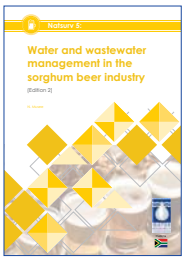
Report No. TT 712/16



Case study for building capacity to support implementation of water services risk management in district municipalities in KwaZulu-Natal and the Eastern Cape

The most effective means of consistently ensuring functional and effective water/wastewater system infrastructure is through the use of a comprehensive risk assessment and management approach that encompasses all components of the water/wastewater system. Fundamental to successful execution of such activities is proper planning. Water safety planning and wastewater risk abatement plans form integral parts of the Department of Water and Sanitation's Blue Drop and Green Drop programmes respectively. In previous projects, the Water Research Commission (WRC) and its research partners developed guidelines and Web-based tools for both these aspects of water services provision. In this follow-up project, the WRC, in collaboration with the Department of Science and Technology, assisted municipalities in the Eastern Cape and KwaZulu-Natal to build capacity around and implement water safety planning and wastewater risk abatement plans.

Report No. TT 693/16



Natsurv 5 – Water and wastewater management in the sorghum beer industry (Edition 2)

This guideline is aimed at updating the first edition of National Survey 5 of 1989 on aspects related to resources management in the traditional sorghum beer industry. The guideline outlines industrial operations, degree to which various resources have been managed based on a set of indicators per unit of production (e.g. specific water intake, specific effluent, etc.), best practices adopted or currently under implementation and, finally, an outline of recommendations on probable improvements that can further enhance resources utilisation in the sorghum beer industry . A key changes observed in this industry is its significant decline both in size and volume of beer produced annually since the first Natsurv was published.

Report No. TT 692/16

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BACK TO TOP

Specialist watershed conference coming to South Africa

Skukuza, in the Kruger National Park, is gearing up to host the 14th International Water Association (IWA) Specialist Conference on Watershed and River Basin Management, to be held on 9 to 11 October.

The specialist conference is intended to present and discuss the latest developments, strategies, techniques and applications of international best practices in integrated watershed and basin management. This conference aims to be a 'think tank' and discussion platform that provides a step forward in terms of awareness, innovative models, and best practices in water sustainability and the allocation of a severely limited resource. Technical sessions will provide a forum for presentations on the challenges of sustainable water management on all scales, from local to global, in the face of drought, flood, changing climate, and the changing human landscape. Conference panels, poster sessions, lunches and technical events will allow for the exchange of ideas between nations, cultures and disciplines.

"these conferences attract a wide range of international scholars, which offers South African delegates the opportunity learn from global best practice"

The theme of the conference, 'Living Catchments', emphasises not only the human element of watershed and river basin management but also the dynamism and complexity as a melting pot of various anthropogenic interests (industry, residential, environmental, institutional, recreational etc.) and their interdependencies with the interests of the natural world. From mountains to prairies, from floodplains to oceans coasts, from cities to towns, villages, ranches, and farms, everyone lives in and benefits from a catchment and, in turn, impacts and is impacted by its water quality and water quantity.

The conference boasts world-renowned keynote speakers, such as Prof Aaron Wolf (transboundary water conflict and cooperation specialist and professor of geography at Oregon State University), as well as Dr Brian D'Arcy (biologist and catchment planning specialist).

The conference covers a wide range of themes related to watershed and river basin management, within the ambit of a catchment lens (holistic, transdisciplinary, multi-sector, multi-partner, multiple scales, integrated etc.). Conference topics include climate change, achieving the Sustainable Development Goals (SDGs), water governance, improving water resource management (with a focus on water quality, eutrophication, hydrological assessments, groundwater, and floodplain management, advancing participatory interaction in these processes. Furthermore, these themes should consider the latest trends in negotiating tensions in basin management, including mining, underground gas extraction, the urban/rural interface, as well as the water-energy-food nexus.

The international conference offers various opportunities to South African scientists, noted Dr Inga Jacobs-Mata, conference organiser and Research Group Leader: Integrated Water Solutions at the CSIR – Natural Resources and the Environment. "IWA Specialist Group conferences offers an opportunity to profile South African scientists and practitioners globally and within the IWA network. In addition, these conferences attract a wide range of international scholars, which offers South African delegates the opportunity learn from global best practice as well as to teach others about what we are doing well in South Africa."

As such, delegates can expect to:

- Learn about the latest developments in integrated watershed and river basin management
- Explore the different approaches for water resource management under accentuated climate variability from various international and multi-jurisdictional perspectives
- Develop feasible solutions for river basin management of transboundary river basins
- Learn and share experiences with international case studies
- Identify international collaborative research opportunities and technical applied projects in watershed and river basin management

"We hope to provide a platform for international collaborative partnerships on watershed and river basin management to be developed and strengthened," noted Dr Jacobs-Mata.

To find out more about the conference, Visit: www.rbm2017.com

BACK TO TOP

Water and society

Winds of change – exploring the growing phenomenon of environmental refugees

The occurrence of environmental refugees – people who have been forced to leave their home because of a marked environmental disruption – is receiving attention for the first time in South Africa. A new research project, funded by the Water Research Commission (WRC) and led by the CSIR, hopes to fill some crucial knowledge gaps on this growing phenomenon. Article by Lani van Vuuren.

UN Photo/Tobin Jones

Earlier this year, drought was threatening families in Somalia.

At the height of the 2015/2016 El Niño phenomenon, more than 36 million people across southern and eastern Africa faced hunger as crops failed amid widespread drought. Potentially scores of people were forced to abandon their homes by this environmental disaster. The exact number is unknown, however, as little research has been done on the subject of environmental refugees, particularly in southern Africa.

All of this is about to change. On 20 June 2017, World Refugee Day, the CSIR with the WRC introduced a new project, titled 'Kukimbia – the impact of environmental refugees in southern Africa' ('Kukimbia' means 'to flee' in Kiswahili). The project will run until 2020.

"This is a first major thrust in this direction for any institution in South Africa," noted Dhesigen Naidoo, WRC CEO, during the launch. "The issue of migration due to environmental factors is hardly new – the environment has driven people from their homes for millennia. The difference now, of course, is that the kind of climate phenomena we are seeing today are largely man-made."

While an increasing number of people are being displaced by disasters such as drought, floods, volcanoes, hurricanes and earthquakes, they are not yet recognised in international law. According to the United Nations, a refugee is considered a person who flees their home country due to a 'well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group or political opinion.' Calls are increasing from the international community to amend this definition to include people displaced for environmental reasons.

BACK TO TOP

"When major natural disasters hit or if sea levels rise dramatically, millions of people are displaced and left without homes, food or other basic resources needed for survival," explains project leader, Dr Inga Jacobs-Mata from the CSIR – Natural Resources and the Environment. "However, because these people are not considered refugees in the traditional definition of the word, they are not always offered the international aid they need."

Research indicates that the phenomenon of environmental refugees is rising, with some institutions, such as the International Red Cross, estimating that there are currently more environmental refugees than refugees displaced because of conflict. According to the Internal Displacement Monitoring Centre (IDMC), the occurrence of displacement closely mirrors people's exposure to hazards around the world. Exposure is increasing because ever growing numbers of vulnerable people live in areas prone to hazards.

The IDMC's report, ***People displaced by disasters – Global estimates 2015***, notes an average of 26.4 million people have been displaced from their homes each year by disasters brought on by natural hazards – equivalent to one person displaced every second. This figure does not include displacement related to drought and gradual processes of environmental degradation, nor does it reflect the complexity and diversity of people's individual situations on how they evolve over time.

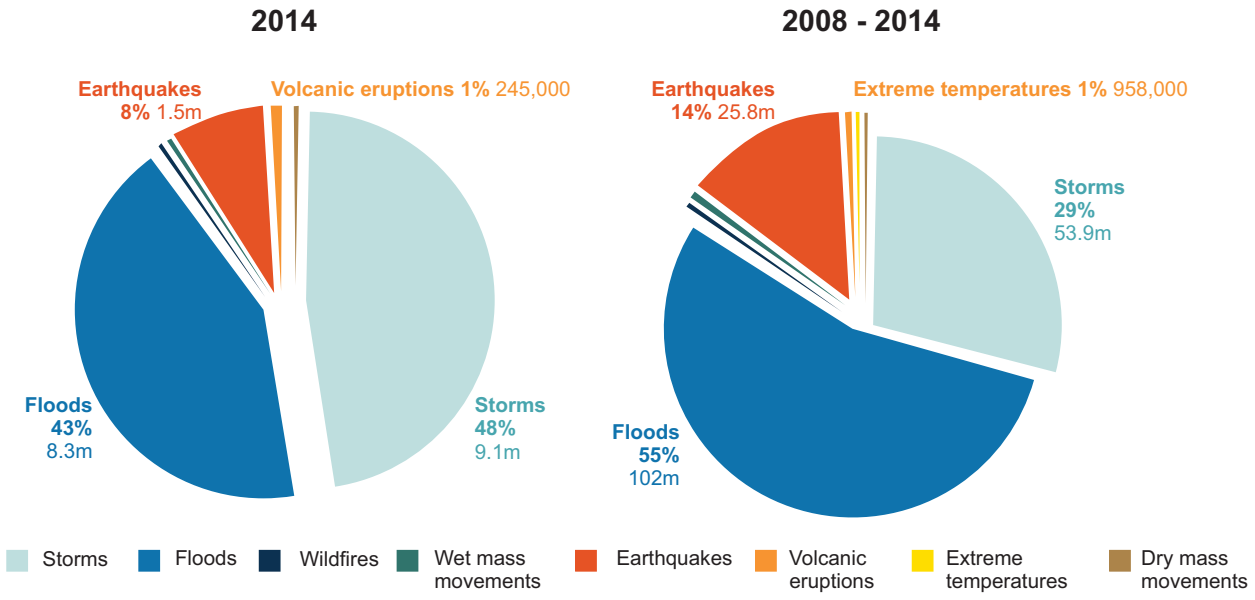
This omission is significant in light of climate change. Even gradual and relatively modest changes in climate can affect the frequency and intensity of hazards and communities' vulnerability to them. Higher temperatures increase the risk of both drought and episodes of heavy rainfall, also known as extreme precipitation events, while rising sea levels make storm surges worse and increase the risk of coastal flooding. Lower agricultural yields associated with gradual changes in climate undermine rural livelihoods and erode communities' capacity to cope with shocks.

UN Photo/Tim McKulka

The phenomenon of environmental refugees is set to increase as a result of climate change.

"Very little attention is placed on environmental migrants in South Africa from a climate change adaptation perspective and, as such, an intervention gap exists currently as to which institution/level of state is responsible to act and in what capacity."

In the last ten years China, India and the Philippines saw the largest displacement events, mostly related to typhoons, cyclones, and floods. However, Africa is particularly vulnerable, as illustrated by past events. For example, by 2009, a severe, persistent, five-year drought stretched across East Africa exerting



Note: figures rounded to nearest 1,000 or 100,000 Source: IDMC data as of 1 June 2015

Global displacement by type of hazard

BACK TO TOP

UN Photo/Tim McKulka

Between 2008 and 2014 close to 770 000 people were displaced in Africa due to natural disasters (other than drought)

a heavy human toll, made worse by violent conflict. The worst affected areas were Kenya, Ethiopia, Somalia and Uganda.

Similarly, in 2000, south-eastern Africa was devastated by heavy rains that began in January. In February, cyclone Eline swept across Madagascar and south-eastern Africa, bringing the worst flooding in decades. This was followed by cyclone Gloria. By March 2000, they had left at least 800 people dead and disrupted the lives of over 2.5 million people in various countries. Mozambique was hardest hit, with almost a million people losing their homes.

The new research project aims to investigate the real impact of environmental refugees in southern Africa, focusing both on internal displacement as well as cross-border displacement, noted Dr Jacobs-Mata. "The project will also investigate the national policy landscape and the preparedness of southern African countries to respond to future internal displacement as a result of environmental disasters."

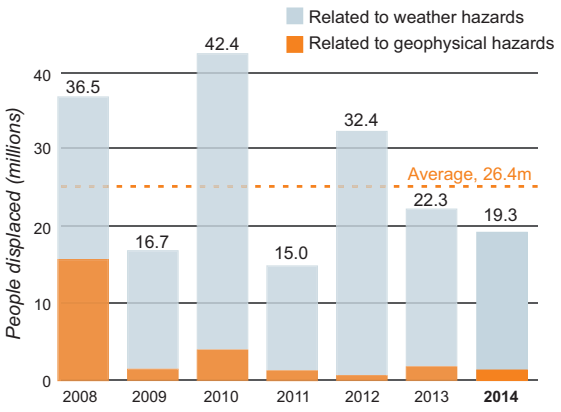
Dr Jacobs-Mata continues to say that, given that this project includes a combination of multidisciplinary, basic and applied research, its impact will be achieved in these areas in different ways. "Firstly, the project aims to strengthen regional and national policy guidelines to better inform the impact of environmental migration in South Africa, including looking the potential of human mobility, and how to systematically integrate it into adaptation planning processes, financial mechanisms, technology transfers and capacity building. Secondly, using evidence-based policy methodology, the project aims to inform national policy."

Environmental refugees – the global picture

- More than 19.3 million people were displaced by disasters in 100 countries in 2014 (latest available figures)
- Since 2008, an average of 26.4 million people have been displaced by disasters each year - equivalent to one person every second
- Around 17.5 million people were displaced by disasters brought on by weather-related hazards in 2014, and 1.7 million by geophysical hazards.
- An average of 22.5 million people have been displaced each year by climate or weather-related disasters in the last seven years – equivalent to 62 000 people every day.
- Climate change, in tandem with people's increasing exposure and vulnerability, is expected to magnify this trend, as extreme weather events become more frequent and intense in the coming decades.

Source: People displaced by disasters – Global estimates 2015

BACK TO TOP



Note: Figures are rounded to the nearest decimal point.

The scale of global displacement by disasters, 2008-2014. (Source: People displaced by disasters – Global estimates 2015)

Through the use of anthropological methods, the project further aims to identify specific case studies and investigate the interplay between environmental changes, stresses on ecological systems, socio-economic vulnerability and consequent population displacement by investigating how people have perceived, experienced and responded to climatic variability and long-term negative climate change. "More importantly, the project will investigate how cultural practices change, how identity formation changes as people's sense of belonging to a place is affected, and finally, how their livelihoods are affected," notes Dr Jacobs-Mata. "The benefit of including this localised and individualised aspect in the study is to better inform adaptive strategies for local communities."
It is hoped that the findings from this study will contributing to the growing body of empirical evidence on the links between climate change and human mobility.

The project has a strong knowledge transfer and dissemination focus, due to the fact that the impact of environmental migrants in South Africa is largely still an under-researched domain. "Very little attention is placed on environmental migrants in South Africa from a climate change adaptation perspective and, as such, an intervention gap exists currently as to which institution/level of state is responsible to act and in what capacity."

To date this work is unprecedented in South Africa. "No research programme of the kind currently exists in South Africa. Given the increasing importance of this topic globally and regionally, establishing a research capability in this field is both opportunistic (given the focus placed on the issue of environmental migration in recent years) and strategic (i.e. an opportunity for South African scientists to lead policy discussions in this domain)," Dr Jacobs-Mata concludes.

UN Photo/Stuart Price

The new study hopes to contribute to the growing body of empirical evidence on the links between climate change and human mobility

BACK TO TOP

Water and mining

Connecting research and policy - Three WRC research reports taken up in new mining and environment policies

Government needs effective research on which to base decisions. The Water Research Commission (WRC) and its research partners are leading the way in ensuring that its research and projects impact on relevant water policies. In the latest example, government's new water use licence application regulations reference the WRC's water, wetlands and mining guides. Article by Kim Trollip.

Wetlands ecosystems are vital ecological infrastructure that provide valuable services to people and are important biodiversity assets. By virtue of their positions in the landscape and relationship to drainage networks, wetlands are frequently impacted by coal-mining activities, especially opencast methods. The impacts are ongoing, since coal is a strategic resource and will continue to be mined to support the country's development. The new water use application regulations that reference the WRC reports now insist that mines avoid, minimise and mitigate their impacts on wetlands.

Dr Jo Burgess, WRC mine-water treatment and management research manager, says she is absolutely delighted at the policy uptake. "These particular publications, the ***High Risk Wetlands Atlas***, the ***Wetland offsets: A best practice guideline for South Africa*** and the ***Wetland rehabilitation in mining landscapes: An introductory guide*** are superb examples of how successful a collaboration between government organisations and the private sector can be." The project was a multiyear collaborative effort between the WRC, CSIR, South African National Biodiversity Institute (SANBI), Working for Wetlands (WfWET), and the Coaltech Research Association. The project delivered an innovative suite of products to limit and mitigate the impact of coal-mining on wetlands.

Connecting research and policy

Globally, the link between academics and policy-makers has been described as fragile, and key disparities can limit how effective academic research can be for policy-makers. Common problems raised are around communication, priorities and

BACK TO TOP

openness. So what did the WRC do to ensure that these important reports were actually taken up in the new regulations?

"Right from the beginning of the research phase of this project, we took great care to include as many representatives from the mining industry as possible in the project's Reference Group," explains Dr Burgess. "This meant that the guidelines would not be developed out into something that is completely impractical or impossible to implement. We also included all relevant government departments in the Reference Group – that meant that the resulting guides would fit the regulatory frameworks, and be enforceable."

Her colleague, John Dini, WRC water governance research manager, agrees. Dini was with project partner SANBI when the research kicked off and he says, "What has been particularly rewarding is to see the rewards of the deliberate approach we took in this project, namely assembling a team that consisted not only of researchers, but also policy advisors. This resulted in an approach with one foot in the technical content and the other in the policy landscape. Coupling the strong multi-disciplinary scientific capacity with an ability to understand and navigate the entry points in the policy landscape proved to be a powerful recipe. The relationships and networks that each team member brought to the project were as important as the knowledge that they brought. This does not mean that working successfully along the science-policy-practice continuum is easy, so when we do get it right and see such a direct uptake of research outcomes in policy, in the form of regulations in this case, it is very rewarding."

Dini adds, "At least in this case we know that the hard work that went into doing the research will not end up just sitting in a set of reports that a limited set of people will read. It demonstrates how research has the potential to contribute to tackling real world problems, rather than just being an academic endeavour."

Project partner and CSIR senior researcher, Dr Arno de Klerk, concurs, "The success of these research reports is a good example of how different organisations can come together to produce really high impact products, utilising the different sets of expertise that they can offer. It required everyone to work together, think outside of the box, interact with stakeholders to make sure we keep on track and, most importantly, that the products being developed are actually relevant, not only for the regulator, but also for industry. I think this made a huge difference ensuring that these products will actually be taken up and used."

During the research phase, the actions set out in the guides for things such as rehabilitation activities were presented by biodiversity and environmental protection experts from organisations like CSIR, SANBI and the Endangered Wildlife Trust as conservatively as possible. Workshop processes were then used to make these activities enforceable, by discussion and adjustment by the team with inputs from government, and implementable by negotiation with the mines, a relationship enabled by the Chamber of Mines.

The result is a set of best practice guides that the industry thinks is not lenient enough, but is achievable, and which the regulator thinks is too lenient, but is possible to enforce. At the same time, the environmental experts who participated think that by adhering to these guides, the mining industry will afford wetlands adequate protection.

After conclusion of the research phase, the guides were presented as many times as possible to as many audiences as could be reached – the mining industry, the water sector, regulators' forums, the research community – to make as many people as possible aware of them and their potential use. The Department of Water and Sanitation (DWS) was included fully in the Reference Group, and went on to champion the inclusion of the guides in the new water use licence application regulations as applicable to the National Water Act (NWA). They went through their internal processes, and now the guides have been identified in the Government Gazette of 24 March 2017.

Dini believes the magic ingredient was the good working relationship between key individuals in the project team and several officials in DWS. These relationships preceded the project. Engagements between these individuals, around taking up some of the research outputs into the regulations, continued long after the completion of the project. The existence of these champions within DWS, who could take content from the project team and inject it into the relevant policy processes within the department, made all the difference.

The reports listed below contain the standardised and accepted methods that must be used for determining the various aspects of assessments during the WUA process related to wetlands:

1) Wetland and riparian habitat delineation document (DWS report on DWS website);
2) Wetland Buffer Guideline (SANBI WRC project and Report, on DWS website)
3) Wetland Offset (WRC report TT660/16; on DWS website)
4) High Risk Wetland Atlas (WRC Report TT659/16, on DWS website)
5) Wetland Rehabilitation in mining landscapes (WRC Report TT658/16, on DWS website)
6) Risk Assessment Protocol and associated Matrix (DWS document on DWS Website)

The above excerpt is taken from the recently gazetted document regulations and references the three WRC research reports.

BACK TO TOP

John Dini

Mining and wetlands can coexist if measures are taken to minimise and mitigate impact. The image shows the Mooifontein wetland.

Photo supplied

The project Reference Group was carefully selected to include members from both government and industry.

"I really hope that these products can be used not only to help protect our wetlands, because our wetlands are very valuable resources, but also to assist industry and add to South Africa's economic growth. Furthermore, I also hope that this will help to streamline the whole authorisation process so that everyone works from the same available information."
Dr Arno de Klerk, CSIR

Beyond the organisations involved was the community of practice that developed around the project. The coal mining industry, through Coaltech and its members, was a strong driver behind the initiation of this work. The mining companies that are members of Coaltech were keen to do the right thing, but felt that some of the information that they needed, for example, to enable them to avoid more sensitive and valuable wetlands that would trigger more stringent conditions of authorisation or no authorisation at all, was not readily available. Representatives from the DWS were involved right from the beginning of the project and had expressed their needs. A level of trust was formed by having these different parties working together, which made the next step of taking some of the outcomes into policy that much easier.

Importance and relevance of this new policy guideline

In addition to their ecological role mentioned above, wetlands help to buffer flood waters, soak up water to release more gradually over time, filter sediments, purify water, and provide forage for livestock and refuge for numerous species. While remarkably resilient in many ways, they are vulnerable to a range of direct, indirect and cumulative impacts. In mining landscapes changes in landscape hydrology and water quality often impact upon downstream water resources and associated users with various consequences for people and biodiversity.

The current state of wetland ecosystems in South Africa is such that impacts on remaining wetlands have cumulative, and sometimes significant consequences. There are indications that the cumulative loss or deterioration of services derived from wetlands is undermining the ability of the affected landscapes to deliver these functions, which in turn has social, economic and ecological implications. This is of direct relevance to the mining sector.

Impacts on wetlands should be avoided and minimised whenever possible. Where wetland impacts or degradation do take place, wetland rehabilitation should form part of the mitigation of these impacts.

The ***Wetland offsets: A best practice guideline for South Africa*** serves as a practical tool to aid in the consistent application of wetland offsets in South Africa. The guideline is primarily aimed at wetland offsets required as part of water use authorisation processes (e.g. in an application for a Water Use Licence under the NWA) where compensatory actions are required to achieve water resource management and biodiversity conservation objectives. The guideline is equally relevant for use in environmental impact assessment processes (e.g. as part of the environmental authorisation process in terms of the National Environmental Management Act or in an application for a mining licence or development of an Environmental Management Programme under the Mineral and Petroleum Resources Development Act.

The ***Wetland rehabilitation in mining landscapes: An introductory guide*** is structured to provide users with the core principles that should inform planning and decision-making at different phases of wetland rehabilitation, namely planning, implementation, and monitoring and long-term management phases. Key elements integral to wetland rehabilitation in each phase are summarised in easy-reference checklists that help users ensure that the guidelines provided in this document are adhered to. An overview of legal considerations for wetland rehabilitation in the mining landscape is also provided.

By consolidating existing guidance on wetland rehabilitation in mining landscapes, this introductory guide aims to promote the standardised application of tools in wetland rehabilitation and improve clarity with respect to wetland rehabilitation planning, design and implementation in mining landscapes. In particular the guidance is intended to provide appropriate practical and strategic approaches to wetland rehabilitation, and to support the development of wetland rehabilitation and management commitments and license conditions that are realistic, achievable and can be monitored. Well planned and

BACK TO TOP

implemented wetland rehabilitation can help to avoid a range of risks for proponents, government and affected communities and ensure compliance with environmental legislative provisions and authorisation requirements.

"Where impacts cannot be avoided and are sanctioned by the regulators, we hope to see the implementation of offsets that are sustainable and adequately compensate for the impacts to wetlands caused by the mining," adds Dini. "Lastly, through the guidance on wetland rehabilitation in mining landscapes, we hope to see post-mining landscapes that achieve, as far as possible, better ecological and hydrological functioning and connectivity than is currently the case."

The bottom line is that trade-offs inevitably have to be made when extracting a strategic resource like coal in areas that are also important for water and biodiversity. The tools provided through the research work help to ensure that the information at the disposal of mining companies and regulators provides the full picture of all the costs and benefits of proposed mining activities, so that decisions on trade-offs can be made on this basis.

As well as the three printed guides, there is a software tool as referred to in the WRC report ***High Risk Wetlands Atlas: Reference Guide to the Mpumalanga Mining Decision Support Tool***, which Dr Burgess says is one of the most valuable resources the WRC has produced yet.

The ***Reference Guide*** report provides the required information for users to install the atlas and access the underlying spatial data, as well as to provide supporting information on the preparation and content of the spatial data.

The atlas provides access to other key data that were not developed by the project but that are very useful for mining planners, such as the new Mpumalanga Biodiversity Sector Plan, updated Protected Area data, revised Strategic Water Source Data, revised Freshwater Ecosystem Protection Area (FEPA) data, and the new wetland data for Mpumalanga.

The way forward

Dr De Klerk is positive about the future, but says work still needs to be done in the ecological infrastructure space to ensure environmental protection, as well as sustainable development and economic growth. "One such priority area we are now working on is the development of guidelines for pans (depressional wetlands) in South Africa. It will be great if this can also be taken up in policy, so that all stakeholders can work off the same available information."

Dr Burgess adds that she hopes to see all future mining activity fully comply with the best practice. "I never want to see a wetland on a pedestal, surrounded by mined out land, again. I very much hope that as more and more mining companies find out about the guides and the requirement to use them the number of poorly cared for wetlands declines to none. I hope that DWS officials are now better equipped to make good decisions on water use licence applications, and that even if some mines do transgress, we now have three new books to throw at them."

Photo supplied

Rehabilitation efforts can also result in employment opportunities.

"In addition to their ecological role mentioned above, wetlands help to buffer flood waters, soak up water to release more gradually over time, filter sediments, purify water, and provide forage for livestock and refuge for numerous species."

Regulations:

National Water Act: Regulations: Procedural requirements for water use licence applications and appeals: http://www.gov.za/documents/national-water-act-regulations-procedural-requirements-water-use-licence-applications-and

Mineral and Petroleum Resources Development Act: http://www.gov.za/documents/mineral-and-petroleum-resources-development-act

Related project reports

- *Wetland Rehabilitation in Mining Landscapes: An Introductory Guide* (**Report No. TT 658/16**)
- *High Risk Wetlands Atlas: Reference Guide to the Mpumalanga Mining Decision Support Tool* (**Report No. TT 659/16**)
- *Wetland offsets: A best practice guideline for South Africa* (**Report No. TT 660/16**)
- *High Risk Wetlands Atlas: Reference Guide to the Mpumalanga Mining Decision Support Tool* (**Report No. TT 659/16**)

To order any of these reports, contact Publications at Tel: (012) 671-9300; email: orders@wrc.org.za or visit: www.wrc.org.za to download a free copy.

BACK TO TOP

Irrigated agriculture

Project modelling irrigation water use through satellite technology progresses

A Water Research Commission (WRC)-funded project team, using a novel approach to estimate the total area and water use associated with irrigated agriculture in South Africa, is seeking feedback on the initial findings. Article by Sue Matthews.

According to the National Development Plan published by government in 2012, agriculture has the potential to create close to a million new jobs by 2030, but one of the actions needed to achieve this is to expand irrigated agriculture.

"Evidence shows that the 1.5 million hectares under irrigation (which produce virtually all South Africa's horticultural harvest and some field crops) can be expanded by at least 500 000 hectares through the better use of existing water resources and developing new water schemes," the document states.

During the intervening five years, these sentiments have been called in to question by various roleplayers from government, academia and agribusiness. Although most agree that irrigation efficiency can – and should – be greatly improved, they view the proposed expansion as overly ambitious, particularly since water shortages already being experienced in so many catchments may worsen with climate change. Practically achievable targets for expansion of irrigation at provincial level are detailed in the Irrigation Strategy for South Africa, published by the Department of Agriculture, Forestry and Fisheries (DAFF) in 2015.

There is also uncertainty over the accuracy of the quoted 1.5 million hectares under irrigation, because estimates vary by a couple of hundred thousand hectares on either side of this figure, and the area actually irrigated changes slightly year to year. The National Water Act requires registration of irrigation water use on the Water Authorisation and Registration Management System (WARMS) database, capturing the 'who, where, why and how much' details. This information has been analysed and results published for 2008 and 2014 (see the South African Irrigation Institute presentation at the SANCID 2014 Symposium on www.sancid.org.za), but it is acknowledged that more detailed analysis and verification of the WARMS database is required.

Now a WRC project is using an 'eye in the sky' approach to develop a methodology that would allow the area under irrigated agriculture to be mapped on a regular basis, while also estimating the volume of water used. Entitled 'Wide-scale modelling of water use and water availability with earth observation/satellite imagery', the project (**no. K5/2401**, with a summary published in the WRC *Knowledge Review* for 2014/15)

BACK TO TOP

is jointly funded by the WRC and DAFF, and is being conducted by a collaborative team under the leadership of Prof Adriaan van Niekerk of Stellenbosch University.

Essentially, water consumption by crops can be determined by estimating actual evapotranspiration (ET) from remote-sensing data, processed with complex algorithms. This is not the first time the approach has been used in South Africa. A previous WRC project by Jarmain et al. (**WRC Report No. TT 602/14**) used satellite imagery and the Surface Energy Balance Algorithm for Land (SEBAL) model to estimate ET, as well as biomass production, crop yield and water use efficiency, for maize and sugarcane in selected growing areas in the Northern Cape and Mpumalanga respectively. That research, which included extensive field measurements and comparison with other models, demonstrated the accuracy of the SEBAL model and the benefits of a remote-sensing approach.

In 2009, however, the developers of SEBAL in The Netherlands had released ETLook, a more advanced model, and it was decided that this should be used to produce ET data for the entire country and to update information on the area under irrigation.

"Because we're looking at the whole of South Africa, with its big climatic gradients, the ETLook model is more suitable than SEBAL, which was developed for a smaller area with more homogeneous climate," says Dr Caren Jarmain, a key member of the project team. "ETLook also splits the evapotranspiration into evaporation and transpiration, which we could not do with SEBAL."

The period 1 August 2014 to 31 July 2015 was chosen for the project, with satellite, land cover and meteorological data fed into the model to produce daily outputs that were combined to generate 12 monthly ET maps. These monthly maps were in turn aggregated into an annual ET map, which represents a 'snapshot' for that year of the water use by vegetation, expressed in mm/yr, over the entire country at a resolution of 250 m.

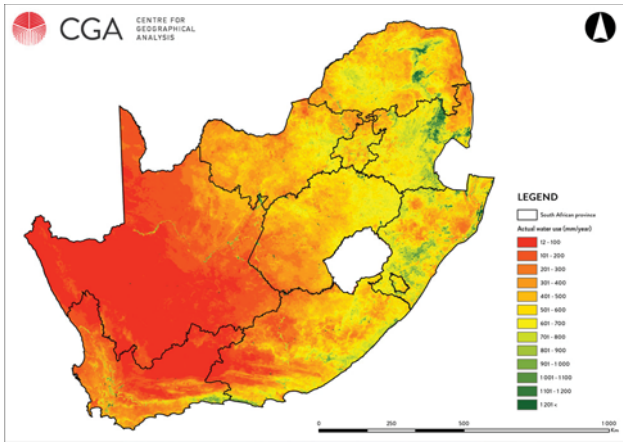
Next, South Africa's likely irrigated areas were mapped as accurately as possible using remote sensing and other spatial data on land cover and field boundaries. The annual ET map and an annual rainfall map were then used to create a map showing the difference between water use and rainfall for every 250 x 250 m pixel. Applying the assumption that irrigation is likely to occur where water use exceeds the rainfall, the first version of the irrigated agriculture map was generated.

"This seemed to work reasonably well for most areas, but there were a few exceptions, so our approach was further refined," explains Dr Jarmain.

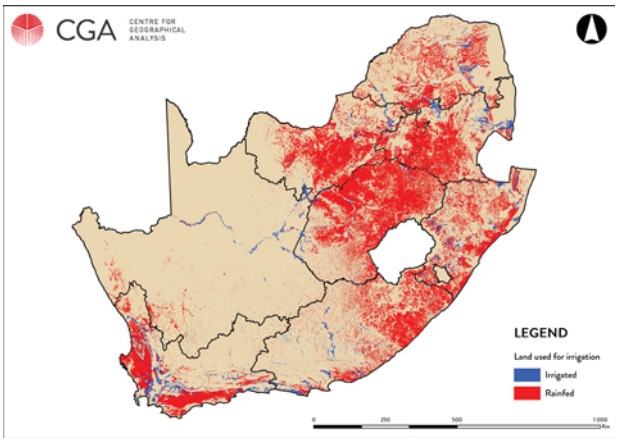
A sophisticated machine-learning analysis was performed using additional datasets derived from high-resolution remote sensing and ETLook modelling that took into account the different climatic regions of South Africa, as well as seasonal influences.

The project team is now seeking feedback on this second version of the map, but reminding responders that the map shows actively irrigated agricultural areas for the year 2014/15 rather than the current situation. Landowners and water managers can visit the Web portal http://sungis10.sun.ac.za/fields_wrc/ to zoom into their area of interest and check whether particular fields are correctly labelled as either irrigated or rain-fed. They can also identify areas under shade-net, enter any other comments, and select the relevant crop type.

Providing information on crop type would allow the project team to estimate the water consumed by specific crops. They have already done this in certain areas where such data is available, which has allowed for some interesting comparisons. For example, a plot of the monthly water use of a field of irrigated table grapes against one with rain-fed wheat in the Western Cape shows that the wheat used slightly more water than the grape crop during the wet winter months and peaked in September, but the grapes consumed significantly more water in summer.

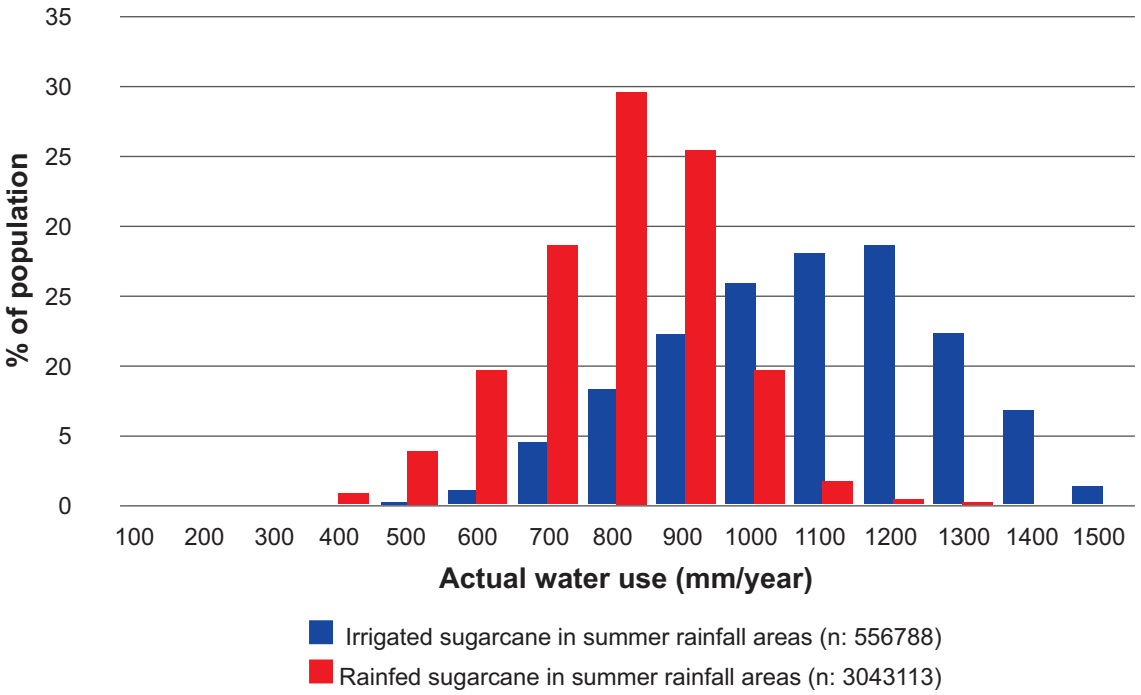


The map of actual evapotranspiration (ET) for the year 2014/15 shows areas with higher water use by vegetation in green and lower water use in red, which is influenced by water availability, climatic conditions and the type of vegetation or crop.



Actively irrigated agricultural areas for the year 2015/15 are shown in blue on this map of South Africa, while rainfed areas are depicted in red.

BACK TO TOP



Analysis conducted for large areas of sugarcane in the summer rainfall region reveal the difference in water use between irrigated (blue) and rainfed (red) sugarcane.

"Our methodology allows us to tell whether or not a field is irrigated, and we can do a water use estimate even if we don't know what the crop type is."

Another example illustrating the difference between irrigated and rainfed fields of the same crop type shows that irrigated sugarcane in Mpumalanga used considerably more water than rain-fed sugarcane in KwaZulu-Natal throughout the year.

While these two examples compared individual fields, water use information can also be extracted for multiple fields of a crop type to glean an understanding of the variation in water use due to differences in water availability, efficiency of water use, cultivation, irrigation systems, cultivars, soils and other factors.

Again considering sugarcane, which is commercially grown in the summer rainfall region, analyses of large areas showed that most of the population in rainfed fields had an annual water consumption of between 700 and 900 mm, while the bulk of the population in irrigated fields used 1 000 to 1 200 mm. In the winter rainfall region, irrigated apples were found to have used more water during the year than irrigated citrus.

The project team would like to do more of such analyses, in light of the fact that many new cultivars and crops have been introduced to South Africa over the past 20 years, and little is known about their water use and crop water requirements.

"Our methodology allows us to tell whether or not a field is irrigated, and we can do a water use estimate even if we don't know what the crop type is – that's the beauty of a remote-sensing model like ETLook," explains Dr Jarmain. "But knowing what the crops are would certainly add more value."

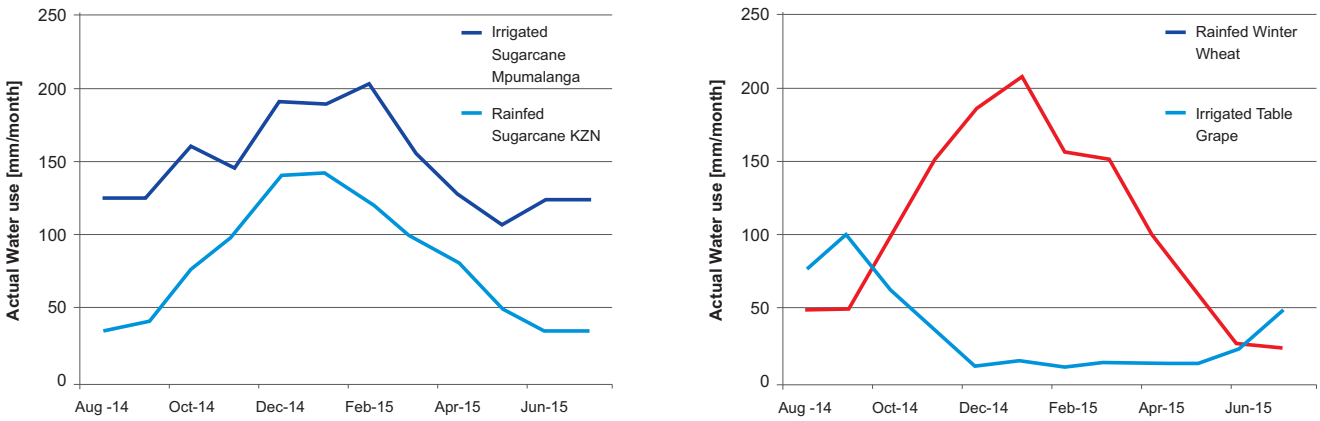
The challenge, however, is to find reliable information on crop distribution.

"Some sectors, like the sugar industry, have detailed maps, but others only have an approximate figure for how many thousand hectares of a crop are grown in different areas," she explains. "We've received the most information from the Western Cape, because the provincial Department of Agriculture has been funding aerial surveys where field boundaries have been digitised and crops allocated to them."

Earlier this year, the department advertised a tender to update the data collected in the previous surveys, which mapped and georeferenced all agricultural commodity production and related infrastructure. A summer and winter 'flyover' survey will be conducted at an altitude low enough to distinguish the various types of summer and winter crops, with vehicle-based surveys undertaken where this is not possible.

Obtaining up-to-date information is beneficial, because farmers sometimes change the crops planted according to market forces or climatic conditions. Dr Jarmain notes, for example, that some 'wine farmers' in the Western Cape have reverted to growing apples, plums or citrus as they were struggling to make ends meet. Indeed, wine organisation, VinPro, reports that the average return on investment fell below 1% in 2016, with some 40% of the 3 300 producers making a loss. The value of the Rand, competition on the international market, and price fluctuations due to supply and demand are just some of the factors

BACK TO TOP



Actual monthly water use (mm) of irrigated and rainfed sugarcane (left) and rainfed winter whea and irrigated table grapes (right).

influencing the profitability of any exported product.

In the case of climatic conditions, the drought that began in the northern parts of the country in 2013 intensified over the next two years, and by the end of 2015 five provinces – North West, Kwazulu-Natal, Free State, Limpopo and Mpumalanga – had declared disaster status. According to the Bureau for Food and Agricultural Policy, many farmers switched from soya bean, which declined by more than 180 000 hectares from 2015 to 2016, to sunflower. The crop is known to be more resilient in drought conditions and has an extended planting window in the western parts of the summer rainfall region, so the area under cultivation expanded by more than 140 000 hectares.

Of course, droughts affect crop yields too. In 2015 the country's total maize harvest was 30% less than the previous year, even though the area planted had only decreased by 1.3%. According to the South African Weather Service, 2015 was the driest year on the national rainfall record, which dates back to 1904. Given that rainfall and biomass production are such key parameters in the ETLook model, is there a concern that the 2014-2015 reference year selected for the project might not be representative of the current or longer term situation?

"Our main expected outcome is to develop the methodology, and choosing a reference year was basically just to test it," says Dr Jarmain. "There will always be years that are drier or wetter in different areas, but the idea is to repeat the process regularly and over time you'd get a better sense of what is happening in an area."

"Automating the process would allow the information to be updated and made available in near real time. Ideally, a web portal could be set up, where maps could be viewed of crop water use on a monthly basis. The 2014-2015 map will be used as a baseline for comparative purposes."

This would not only facilitate better monitoring of water use, but would also assist managers in making decisions on possible expansions in irrigated agriculture. One of the project's aims is to show how the methodology can be combined with a water accounting framework to assess the water available at different scales.

"For an individual catchment, if we know how much water we have from rainfall and how much is used for irrigation, plus we know of other water extractions taking place and we know what the environmental requirements are, we can get some idea of whether this is a vulnerable catchment," says Dr Jarmain. "If it's on the negative side of the balance sheet and there's clearly no water, the managers could start looking at how the water has been allocated, and it should be a no-go sign for any new developments. But if it's on the positive side, it would indicate that there is at least a chance for new allocations, requiring more detailed investigation."

The project is managed by Dr Gerhard Backeberg, WRC Executive Manager: Water Utilisation in Agriculture, who reiterates that the main purpose of the research is to establish the baseline of the area irrigated and ET crop water use with application of satellite imagery.

"The project is due for completion in March 2018 and the report published by the middle of next year," he says. "The information generated with this modelling approach should in future be operationally implemented and updated on preferably a monthly basis. Refinement with additional research and development is also required." This includes, for example, comparing the area irrigated with suitability of soils for irrigation, investigating water application in relation to ET crop water requirements, analysing irrigation type (permanent, supplementary or occasional) and methods (surface, sprinkler or micro/drip), evaluating the lawfulness of water use and assessing the scale of irrigation schemes.

- The Wide-Scale Modelling of Water Use and Water Availability with Earth Observation/Satellite Imagery project is being carried out by Stellenbosch University, in partnership with eLEAF®, Agricultural Research Council, GeoTerra Image® and independent consultants. To contact the project team, email Dr Caren Jarmain at cjarmain@gmail.com.

BACK TO TOP

Women in water

The science of women in wetlands

A new generation of scientists is contributing to our understanding and appreciation of wetlands. The Water Wheel spoke to some of the female researchers working on the frontiers of research in this field.

In ancient times, some cultures brought ritual offerings to wetlands to show their appreciation and marvel. Today, a new generation of wetland believers bring their valuable knowledge to many forums to help protect and manage these water resources.

Water is life and wetlands are an integral part of that cycle, they believe.

While remarkably resilient in many ways, wetlands are vulnerable to a range of direct, indirect and cumulative impacts. Studies in several major catchments in South Africa reveal that between 35% and 60% of wetlands have been lost or severely degraded.

People should, therefore, care about wetlands because of water, **Dr Althea Grundling** emphasises. Dr Grundling, a senior wetland researcher at the Agricultural Research Council's Institute for Soil, Climate and Water (ARC-ISCW) Water Science Programme, is one of the researchers who are improving our understanding of wetlands and their management. She holds a doctoral degree in Geography from the University of Waterloo in Canada.

Dr Grundling explains, "Wetlands are natural features in the landscape that offer many advantages such as biodiversity, wildlife and fish habitat, winter pasture, erosion control, open space and aesthetics but most important: water storage, even in the midst of severe droughts."

Dr Grundling, a UNISA Research Fellow and a member of the International Mire Conservation Group, says she has never looked back since venturing into this field. "I did not choose wetland research; it chose me," she says. "It is complex, yet logical and I see the importance of healthy wetlands to improve people's lives. There are ample opportunities for women to grow in wetland-related professions."

The impact of her work includes understanding the wetland processes on the Maputaland Coastal Plain, to unravel and unpack the hydrology links within this sensitive primary aquifer. "Research studies like these not only support the wetlands strategy of the ARC's Water Science Programme but it also actively involves students, whom I mentor and support. An important part of my work is to publish and present research findings, establish collaboration and partnership with universities, organisations, municipalities, national departments alongside regional roleplayers and small-scale subsistence farmers."

The single biggest change needed to improve the state of wetlands is to change human behaviour and perceptions, she believes. This can be done through awareness raising and education. "One should understand how to relate to water and wetland environments," she notes. "If you change the hydrology of a wetland, for example through draining, ploughing or over-grazing, that can result in erosion. If you alter the hydrology of the catchment by various land use practices including mining, agriculture, urbanisation and plantations, it changes the state of the wetland. We need to understand and explain the flow paths of water in the landscape and how the wetlands depend on them."

Dr Lulu Van Rooyen (Pretorius), a Post-Doctoral Research Fellow at the University of KwaZulu-Natal (UKZN), shares Dr Grundling's passion for wetlands and particularly peatlands. Dr Pretorius has been involved in research on the Maputaland Coastal Plain, which has improved our understanding of the

BACK TO TOP

peatlands of north-eastern KwaZulu-Natal. Her work has also contributed to current knowledge of wetland delineation on sandy coastal aquifers.

Says Dr Pretorius, "This is an exciting time to be part of such a multifaceted and evolving field of research. All women have the power to make considerable contributions in their surroundings - not only in terms of wetlands, but towards any form of best practice and ecological, social, and economic responsibility."

Dr Pretorius holds a doctoral degree in Environmental Management from UNISA. What prompted her decision to follow this career path? "I was actually going to study a BMus degree. But I have always been fascinated with the forces of nature and the way things are connected ecologically, especially within our aquatic systems. I find the tranquillity of being outdoors a very personal and grounding experience – a place where I can meet with God and His creation."

Dr Pretorius loves trampling around in wetlands in her gumboots. "I love discovering them and putting the 'puzzle' of topography, geology, hydrology, soil, organisms, and wetland use together. I love the dynamic nature and inter-connectedness of wetland systems in the landscape. It forces the research and researchers to be dynamic and inter-connected as well!"

Currently, Dr Pretorius has a two-year post-doctoral position with the UKZN, funded by the eThekwini Municipality. She is developing a long-term ecological monitoring plan which will be used to understand the impacts caused by anthropological and climate change pressures. "Wetlands are the kidneys of our environment," she states."It is one of the biggest units in our ecological infrastructure, and we gain more value from them than most people realise."

Dr Heidi van Deventer, a senior researcher in the CSIR's Earth Observation Research Group of the Natural Resources and Environment Unit, agrees. "We need to view ourselves as part of nature, not separate from it, and not ruling it."

Dr Van Deventer holds a doctoral degree in Geography from the UKZN. Her work combines geographical information systems (GIS) and earth observation or remote sensing for understanding and monitoring wetland ecosystems.

Dr Van Deventer has been leading the freshwater component of the National Biodiversity Assessment for 2018. She has also been involved in the development and use of remote sensing indices for monitoring of wetland vegetation and other freshwater essential biodiversity variables. Currently, she is leading the WRC-funded project that investigates the capability of earth observation in mapping and monitoring wetland vegetation to be completed by March 2020.

Hiking through the iSimangaliso Wetland Park as a teenager gripped her attention about wetlands. "The fact that it was wild and inaccessible humbled my sense of humans' position in nature. Perhaps what fascinates me most of wetlands is that it restricts our ease of movement in the landscape and, because it is difficult to access all parts of a wetland, one would need some level of earth observation to be able to see and understand it."

Yonwaba Atyosi, an MSc student at the University of Fort Hare, has also been using remote sensing in her work. She employs multi-temporal assessment of spatial changes in the distribution of estuary vegetation.

Atyosi is a Professional Development Program student at the ARC-ISCW under its Water Science Programme. She is focusing on the relationships between wetland types, geology, hydrology and geomorphology. "People are not aware of their functions and importance," she points out. "Wetland education is key." "With our country threatened by droughts, I felt a need to do water-related research to fill in gaps in knowledge of this field while using GIS and remote sensing which I am very passionate about."

BACK TO TOP

A lot of wetland research has now become interdisciplinary. **Zikhona Gqalaqha** has, for instance, been identifying wetland properties conducive for the development of Rift Valley Fever.

She is an agriculture student at the University of Free State (UFS) and is also part of the ARC's Professional Development Programme in its Water Science Programme.

Her work explores the interface between wetland research and agricultural sciences. The aim is to understand the spread of the Rift Valley Fever virus in Africa. Her work will assist decision- makers on how to treat this disease without destroying wetlands. "We are hoping to find out if the virus causing this disease hibernates in the soil," she explains. "My role is to identify wetland soil properties that are conducive to the development and survival of the virus."

Many things influenced her decision to follow this career path. "By studying soil science, I was introduced to the characteristics and importance of wetlands. I realised that by studying and understanding wetlands, I could possibly bring a solution to the water scarcity problem back home (in the Eastern Cape). In the past, we used to collect fresh drinking water in the wetland and irrigation water for crops in the villages. People went the extra mile utilising wetland vegetation to make brooms, hats and mats to sell and make a living. Even today, the wetland in my village still provides clean water for the community."

"There is a link between the environment, ecology, agriculture, conservation science, climate science and human health (termed 'One Health'). One can therefore not address human health while ignoring the ecosystem's health."

Understanding wetland systems are key to make informed decisions about them, according to **Lizette Delport**. She works as an in-house wetland specialist for an environmental consulting company.

Says Delport, "Water is the essential element for all survival, and I wanted to be a part of protecting such a valuable resource." Delport recently completed her MSc in Aquatic Health at the University of Johannesburg.

Her work includes functional assessments of wetlands, rehabilitation and monitoring. "There are many developers that need to understand the importance of protecting wetlands during construction and operation. We aim to inform them of wetlands on site during the first steps of planning so they can make the necessary changes to the layout."

Kate Snaddon, an ecological consultant at the Freshwater Consulting Group, is also furthering our understanding of the fragility and resilience of inland aquatic systems. Snaddon is the non-executive Director of the Freshwater Research Centre, and Chair and Founding Member of the South African Wetland Society.

Snaddon, who obtained an MSc degree in Freshwater Ecology from the University of Cape Town, is involved in the mapping and describing of wetlands and rivers.

Says Snaddon, "I believe that we need to focus our undivided attention on the aquatic ecosystems that sustain our planet. We need to respect the connectivity between ecosystems, and between humans and ecosystems."

BACK TO TOP

The link between water, life and clean water is clear. Yet there is no magic solution to improving the state of our wetlands. This the view of **Nancy Job**, a GreenMatter Postgraduate Fellow and PhD student at the UFS.

Says Job, "We should continue to grow our field of practice, to welcome new energy and solutions. There is not enough investment in and encouragement of people, including those within the government who are mandated to take forward the conservation of our wetlands."

Job got her first job as a wetland consultant in 2000 in the USA. She has since then worked as a wetland consultant, identifying and delineating wetlands and assessing the potential impacts of proposed change in land use. For the last ten years, her research has focused on wetland inventory and conservation planning. This includes being a part-time associate of the WWF Mondi Wetlands Programme, a wetland conservation NGO.

What prompted her to follow her current career path? Says Job, "The encouragement of a friend led me to an adventure – I volunteered in the Pacific Northwest (Canada) as a technical field assistant to a PhD student studying the effects of logging of 100+-year-old ('old growth') trees on a specific frog species which spends roughly five years of its' life cycle in mountain streams. I loved the work and followed up with more hard work and volunteering to further develop my skills.

"It was a combination of taking the initiative to create opportunities for myself, the luck of having doors open, the generosity of great mentors, helped in part by my enthusiasm to learn more about this fascinating field which I had 'discovered'. Out of this came a good set of references, securing me a place in the year-long Wetland Science and Management postgraduate diploma at Washington State University, which accepts only a small number of applicants based on the submittal of motivation for why they should select you. This is how I changed careers, and I haven't looked back!"

Her current work includes investigating the impact of hillslope hydrological processes on wetland form and function. She is also doing preparations (in French) for the development of a national wetland management plan for Rwanda.

Job remains committed to lifelong learning about wetlands. "I guess I am driven to keep learning – I am also in my second year of a PhD investigating the role of hillslope hydrology in driving the hydrology of certain wetlands and highlighting the source areas. This is partly funded by the WRC."

She loves being out in the field, augering for soil samples. "I love the detective work of figuring out how the wetland works, and the understanding that is revealed by looking beneath the soil surface." One of her favourite wetlands remains the Goukou wetland, where she did her Masters research thesis. "It is a very beautiful peat wetland, fascinating in that it took thousands of years to accumulate," she says.

What has been her greatest achievement to date? "I'm proud of my collaborations with CapeNature, SANParks and SANBI in ground-truthing and inventory of wetlands."

Her message to inspire other women in this field? "Keep going; we need you! Create your opportunities. I don't think there are any shortcuts to avoid the necessary hard work and determination, but don't forget to lend a hand to your colleagues, they'll reward you in turn with advice and encouragement."

Antoinette Bootsma is another female scientist with a fascination in wetlands. Bootsma, a consultant at Limosella Consulting (Pty) Ltd, wants to get a better understanding of wetland ecohydrology. This is to inform management recommendations and rehabilitation. "Wetlands tie in aquatic ecosystems with vegetation ecology which were the two things I wanted to explore as career options," she says. "I am passionate about natural processes at a landscape level. I think I have always had this passion, even as a child. Wetland ecohydrology is just a perfect fit for me."

Boontsma, who recently completed her Masters thesis, assessed wetlands as part of the environmental authorisation process. She was tasked with the first audit of wetlands in the City of Johannesburg in 2008. "This was a spatial layer identifying where wetlands were expected to occur in this municipality so that various processes in development planning could be aligned. This layer has since been refined, and other municipalities have developed their own layers. I feel that the body of work of which my project contributed to planning to ensure the continued function of wetlands in these urban areas."

Wetlands are valuable assets, both in terms of the hydrological and biodiversity functions they provide, but also as aesthetic components of our urban landscape. She points out, "If developers and municipalities could work together to incorporate functional wetlands into development layouts, rather than see them as complete no-go areas or areas to be built on, we could improve the quality of our human habitat so much. It is a mindset change that is desperately needed.

Boontsma concludes, "There is a lot of intuition, grace and discipline that women can bring to this field. For me, an understanding of wetlands is very intuitive. It's a gut thing. And that is something women are very good at."

BACK TO TOP

Water use efficiency

Benefits flow from SA water innovation to irrigation schemes, farms

South Africa has been at the forefront of many innovations for irrigation and water management through research and development over recent decades. In particular, the Water Administration System (or WAS) has been hailed as one of the best examples of research-based innovation for water saving in the sector, both locally and internationally. Article by Jorisna Bonthuys.

WAS is used for water distribution management and the calculation of canal and dam operating procedures. It has been developed and refined with mainly funding from the Water Research Commission (WRC).

From Vaalharts tot Hartbeespoort users employ it to save time, money and water.

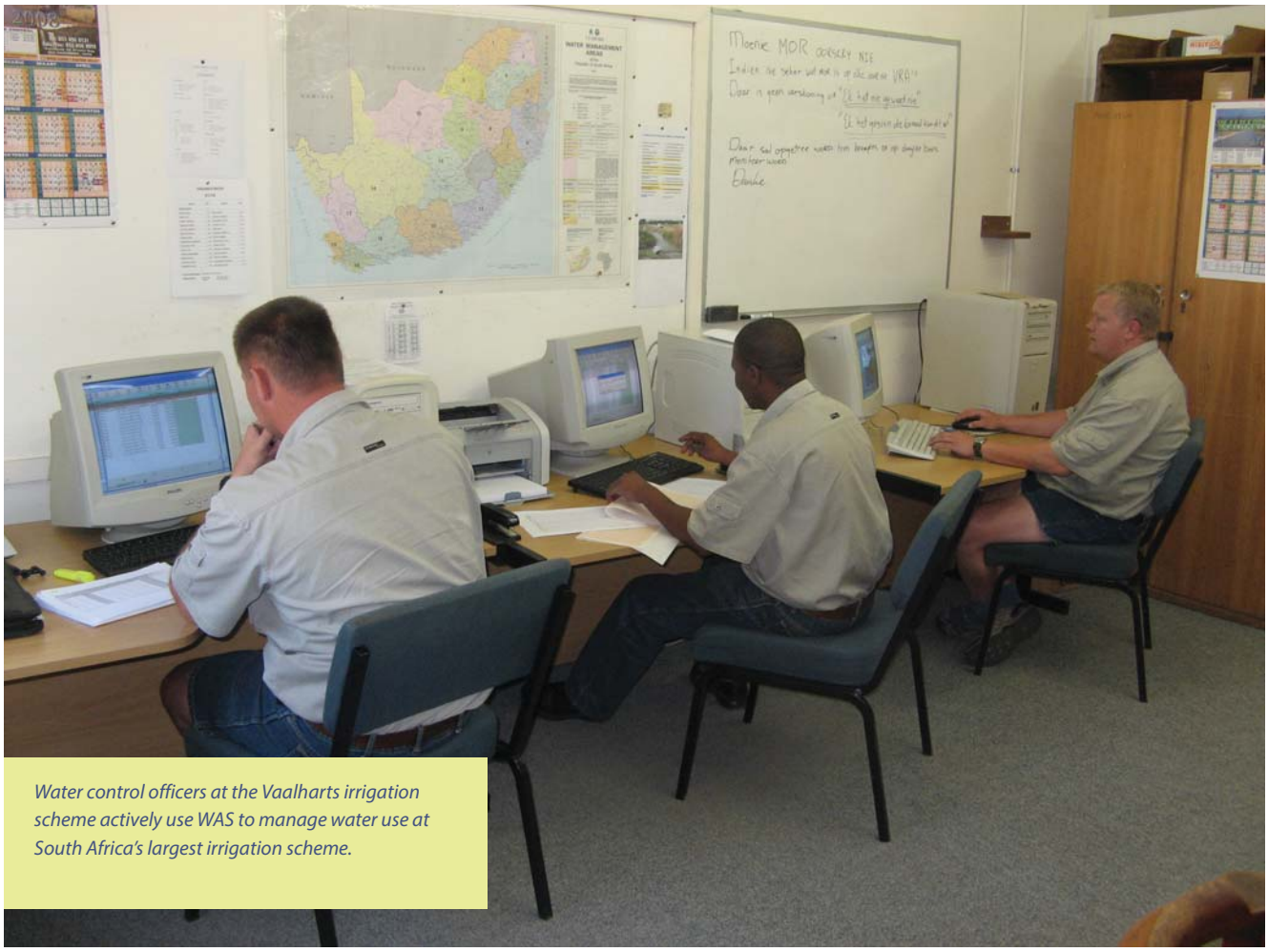
Says Dr Gerhard Backeberg, the WRC's Executive Manager: Water Utilisation in Agriculture, "Over a period of 25 years, WAS has evolved in response to local irrigation water user requirements and to manage water use on demand."

The system was designed for those irrigation schemes that operate on the demand system and distribute water through a network of rivers, canals and pipelines. The system helps to provide just the right amount of water at the right time and place, with the least water loss.

The WAS has grown over the years, since starting as a simple water ordering program in 1986 at the then Loskop Government Water Scheme, into the fully fledged integrated water distribution management system that it is today. Research was done to link the WAS with farming risk and irrigation scheduling modelling so they can be used as tools to minimise distribution losses and maximise efficient water use. This was followed by a technology transfer project to show how the different models can be implemented from catchment to scheme as well as to farm and field scale.

Currently, this system is being used by all the major irrigation schemes as well as some smaller irrigation boards. Notes Dr Backeberg, "This uniquely South African information system brings about a reduction in water losses and offers a low-cost option to achieve real water savings. It speaks to our national water realities in a practical and cost-effective way."

BACK TO TOP



NB Systems

Water control officers at the Vaalharts irrigation scheme actively use WAS to manage water use at South Africa's largest irrigation scheme.

Enabling irrigation through better measurement

As is the case in many countries of the world, the local agriculture sector is under pressure to increase its water use productivity. In the case of irrigation schemes, efficiency gains can result in water savings if the conditions of water use entitlements are met.

Water has to be measured for sustainable production, Dr Backeberg points out. This is often a tricky task, given the nature of the flow of water from an irrigation source to the farm.

This journey is often long and intricate. Water is released from storage dams or reservoirs through canals, or abstracted from rivers, or pumped from boreholes or tube wells. On irrigation schemes, it is then distributed through a network of canals and pipelines to reach individual farms. At the farm level, water is stored in irrigation dams or applied on fields by using different irrigation methods, depending on crop water requirements and the local soil water conditions.

Says Dr Backeberg, "There is a linkage in the flow of irrigation water from scheme to farm to field level. In this process, the focus should be on maximising the consumptive and beneficial fraction of water for food production as well as the non-consumptive and recoverable fraction of water for alternative uses within the water balance framework."

This uniquely South African information system brings about a reduction in water losses and offers a low-cost option to achieve real water savings."

"The efficiency of operating a canal distribution network or irrigation scheme is often determined by losses caused by spillage, leakage and evaporation. WAS provides relevant water intelligence on all these levels."

According to Dr Nico Benadé from NB Systems and the original developer of the system, the WAS can help reduce water distribution losses from 40% to 20%. Dr Benadé, a civil engineer and programmer, provides services support for this system. On irrigation schemes such as Loskop, in Mpumalanga, and the Lower Olifants River, in the Western Cape, this level of water saving has consistently been achieved over many years. Substantial annual reductions in water losses have also been recorded on the Vaalharts irrigation scheme, which is the biggest in the country.

The benefits of improved measurement and adjusting management practices accordingly can be huge. With an average authorised water allocation of about 8 000 m^3 per

BACK TO TOP

NB Systems

Dr Nico Benadé received the WatSave Innovative Water Management Award from the International Commission on Irrigation and Drainage in 2006 for his development and continued implementation of the WAS.

Lani van Vuuren

Loskop Dam. The WAS was initially implemented at the Loskop irrigation scheme but is now implemented on 21 schemes across the country.

hectare and reducing average water losses from 40% to 20%, this amounts to average water savings of 1 600 m^3 per hectare per year. The non-consumptive and recoverable fraction varies from 50% to 90% of water savings, thus from 800 to 1 440 m^3 per hectare per year, depending on amongst others the state of infrastructure and management levels. The total volume of the non-consumptive and recoverable fraction of water savings is related to these variables and the total irrigated area on which reduced water losses can be achieved.

The system also has many water management abilities that could make life easier for its users. Among its capabilities, the WAS calculates water releases from rivers and canal networks, taking lag times and water losses into account.

Its benefits include the improved control of water orders and releases, distribution and water use, the management of date and time-related flow data collected from electronic loggers and improved overall management of irrigation schemes. The WAS also promotes efficient water use at the farm level by enabling water supply of the required volume at the requested time.

Says Dr Benadé, "WAS reduces human errors that could cause significant water losses in irrigation schemes. It improves irrigation scheme management, financial administration and productivity. This enables users to manage irrigation with greater precision and on demand. Above all, it saves water."

What makes the WAS unique is that it gives an overview of water resources from the dam or weir wall to an individual farm, tracking water flow, distribution and losses along the way. This is, for instance, done by calculating water releases from the main canal allowing for lag times and water losses such as seepage and evaporation. To do this the schematic layout of the canal network or river system is captured along with details such as the position of sluices and pumps, the canal or river slope, measure structures and canal capacities.

Currently, 21 major irrigation schemes implement the system, covering a total area of about 182 000 hectares.

User-friendly irrigation intelligence

WAS consists of nine modules that can be used partially or as a whole, depending on the requirements of the particular irrigation scheme and local conditions. This includes modules like water orders, water release, crop water use and water accounts. These modules are fully integrated, making it possible to cross-reference relevant data and information.

"At a time when innovative science and informed management practices are paramount, given recent droughts and South Africa's emerging water realities, the WAS is ideally placed to support irrigation scheme managers and water users in agriculture."

The system is applied for generating water use efficiency reports, water transfers between users, calculation of scheme water balances, dam information, calculation of water releases for distribution, billing systems and a bulk SMS system, amongst others. It has an easy to use system with step by step training documentation that can be accessed online.

The recent launch of the WaterAdmin website completes the development circle for country-wide implementation of the WAS, Dr Backeberg points out.

The website, with its dynamic reporting capabilities, provides support and a water use reporting platform for irrigation schemes that are using this administrator system for water distribution management purposes. It is now, for instance, possible for irrigation schemes to generate and upload their water reports onto the website using this system. The information can then be downloaded and imported into the iScheme database at NB Systems where a summary of water losses table is uploaded automatically.

Dr Benadé adds, "The integration of the WAS and the WaterAdmin website has created a platform that makes it possible to report on water losses nationally. The beauty of it is the fact that the whole process is automated. The only requirement is that an irrigation scheme must have the WAS installed, have good measuring stations in place and have access to the internet."

BACK TO TOP

The system uses an open source database called Firebird (SQL-based) to build its datasets. It can be used in a small water office that manages only a few abstractions or to manage thousands of abstractions and measure stations at a catchment agency level.

Securing local water futures

For the past two years, the Strategic Water Partners Network (SWPN) has implemented a project to roll out the WAS at selected irrigation schemes across the country. This network – a partnership that involves government, business and civil society - wants to close the 17% gap between water supply and demand that is expected in South Africa by the year 2030.

The result of this work is that close to 110 million m^3 of irrigation water have been "saved" during the last two years, according to a recent notice. At 55 million m^3 per year, this saving is about half the annual water use of Nelson Mandela Bay Metropolitan Municipality and about 2% of the so-called water gap between water supply and demand (of 2.7 billion m^3 per year) expected in 2030. More importantly, continued efficiency in the agriculture sector will enable the creation of jobs in agriculture as envisioned in the government's National Development Plan. Further roll-out of the WAS is planned this year.

At a time when innovative science and informed management practices are paramount, given recent droughts and South Africa's emerging water realities, the WAS is "ideally placed" to support irrigation scheme managers and water users in agriculture, in particular for more water-efficient food production, Dr Backeberg argues. "WAS is a prime example of taking the science innovation process through the full cycle – from research to practical application to exploitation of its commercial potential," he says. "It remains a major challenge to achieve water savings by reducing distribution losses, and this system does that."

The Lower Olifants irrigation scheme is one of the oldest irrigation schemes in the countr where WAS is being implemented.

The Water Administration System in a nutshell

- WAS offers tailor-made, proven technology for irrigation scheme management.
- It is an integrated information management system used for water distribution.
- WAS is implemented on all the major irrigation schemes in South Africa.
- The system can reduce water distributions losses by up to 20%.

"WAS is truly an innovation which has progressed through the stages of research to technology exchange and then to practical implementation"

WAS has an estimated potential reach, or expanded implementation of up to 600 000 hectares of irrigation schemes nationally if the requirements of an investment in water-measuring devices, information technology and training of water managers are in place. Dr Backeberg believes WAS shows great potential to be rolled out as an integrated information system for canal water management and will help to enhance water use efficiency. "We know more water savings are possible by using this system," he says. "It already contributes to reduction in irrigation water losses, better control over receipt of water user charges and general improvement of all aspects of management of an irrigation scheme."

In some cases implementing this system does need a mind-shift from water control officers, Dr Benadé points out. "Some practices have to change to improve results and provide better services for users. This involves switching from a manual to a computerised information system. Skills development of water control officers remains relevant."

Dr Backeberg concludes, "WAS is truly an innovation which has progressed through the stages of research to technology exchange and then to practical implementation to increase profits. If its implementation expands, it can release more water savings back to agriculture or for other purposes, such as domestic or industrial water uses."

Visit www.wateradmin.co.za for information.

BACK TO TOP

Water-energy nexus

Water-smart energy planning in South Africa – World Bank report

Water and energy are often entwined in the sense that the use of one depends on the availability of the other, a concept known as the water-energy nexus. Improving our understanding of this complex interdependence and developing appropriate tools to assist decision-makers with future infrastructure planning are essential for continued sustainable development in the face of the uncertainties posed by climate change. Starting with South Africa, the World Bank has embarked on a global initiative called Thirsty Energy to help countries tackle the challenge of managing the water-energy nexus in an integrated manner. Compiled by Lani van Vuuren.

According to the World Bank, South Africa represents an ideal case study of the challenges that the Thirsty Energy initiative is designed to address. South Africa is a water-stressed country that is also experiencing a crisis of electricity supply. The sustainability of water and energy supplies is uncertain, as is the impact of shortages on social well-being, the national economy, and the environment, particularly in the context of climate change.

In contrast to many other developing countries, South Africa has long had processes for long-term planning related to the supply of energy and water. Planning for one has historically taken into account the cost and scarcity of the other, though to varying degrees. For example, Eskom has a policy known as 'zero liquid-effluent discharge', and has made significant historical investments in dry cooling for coal-fired power plants as well as plans to use dry cooling for all future plants. (This despite the fact that dry-cooled plants are, on average, 10% more capital intensive and 2% less efficient than wet-cooled plants) In addition, the National Water Resource Strategy and other water resources planning studies consider the future water needs of the power sector. This has resulted in the development of an integrated system of large dams and interbasin transfers to ensure a reliable water supply to the energy sector.

BACK TO TOP

Overview of the modelling methodology

The World Bank case study is the first time the cost of water supply has been assessed in a sector-wide energy-supply expansion plan. By documenting the methodology, the authors aim to help energy sector planners and modellers properly incorporate water constraints in their work.

The so-called South Africa TIMES model (SATIM), a public domain energy systems model developed by the University of Cape Town's Energy Research Centre, was selected as the basis for the development of a water-smart energy planning tool as an important first step towards an integrated water-energy planning methodology. SATIM is a national model built using the TIMES modelling platform, a partial-equilibrium linear optimisation framework capable of representing an entire energy system, including its economic costs and emissions.

Given that virtually all water in South Africa is allocated, any future demand for water in the energy sector will require the need for new regional water infrastructure, including inter-regional exchange possibilities, to better understand the impact of water-supply costs on the energy sector. The World Bank model produces a least-cost energy-supply plan through 2050 that minimises the cost of both energy and water supply.

The scenarios selected for analysis reflect main drivers of investment uncertainty in water and energy supply that are of key importance to South Africa. Specifically, the SATIM model has been used to examine several questions facing the country, among others:

- How does accounting for regional variability in water availability and the associated infrastructure costs of water supply in different regions affect future energy planning?
- Is the current policy of dry cooling for new coal-fired power plants economically justified?
- How does a dry affect coal investments in the Waterberg region?
- How does the cost of water affect shale gas production?

Main findings

The report's most important message is that accounting for the regional variability of water supply and the associated costs of water-supply infrastructure can significantly impact energy planning, especially in a water-scarce country such as South Africa. The case study highlights the importance of the spatial component of energy and water resources — particularly in countries where water availability varies widely from region to region—and its potential impacts on the overall cost of different energy technologies.

For example, when taking water-supply infrastructure costs into account, the energy model chooses dry cooling for most coal-fired power plants. Thus, dry cooling makes economic sense in South Africa even if it decreases power plant's efficiency and has higher capital costs. This has huge implications for the energy sector's water needs.

After incorporating the true cost of water supply into the energy model, the power sector's water intensity drops to a quarter of the "no water cost" 2050 level. In contrast, omitting water costs in the energy model results in an increase of water consumption for the power sector by 77% and for the whole energy system by 58% since the model chooses technologies that are more water intense.

Summarising, if water has no cost, the model chooses to use more of it to develop energy resources. Once the costs of water are reflected in the model, technologies that are less water intense and that initially seemed more costly become more competitive. This finding is important because it shows that looking at a system as a whole (including water), results in different energy choices than if we just optimise for energy resource development alone.

The Waterberg region provides a good example of the importance of accounting for water cost in energy planning, and highlights the specific regional challenges of the water-energy nexus. In Waterberg, the energy sector is the largest water user, with power plants accounting for the largest share.

Of water costs were not taken into account in energy-system planning through 2050, water consumption would rise from 45 million m^3 in 2015 to almost 900 million m^3 by 2050, with power plants approaching 80% of the total water consumption in the region. Under the contrary scenario, power plant water consumption drops to less than 100 million m^3 by 2050, and total water consumption in the region is about 250 million m^3.

Other than the water consumed by power plants, the two reference scenarios have similar total system cost, energy-supply expenditures, and primary and final energy consumption results.

Interestingly, the reference scenario with water costs produces slightly more carbon dioxide (CO_2) emissions than the scenario without water costs, despite generating 1.3% less electricity with coal and 2% more with renewable energy technologies (chiefly wind and solar), which require no water to generate electricity. The higher CO_2 emissions stem from the higher unit emissions of dry-cooled power plants.

"Finally, the study notes that the highly integrated nature of the South African water-supply system creates some resilience to the impact of climate change, but increasing temperatures may affect the efficiency of dry-cooled systems."

What about shale gas?

The World Bank study confirms that, while shale gas appears to be quite attractive for electricity generation, it will require investment in additional water-supply infrastructure for major development as well as careful consideration of broader water-related risks.

BACK TO TOP

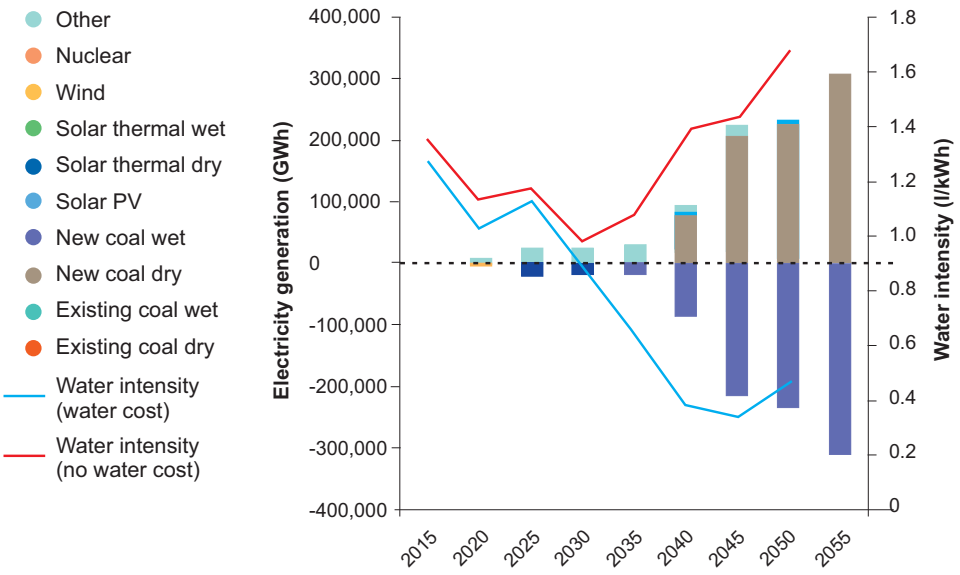


Figure 1 – Difference in electricity generation by type and water intensity for reference (water cost) and reference (no water cost)
Source: Modelling the water-energy nexus: How do water constraints affect energy planning in South Africa?

"the analysis demonstrates the importance of identifying a water-smart energy development plan, in which infrastructure investment levels and water-supply costs are taken fully into consideration."

Using the limited data available, the model suggests that the use of shale gas for power generation will grow at a similar rate once the costs of supplying water are taken into account. In other words, the cost of water does not appear to be the main driver of decisions about whether to invest in shale gas to generate power. However, regional water-supply costs could potentially double in certain regions because of demand from shale gas production, thereby affecting not only the producers but other water users as well through lowering of the groundwater table and increased risks for surface and groundwater pollution.

Under the modelled scenario, an assumed limit on on-site groundwater usage of 1 million m^3/year leads to a reliance on trucked water for the early stages of development of the shale gas sector, resulting in relatively high water-supply cost. However, the construction of a pipeline in 2030 to bring water into the shale production area reduces the cost of supply by about 95%, and this assumed lower cost accelerates shale gas development.

Finally, the study notes that the highly integrated nature of the South African water-supply system creates some resilience to the impact of climate change, but increasing temperatures may affect the efficiency of dry-cooled systems. The final report highlights the fact that trade-offs between the power sector, urban water supply, and water for agriculture need to be explored further, particularly for key systems (e.g. the Vaal and Orange River).

The World Bank study confirms that accounting for the regional vari¬ability of water supply and the associated costs of water-supply infrastructure can significantly impact energy planning, especially in a water-scarce country such as South Africa.

The findings of the World Bank study exemplify how integrated and regionally disaggregated water-energy modelling and analysis can better inform decision-makers of the potential costs, benefits, and risks of alternative policies and technology choices under a range of possible water and energy conditions. In particular, the analysis demonstrates the importance of identifying a water-smart energy development plan, in which infrastructure investment levels and water-supply costs are taken fully into consideration.

To access the World Bank report, Modelling the water-energy nexus: How do water constraints affect energy planning in South Africa?, Visit: https://openknowledge.worldbank.org/handle/10986/26255

BACK TO TOP

Water supply

Where will our future water-supply come from? The challenge with non-conventional options

South Africa's National Water Week theme, 'Water and sanitation are human rights', evoked deep thinking about how the country can sustainably provide water to its citizenry amid growing demand. Article by Jeremiah Mutamba of Trans-Caledon Tunnel Authority.

South Africa's conventional (mostly surface) water sources have been unable to cope with growing demand. Most of the economically viable dam sites having been fully developed.

This challenge is further exacerbated by a number of poignant factors, namely, growth in population which concomitantly drives demand, economic growth, the need to improve livelihoods, continued pollution of freshwater sources and the potential scourge of climate change. Drought conditions, such as those recently experienced in many parts of the country, combined with high system losses, further worsen the situation.

Average non-revenue water is estimated to be 37%, while current demand levels are estimated to be in the region of 15 x 10^3 Mm^3 per annum and projected to increase to 17.7 x 10^3 Mm^3 per annum by 2030 (WRG, 2009), at which point demand outstrips economically usable freshwater supply. Total local yield, including further developments, is estimated to be 15 x 10^3 Mm^3 (Adewumi ***et al.***, 2010; WRG, 2009). With limited and already stretched water resources barely meeting ever-growing demand, South Africa is challenged to improve its water use efficiency as well as proactively explore alternative water sources, including non-conventional options. These options include: wastewater reuse, greywater use and seawater desalination.

This article briefly discusses the challenges facing South Africa in promoting proactive use of non-conventional water sources.

Non-conventional water sources

The three non-conventional water sources mentioned above hold a lot of potential in South Africa. With more than 2 500 km of coastline, seawater desalination has significant potential for the coastal cities. In this vein, a number of coastal cities, for example Cape Town, Durban and Nelson Mandela Bay, have progressed in investigating seawater desalination. However,

BACK TO TOP

few have progressed beyond investigative work, with the few implemented projects being small desalination plants.

"Notwithstanding legislative provisions, concrete strategies, known potential, technological advancements and research, seawater desalination and water reuse still encounter considerable challenges to effectively contribute to South Africa's water -supply basket."

Similarly, South Africa has significant potential for greywater and wastewater reuse. Adewumi ***et al.*** (2010) estimate the total usable return flows as 1.2 x 10^3 Mm^3 per annum. Turton (2015), however, estimates South Africa's daily wastewater volume as 4.9 million m^3 per day, which is equivalent to 1.8 x 10^3 Mm^3 per annum of wastewater. Apart from indirect reuse through return flows to receiving rivers and, while there are known pockets of reuse in the country, the proportion of planned water reuse in South Africa is very small compared to the national potential.

Over time, there has been significant research and technological developments to support seawater desalination and water reuse. The country's water legislation supports both water reuse and desalination. Further, South Africa, as part of its National Water Resources Strategy 2013 Edition, developed and published sound strategies to guide both desalination and reuse.

Notwithstanding legislative provisions, concrete strategies, known potential, technological advancements and research, seawater desalination and water reuse still encounter considerable challenges to effectively contribute to South Africa's water-supply basket. While there are other bottlenecks, a few set of factors critically influence the slow uptake for water reuse and seawater desalination. The instrumental factors holding back large-scale reuse and desalination include: perceived high unit cost of desalination projects, lack of localised best practice, poor public perception for reuse, and the need to learn from international approaches to drive reuse and desalination. These four factors are briefly discussed in the next few sections.

Challenges affecting non-conventional water sources

Traditionally, desalination water is considered much more expensive compared to conventional water sources. Tariffs for conventional water in South Africa's coastal metros ranges from R11.63/kℓ to R16.54/kℓ. The cost varies from location to location depending on associated infrastructure for water abstraction, conveyance, treatment and distribution.

In comparison, benchmark production cost for desalinated water range from R8.10/kℓ and R16.20/kℓ also influenced by capital and operational cost outlay for each project. Notably, the quoted desalination cost estimates exclude distribution and other related costs which will push up the unit cost at the tap. Agreeably, the desalination costs are on the higher end of conventional water supply costs. However, these costs, with improvements in technology over time have been slowly approaching affordable levels.

It is important to also consider that most, if not all, economical conventional water supply sources have been fully developed, leaving more expensive options. As such, desalination costs should be compared with the next complex and likely more costly conventional options as these are the ones remaining following development of most economical options.

BACK TO TOP

While South Africa has a few cases of both wastewater reuse and small-scale desalination projects, it is acknowledged that the country lacks substantial experience and expertise in large-scale projects in both domains. In addition, the knowledge levels of wastewater reuse among potential users is low – an additional factor which fuels pessimism and anxiety among would be users. These factors result in subdued public trust in our utilities' ability to safely deliver such complex projects. Po ***et a***l. (2004) posits that public's trust in a utility's ability to provide safe and reliable treated wastewater is a critical factor to why residents are willing to reuse wastewater.

By its nature and value-chain history, reclaimed wastewater attracts a lot of resistance from society – a challenge relating to the perception the public has on the water source. This perception negatively influence the public's willingness to use reclaimed water. This challenge is, however, not unique to South Africa as many countries that have attempted reuse programmes have battled to secure public buy-in. A number of authors (Adewumi ***et al.***, 2010; Bhungu, 2014; Robinson ***et al***., 2005; Vedachalam & Mancl, 2010) have identified public perception as a major obstacle to wastewater reuse.

As such, it is important to underscore public perception challenges can ruin a reuse project irrespective of scientific and engineering-based considerations (Vedachalam & Mancl, 2010). Locally, while a diverse number of successful reclamation projects have been implemented, some projects have been victim to the public perception and acceptance dilemma. One of such examples is the eThekwini Wastewater Reuse project which has been shelved mainly from public perception challenges.

To circumvent this, it is imperative that extensive public engagement and awareness programs are instituted, including involving the key stakeholders and would be users in strategic decision making. End-users need not only be consulted, but should to be part of the solution formulation and decision-making right from the early stages of the project conception. In addition, transparency is pivotal for the process to gain the trust of the people and have legitimacy. In Australia, for example, a perception survey conducted by Po ***et al***. (2004) revealed that public trust was instrumental in the success wastewater reuse projects. It is important to highlight that this approach tends to increase the project cycle. However, given the high risk for the project to fail due to lack of public buy-in, the prolonged project cycle is necessary to ensure successful project delivery.

Complex projects and programmes like seawater desalination and wastewater reuse tend to invoke anxiety and, perhaps, some phobia – mainly because of the associated high risks and attendant implications in the event of failure. This is particularly so where a country is breaking new ground – which is the case for both programmes in terms of large-scale projects.

For example, a failed direct reuse project can pause unthinkable health hazards with concomitant large public outcry. Similarly, large-scale desalination projects, if developed as drought mitigation interventions, have the risk of, as the case of many of Australia's projects, white elephants should the drought be broken. Such outcomes unfortunately can be seen as suicidal and professional liabilities to sector players. As such, due care and meticulous planning are required when considering such projects. South Africa can draw credible lessons and the lead of other nations that have successfully introduced these two water resource options into their water mix.

Credible lessons on desalination and water reuse can be sourced from the many countries including Australia, Israel, Singapore and USA. A number of Middle East countries, such as Saudi Arabia, also offer powerful lessons on desalination projects.

Critical lessons South Africa can adapt from international experiences include establishing a steering node to guide selection of appropriate technologies, criteria and administrative changes that will guide safe wastewater reuse as did the team that led reuse in Arizona in the US (Fulton, 2014); and having a high profile champion to lead an advocacy programme for the initiative as did Singapore in its water reuse programme. Importantly, these approaches will need to be supported by an extensive and transparent stakeholder engagement programme to take the people along as seen in some Australian and US projects (Biggs, 2017; Bloxom, 2017).

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BACK TO TOP

Dialogue explores the plight of environmental refugees

Speakers at the dialogue included Dhesigen Naidoo (WRC), George Kuchio (United Nations Refugee Agency), Dr Harrison Pienaar (CSIR), Dr Inga Jacobs-Mata (CSIR), Dr Brilliant Petja (WRC) and Dr Francois Engelbrecht (CSIR).

On World Refugee Day, 20 June 2017, the Water Research Commission (WRC), with the CSIR, launched a new project at a special dialogue titled, 'Taking stock of the impact of environmental refugees and climate-induced migration in southern Africa'. While Dr Harrison Pienaar of the CSIR Natural Resources and the Environment and Dhesigen Naidoo, CEO of the WRC, sketched the background and importance of the new project, Dr Inga Jacobs-Mata of the CSIR provided insight into the objectives of the research. Then the CSIR's Dr Francois Engelbrecht provided an overview of climate induced migration over southern Africa, followed by Dr George Kuchio of the United Nations Refugee Agency, who provided an international perspective.

Dr Brilliant Petja of the WRC presented opportunities in light of climate change. Dr Shafick Adams of the WRC then provided some closing remarks. The dialogue incorporated a range of different perspectives: governance and law, climate change, land-use, as well as national disaster response and international aid perspectives to explore the climate change-environmental degradation-migration nexus. From the discussions it became clear that context-specific evidence needs to be improved to better inform policies related to environmental migration.

More efforts should be made to strengthen local research capacity and expertise to improve data at the local level. Understanding the impacts of migration on migrants, on communities of origin and on communities of destination must be improved to better assess whether and how migration can contribute to reducing vulnerability or, on the other hand, to fuelling increased risks. Also read the article on page 12.

The research project , which commenced in April, will run until 2020.

BACK TO TOP

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

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

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