THE
WATER WHEEL

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MORE, BETTER GRAZING THROUGH SMART IRRIGATION

- What will it take to craft a water secure future?
- Introducing the science of hydropedology

WATER RESEARCH COMMISSION

science & technology
Department: Science and Technology
REPUBLIC OF SOUTH AFRICA

WATER RESEARCH COMMISSION

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WATER TECHNOLOGIES DEMONSTRATION PROGRAMME
An initiative of the Department of Science and Technology and the Water Research Commission

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AIMS TO
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SERVICE OFFERINGS FROM WADER

01 Some funding for technology demonstrations

02 Access to information on a range of technologies

03 Credible technical information

04 Opportunities to connect/link with other entrepreneurs/innovators/test bed partners

05 Matchmaking with municipalities, innovation players, funding organisations & investors

06 Growth of SMMEs and enterprise development

07 Technical advice using scientific protocols

08 Driving innovations in priority areas of the Water RDI Roadmap and the NWRS II

KEY STAKEHOLDERS FOR WADER

- Entrepreneurs/innovators
- Water boards/utilities/municipalities
- SMMEs
- Investors/funders (local and international)
- Government departments
- Technical consultants

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A recently completed research project is assisting farmers in the correct application of water for pastures. See article on page 12.

Fluid Thoughts

South Africa – a global water capital

World Water Day, 22 March 2017, was a special day in South Africa's water history.

This was when eThekwini was the venue for the launch of the 2017 United Nations (UN) World Water Development Report, as well as the announcement of the 2017 Laureate of the Stockholm Water Prize, two major annual water milestones. President Jacob Zuma, in his capacity as a member of the UN Secretary General's Head of State Panel on Water, emphasised the need to join forces around the world in a race against time. That race is the achievement of the Sustainable Development Goals (SDGs) for water and sanitation. Universal access to safe water and improved sanitation by 2030, leaving no-one behind, is perhaps one of our most ambitious multilateral goals to date.

And this is only the beginning. The UNFPA (UN Population Fund) estimates that the global population will exceed 9.7 billion by 2050. This will be an additional 3.1 billion people in urban areas, with the largest population increase being in Africa, given its current youth dominated demographic profile, followed by Asia. This is the next step to the SDGs, the Ten Billion Initiative and the challenge of water and sanitation access to a highly urbanised 10 billion world in 2050. This is a formidable task that requires strong leadership. In his statement, the Vice-Chair of Un Water, Joakim Harlin, called the South African event the largest event in the UN system on World Water Day 2017. There were many international delegates that also referred to South Africa's global water leadership during the three day summit with some using the term 'global water capital'.


WRC CEO, Dhesigen Naidoo

This begs the question. What is a global water capital, and does South Africa meet the criteria to legitimately be called one? We know that in spite of being a very dry country in all our recorded history, in fact, currently the 30th driest country on Earth, we have also maintained a reasonable level of water security over time, including during very harsh drought spells. We have also been successful in developing a water intensive economy through smart storage infrastructure, inter-basin transfer schemes and innovative international arrangements. We have also had our fair share of water, wastewater and sanitation challenges.

So, what would be the characteristics of a global water capital? It has to be a country that leads in the international water dialogues. Here South Africa has a favourable reputation. Apart from being a member of the UNSG's 11 Heads of State Panel on Water (HLPW), water and sanitation minister, Nomvula Mokonyane, has ensured that South Africa has become a leading voice on both on the continent and globally on both water and sanitation matters. South African institutions like the Water Research Commission, our universities and the leading water boards have been prominent in many of the global dialogues, such as the Stockholm International Water Institute's World Water Week, the Singapore International Water Week, the World Water Forum, the International water Association and many others.

The second characteristic would be research and innovation leadership. South Africa does well on the knowledge generation front ranking in the top 20 of the ISI index with respect to publications in the water resources domain. Our innovation record is currently less impressive. South Africa can claim high impact world firsts such as reverse osmosis membrane technology, dry cooling demonstrated at scale in electricity generation, and more recently, some of the world's best 'new toilet' candidates. We are, at the same time, candid that we have to go up a gear in water and sanitation innovation, and this is an important component of the Water Research Commission's new Corporate Strategy.

The third characteristic is water business leadership. South Africa has a very developed water utility sector in the form of water boards as well as local authorities that are successful as water authorities. One of these, the very City of eThekwini that hosted World Water Day, was the recipient of the Stockholm Water Industry Award in 2014. There is, however, a conspicuous absence of a significant South African water private sector of international note. The result is that we have the double challenge of not only the lost opportunities of a growing international market for water and sanitation goods and services, but experience the disadvantage of being a net importer of these solutions and subject to the challenges of currency fluctuations and other risks associated with a negative water goods and services trade balance.

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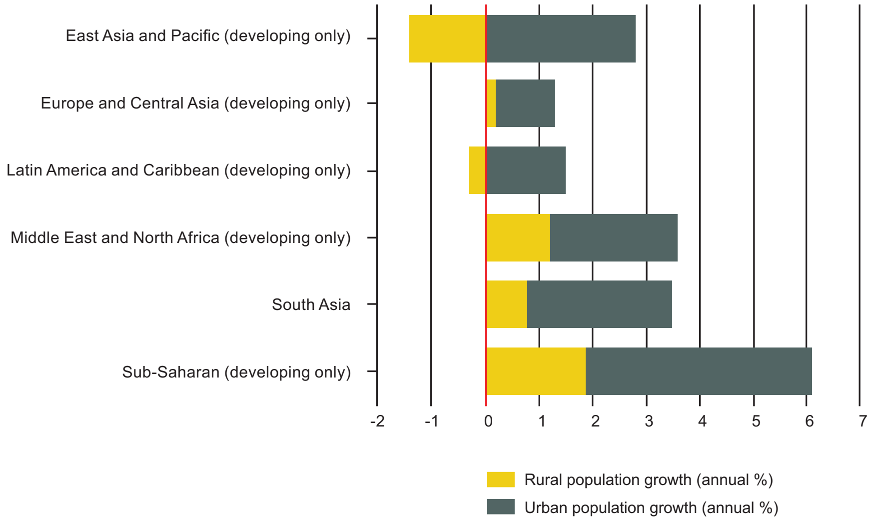
There are, however, some positive notes in this direction. The WRC's business development initiatives are showing early successes in its innovation, water technologies demonstration programme and technology assessment portfolios. In May, Minister Rob Davis launched the latest IPAP (Industrial policy action plan) which, for the first time, includes a chapter on water as a national priority for industrial development, in its own right.

The summary is that South Africa is already a very prominent player in the international water and sanitation domain, and has the building blocks to in the next five years become an undisputed global water capital. Its rate of success will depend on what you and I as players in the South African water sector do to demonstrate our readiness for water and sanitation global leadership. This means in practice the following – growing the water business in South Africa, building at scale our human capital, pushing further to be on the cutting edge of the development of technologies and solutions, and, becoming global leaders in water wise behaviours.



The world's population is becoming increasingly urbanised. An additional 2.3 billion people are expected to live in cities by 2030.

Water Diary

Water history
June 15-17
The conference of the International Water History Association will be held in Grand Rapids, Michigan, USA. The conference is co-hosted by Western Michigan University.
Visit: www.iwha.net

Aquatic science
June 26-29
The annual conference of the Southern African Society of Aquatic Scientists will take place at the Birchwood Hotel and OR Tambo Conference Centre. This year's conference is hosted by the University of Johannesburg. Visit: http://www.riv.co.za/sasaqs/nextcongresses.html

Geomorphology
July 25-28
The biennial conference of the South African Association of Geomorphology will be held at the University of Swaziland with the title 'Southern African Geomorphology: Pure and Applied'. A number of themes have been identified for papers, including soil erosion and rehabilitation in theory and practice; bio-geomorphology; fluvial geomorphology, the geomorphology of wetland systems, and coasts and coastal stability, among others. Visit: http://saag2017conference.com/

Catchment management
October 9-11
The International Water Association in association with Water Institute of Southern Africa (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 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 WISA 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

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News

UP appoints new Dean in Faculty of Health Sciences

The University of Pretoria (UP) has appointed Prof Tiaan de Jager as Dean of the Faculty of Health Sciences.

Before the appointment Prof De Jager held the position of Deputy Dean: Research and Postgraduate Studies, Professor: Environmental Health in the School of Health Systems and Public Health, and Director of the UP Institute for Sustainable Malaria Control. He is also an Extraordinary Lecturer in Andrology in the School of Medicine's Department of Urology.

Prof De Jager completed a Masters degree in zoology at the University of the Free State before obtaining a PhD in Reproductive Biology: Urology at UP. He also completed a post-doctoral fellowship at the Université Laval in Quebec, Canada, a research skills for health professionals programme at the University of Oxford and a reproductive toxicology programme in environmental health and safety at the University of Surrey, UK.

Prof De Jager has a C1 rating from the National Research Foundation and has obtained international recognition for his work. He is currently involved in various research projects, including ones focusing on malaria, reproductive toxicology and environmental health.

South Africa's first biological invasions status report underway

The South African National Biodiversity Institute (SANBI) has launched a process to develop the first national status report on biological invasions in South Africa.

The report is due for completion in October.

'Biological invasions' refers to the process whereby organisms are transported by humans (either accidental or intentionally) to areas where they are not naturally present, and that on reaching such areas the organisms survive, breed and spread with the potential to cause a wide variety of significant negative environmental and socio-economic impacts.

The status report intends to inform the development and ongoing adaptation of appropriate policies to reduce the negative impacts of invasive alien species on natural ecosystems, the economy and the society.

Many alien species are beneficial; almost all agriculture and forestry in South Africa is dependent on organisms deliberately introduced by humans (including wheat, maize, sheep and eucalypts). Preserving the benefits from these introduced species while limiting potential negative impacts from invasions that might result as a consequence, is a major challenge.

However, the purpose of the status report is to address the status of the relatively small number of species that have become problematic and are listed as invasive, including those that have been listed as prohibited. The report will be structured around four aspects. Firstly looking at pathways of introduction and spread; then looking at the status, distribution, and impacts of individual alien species; thirdly, the degree to which areas are invaded and impacted upon by alien species; and finally, the effectiveness of interventions.

Dr Sebataolo Rahlao, Director: Biodiversity Pressures and Responses, leads the SANBI team, which has partnered with the Department of Science and Technology-National Research Foundation Centre of Excellence for Invasion Biology at Stellenbosch University to compile the report. Relevant experts have also been engaged.

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Another El Niño 'likely' to hit South Africa

South Africa could be hit by another El Niño during the next summer season, with concomitant dry weather and likelihood of drought.

This is according to South African Weather Service's (SAWS's) Chief Forecaster, Dr Eugene Poolman. He was speaking at the March meeting of the National Disaster Management Advisory Forum. Present at the gathering were representatives from national government departments, provincial disaster management heads and other stakeholders, including Eskom and the South African Bureau of Standards.

Dr Poolman said that although most parts of South Africa recently experienced above normal rainfall, SAWS's forecasting showed the likelihood of the El Niño Southern Oscillation making a comeback in a few months. "Forecasting systems currently indicate an increased likelihood of an El Niño phase to develop towards the spring season. The likelihood has increased from previous assessments and as we near the winter period, these forecasts improve in reliability."

Dr Poolman noted that it was too early to predict the impact of the phenomenon on the next summer season over southern Africa, but added that SAWS would continue to monitor the development of these conditions and provide regular updates.

The Head of the National Disaster Management Centre, Dr Maphaka Tau, said: "We are not out of the woods yet. It is absolutely necessary that we continue applying risk reduction, mitigation planning and water conservation interventions." Dr Tau implored provincial disaster management heads who were present to commit to a vigorous approach to disaster risk reduction planning that puts communities at its centre. "We need to translate our plans into meaningful interventions that have a lasting impact on the people of South Africa. It is important that we take our work seriously, remain accountable and put people first."

The gathering was also updated on the coordination of recent drought mitigation plans led by the Department of Cooperative Governance.

New partnerships for capacity building

Annually supporting an average of 400 students, the WRC is a key player in not only supporting the development of new knowledge but also the advanced skills required to develop these solutions. In turn, the Energy and Water Sector Education Training Authority (EWSETA) has a pivotal role to play in orienting its 353 water sector levy payers towards emerging water solutions and innovations and driving investments in skills and training. To streamline the water sector skills pipeline and prepare water sector employees for the water jobs and opportunities of the future, the WRC and EWSETA signed a collaborative agreement on 15 March 2017. This collaboration focuses on exploring how to unlock opportunities for exposure to emerging water solutions and innovations using existing bursary, learnership and internship processes. Also, using mechanisms such as the Water Technologies Demonstration Programme the partnership hopes to unlock opportunities to expose new water sector entrants to technology demonstrations and management processes. This partnership also allows for the co-creation of new and more relevant mechanisms that will accelerate and streamline the water skills pipeline.

Tripartite MOU set to benefit drought-stricken Namibia

The departments of water and sanitation (DWS), international relations and cooperation (DIRCO) and Rand Water signed a memorandum of understanding (MOU) with the Namibian government to provide much-needed relief to drought-stricken Namibia.

The MOU, which was signed on 6 April in Pretoria, is the upshot of President Jacob Zuma's announcement in 2013 to provide a cash injection of R50 million to Namibia to cushion the impact of drought. The funds will be disbursed through DIRCO's financing vehicle, the African Renaissance Fund and will be used to drill boreholes. The relief effort will benefit the regions of Ohangwena, Zambezi, Kavango, Omaheke and Kunene. Rand Water has been appointed the implementing agent for the project.

Speaking at the signing ceremony, DWS Director-General, Dan Mashitisho, said the signing of the agreement would give further impetus to the cementing of South Africa-Namibia water cooperation relations, emphasising that this was against the background of the drought that was still present in both countries. "The technical cooperation support by South Africa to Namibia on drought relief bears testimony to the political commitment demonstrated by our Heads of State in contributing to the water and sanitation agenda of Africa where African countries committed themselves to increasing their water mix, including around issues of groundwater."

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Global

Monitoring corruption to achieve the SDGs

Transparency International has published a resource guide on Monitoring Corruption and Anti-corruption in the Sustainable Development Goals (SDGs). The publication stresses the important role of civil society organisations in monitoring corruption. It also points to major limitations in how the official SDG monitoring mechanisms take into account corruption and advocates mainstreaming reporting on corruption across the SDGs.

Corruption is a factor limiting development processes and directly affecting how and if all the SDGs can be achieved. It must, therefore, be taken into account across the board. To that end, the report provides guidelines to help identify potential indicators and data sources. Sample indicators are also provided for monitoring corruption for five key SDGs.

To access the publication,
Visit: www.transparency.org

Governments not keeping pace with growing demand for higher education

A new policy paper from the Global Education Monitoring (GEM) Report and the International Institute for Educational Planning at UNESCO shows that the number of university level students doubled to 207 between 2000 and 2014.

Governments are struggling to keep pace, with rapidly rising demand and large disparities in access, with a large cost of higher education often falling to families, many of whom cannot afford it.

The new paper, *Six ways to ensure higher education leaves no one behind*, sets out a series of measures to make higher education more equitable and affordable, including to ensure that student loan repayments do not exceed 15% of a student's monthly income.

"By creating and transmitting vital knowledge, skills and core values, higher education is a cornerstone for achieving the Sustainable Development Goals," said Irina Bokova, Director-General of UNESCO. "Demand for higher education is going to continue rising. Governments must respond by introducing a range of new policies that will ensure expansion doesn't leave the marginalised behind, and that access is based on merit, not privilege."

Analysing global trends, the paper also shows that only 1% of the poorest students have spent more than four years in higher education, compared to 20% of the richest.

In South Africa, around one-sixth of African and coloured students attended higher education in 2013, compared to over 50% of white students. In Mexico, less than 1% of the indigenous population attended higher education. In China, youth from rural areas are seven times less likely to attend university than students from urban areas.

UNESCO advices governments to use a combination of policies aimed at helping the disadvantaged, such as low tuition fees, need-based scholarships and loans repayments adjusted according to income, to help families manage the costs. The paper draws on a range of examples to show how different countries are expanding and diversifying higher education offerings to achieve greater equity.

"The last thing we want is for higher education to be the ball and chain around students' ankles," said Aaron Benavot, Director of the GEM Report. "Coping with dramatic student expansion is not easy, but there are policy solutions governments can put in place to stop the bill falling to households."

To access the policy paper,
Visit: http://bitly.com/tertiaryed

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Tracking water productivity via satellite

Measuring how efficiently water is used in agriculture, particularly in water-scarce countries, is going high-tech with the help of a new tool developed by the Food and Agriculture Organisation of the United Nations (FAO).

The WaPOR open-access database has gone live, tapping satellite data to help farmers achieve more reliable agriculture yields and allowing for the optimisation of irrigation systems. The database allows for fine-grained analysis of water utilised through farming systems, generating empirical evidence about how it can be most productively used.

Worldwide water utilisation – the majority of which is used by agriculture – has outpaced the rate of population growth for most of the last century and some regions are close to breaching viable limits. "Water continues to surge at the same time that climate change – with increasing droughts and extreme weather – is altering and reducing water availability for agriculture," noted FAO Deputy Director-General, Climate Change and Natural Resources, Maria Helena Semedo. "That puts a premium on making every drop count, underscoring the importance of meeting growing food production needs from efficiency gains."

WaPOR sifts through satellite data and uses Google Earth computing power to produce maps that show how much biomass and yield is produced per cubic meter of water consumed. The maps can be rendered at resolutions of as little as 30 to 250 m, and updated every one to ten days.

FAO's team of information technology and land and water officers has designed the system – through a US$10-million project funded by the Government of the Netherlands – to cover Africa and the Near East, with a focus on key countries that are or are projected soon to face physical or infrastructural water scarcity.

Country level data was to be made available by June for Benin, Burundi, Egypt, Ethiopia, Ghana, Jordan, Kenya, Lebanon, Mali, Morocco, Mozambique, Rwanda, South Sudan, Syria, Tunisia, Uganda, West Bank and Gaza strip, and Yemen. Even more detailed data will come online in October, starting with pilot areas in Lebanon, Ethiopia and Mali.

International report stresses need for increased efficiency to meet SDGs

Countries are not increasing spending fast enough to meet the water and sanitation targets under the Sustainable Development Goals (SDGs). This is according to a report published by the World Health Organisation (WHO) on behalf of UN Water – the United Nations inter-agency coordination mechanisms for all freshwater-related issues.

"Today, almost two billion people use a source of drinking water contaminated with faeces, putting them at risk of contracting cholera, dysentery, typhoid and polio," noted Dr Maria Neira, WHO Director. "Contaminated drinking water is estimated to cause more than 500 000 diarrhoeal deaths each year, and is a major factor in several neglected tropical diseases, including intestinal worms, schistosomiasis and trachoma."

The report stresses that countries will not meet global aspirations of universal access to safe drinking water and sanitation unless steps are taken to use financial resources more efficiently and increase efforts to identify new sources of funding.

According to the UN Water Global Analysis and Assessment of Sanitation and Drinking Water (GLAAS) 2017 report, countries have increased their budgets for water, sanitation and hygiene at an average rate of 4.9% over the last three years. Yet 80% of countries report that water, sanitation and hygiene financing is still insufficient to meet nationally-defined targets for water, sanitation, and hygiene services.

In order to meet the SDG targets, the World Bank estimates investments in infrastructure need to triple to US#114 billion per year – a figure which does not include operating and maintenance costs. "This is a challenge we have the ability to solve," noted Guy Ryder, Chair of UN Water. "Increased investments in water and sanitation can yield substantial benefits for human health and development, generate employment and make sure that we leave no one behind."

To access the GLAAS 2017 report, Visit: http://bit.ly/2cLHjzg

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Opinion

Cape Town – lessons from the drought

By the end of April, the levels of Cape Town's dams were hovering at only 23%, and Capetonians were watching the skies closely for the onset of winter rains. According to Dr Kevin Winter of the University of Cape Town's Future Water Institute the current drought being experienced in the Western Cape region has a number of lessons to offer. He offers up some solutions that must be put in place if we are to avoid this same scenario in the coming years.

Water consumers in Cape Town rely almost entirely on stored surface water for drinking and every other purpose. There are not many countries that are capable of achieving water quality to potable standards.

The population of Cape Town has increased from 3.9 million (1996 census) to an estimated 6.4 million, which is an increase of 58%. But during this time, the stored water capacity has increased by only 14%. In addition, the long hot dry summers from 2015 to the present, and the below average rainfall for the region, has reduced the viable water reserve to the current position of approximately 18% [by March 2017]. The taps could run dry.

The lessons

What have we learnt from this crisis so far? To date, there are three important lessons:

1. Water consumers are capable of using less water. Over the last 12 months, consumers have achieved the 30% reduction as required by Level 3 water restrictions – a reduction from 1.1 billion litres per day to 750 litres per day.
2. Rainfall variability over the Western Cape is taking water resource management into unchartered territory: climate uncertainty, increasing population, urbanisation and water demand. Government will need to react much faster with the implementation of restrictions, and have the capacity to keep these in place, to ensure that the main dams are at least 80% full by the end of October each year.
3. This present crisis is an opportunity to fast track initiatives that will make Cape Town a more water-sensitive, climate-resilient city. The lesson is that we have to be quicker and smarter in adapting to water scarcity.

The City of Cape Town reacted slowly to the decline in water

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storage levels, which became evident towards the end of October 2016. Although Level 1 restrictions were already in place, Level 2 restrictions were only introduced in January, and it took a further six weeks before the effect of these restrictions were observed. The lag in this adjustment could be crucial. Level 3B restrictions were issued on 1 March, placing a further curb on water use for irrigating gardens, sports fields and constraining business activities that are highly reliant on water.

The City has struggled to bring the overall consumption to the level of 800 million litres per day and more recently to achieve a new target of less than 700 million litres per day for the city as a whole. The new target could be out of reach. Meanwhile, thousands of residents are engaged in social media, where advice and shared experiences are raising general awareness. There is lots of evidence showing how citizens are adapting to water scarcity, for example, by installing home-made greywater and water-harvesting systems.

The City is set to continue its strategy to restrict water demand – and rightly so considering the immediate crisis. It will be a tragedy for a city of over six million people to be without water. It is likely that the tragedy will be averted for now, but it could be a close call because weather patterns are increasingly uncertain. And there are expectations of another below-average rainfall season ahead.

Future water

By 2021 the City, in conjunction with the Department of Water and Sanitation, will introduce new schemes to exploit water from sources that include a small-scale desalination plant; water from the Table Mountain aquifer; pumping excess water from the Berg River Dam to the Voëlvlei Dam; and improving the yield from treated water. However, these medium- to long-term schemes will not help the immediate crisis.

This is the opportunity to take a bold new lead by investing in measures that will build a climate-proof, water-sensitive city. A multi-pronged approach is required to manage existing supplies efficiently and to access new water sources, including treated water, stormwater and the sustainable abstraction of groundwater.

The future city of Cape Town will demonstrate how it values water as a critical resource that sustains human life adequately, provide dignity for all, and showcases the role of water in supporting the environment.

The current crisis represents a critical moment for fast-tracking integrated, innovative, water cost-effective solutions that can be introduced over the next 12 months. It needs to start now as a catalyst for investing in medium- to long-term technologies, tools and techniques to ensure that the city never has to face the risk of running out of water. This is an imperative, not an option.

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Irrigation

New guidelines to determine pasture water requirements

A recently completed project funded by the Water Research Commission (WRC) has culminated in the publication of guidelines on irrigating mixed pastures for livestock grazing. Article by Sue Matthews.

It's a tough gig being a farmer nowadays, with profit margins continually eroded by rising input costs, and water availability declining due to competing demands. Some 60% of water use in South Africa is for agricultural irrigation, and farmers are increasingly aware that it is in their own interest to improve the efficiency of their irrigation practices because this has a direct impact on the amount of money they must spend on electricity and fertilizer. Get it wrong, and they've not only paid Eskom more than necessary, but also wasted precious water and expensive fertilizer through runoff and deep percolation, which leaches nutrients out of the crop's root zone.

About 16% of the total area under irrigation is pasture cultivated for livestock production, with ryegrass, kikuyu and lucerne being the most common species. While ryegrass and kikuyu are the primary sources of feed in the pasture-based dairy industry, concentrated in the high-rainfall areas of the KwaZulu-Natal midlands and the Western and Eastern Cape coasts, lucerne is predominantly cultivated in the drier parts of the country for hay. In other words, it is grown specifically to be cut, dried and stored as nutritious fodder to supplement grazing in poor-quality natural veld, particularly during winter. Being a nitrogen-fixating legume, though, lucerne is increasingly also sown with grasses in mixed pastures in the dairy production areas as a way of reducing fertilizer application and providing more palatable, digestible and nutritious grazing than grass alone.

Managing these mixed pastures is considerably more complicated, however. For one thing, the species making up the mix probably have different water requirements, so how do farmers ensure optimal irrigation scheduling?

"Knowing how much water to apply through irrigation and how often is no trivial matter," says Dr Wayne Truter, a pasture

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UP

Using measured in-field research data together with the models SWB and DairyMod, the project team was able to generate irrigation guideline tables for different pastures.

UP

A mixed pasture made up of tall fescue and white clover.

specialist in the University of Pretoria's Department of Plant and Soil Sciences. Dr Truter headed up a recently completed research project funded by the WRC entitled 'Water use and crop parameters of pastures for livestock grazing management', and is lead co-author of the project report and the accompanying technology transfer document, 'Irrigation guidelines for mixed pastures and lucerne'.

Dr Truter explains that the broad guideline for irrigating most temperate grasses and legumes is 25 mm of water per week, regardless of season or region, but evaporative demand obviously differs between locations, with changing weather conditions, and as crop canopy cover varies. A rigid guideline of 25 mm per week will therefore lead to over- or under-irrigation at different times and places.

A previous WRC-funded project in which he was involved, completed in 2012, focused on irrigation management of ryegrass pastures, with limited research on kikuyu and kikuyu-ryegrass mixtures. It culminated in the publication of irrigation guidelines for ryegrass in the major pasture-growing areas of South Africa.

The more recent project expanded this research to various mixtures of grass species such as ryegrass, kikuyu, tall fescue and cocksfoot with the legume species, lucerne and white clover. The project team, which included research collaborators from the University of KwaZulu-Natal, conducted evaluation trials to improve understanding of pasture water requirements at the University of Pretoria's Hatfield Experimental Farm in Pretoria and the Western Cape Department of Agriculture's Outeniqua Experimental Farm in George, representing the summer and year-round rainfall regions respectively. Monitoring sites were also established on farms situated 120 km north-west of Pretoria and in the Cedara region of KwaZulu-Natal to measure water use and growth rate of commercially planted lucerne and mixed pastures under irrigated conditions.

Most pastures, whether monospecific or mixed cultures, are perennial production systems with a lifespan of at least five years. During this time they are repeatedly defoliated by grazing livestock or mechanical cutting, left to regrow for six to eight weeks, and then defoliated again. One of the main findings of the research was that less water than the current guideline of 25 mm per week is required in the first two weeks after defoliation, because the smaller canopy shading the soil surface means that more water is lost through evaporation.

On the other hand, if the period between grazing or cutting cycles is too long – resulting in a large and dense canopy – water use will be high, but since the plants will likely have reached reproductive maturity, the quality of pasture will start to decrease. Furthermore, the species in a pasture mixture may have different growing seasons, so even if the canopy is fully developed a higher percentage of water may be lost to drainage if one of the species is in a dormant phase.

In fact, different cultivars within the same species have distinct preferences that further complicate pasture grazing management. For example, two varieties of lucerne – WL357 and WL711 – were used in trials conducted at the Outeniqua Using Experimental Farm. The kikuyu-lucerne WL357 mixture was comprised of mostly kikuyu during winter, lucerne during summer, and similar compositions of kikuyu and lucerne in autumn, because lucerne WL357 is a semi winter-dormant cultivar. By contrast, lucerne WL711 is highly winter-active, and made the largest contribution to the kikuyu-lucerne WL711 mixture in winter, even though kikuyu remained the dominant component. As a result, the kikiyu-lucerne WL711 mixture had a higher yield than kikuyu-lucerne WL357 in the cooler seasons and vice versa for the warmer seasons. Clearly, it would not make sense to apply the same amount of water to the two mixtures throughout the year.

Based on their research findings, the project team was able to estimate the water requirements of various pasture species and mixtures in all four seasons. For example, while kikuyu grown on its own at the Hatfield Experimental Station would require as little as 12 mm of water per week in winter, when it is dormant, this would increase to 30 mm per week in summer. When mixed with lucerne, which has higher water usage, slightly more water would need to be applied, rising to 34 mm per week in summer. However, a kikuyu-lucerne mixture at the Outeniqua Experimental Farm would likely only require 28 mm per week in summer.

A table showing the various water requirements is provided in the two project documents as a general guideline to irrigation, although applying these figures to other sites with different climatic conditions and soil characteristics would of course

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The project team was able to estimate the water requirements of various pasture species and mixtures in all four seasons.

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seem inherently risky. Truter explains that using the guideline values in conjunction with some basic monitoring data would improve their reliability considerably. Most important is the evapotranspiration (ETo) value – recorded by the simple weather monitoring systems most farmers have on their land, or provided by local weather stations in the vicinity – as this allows one to benchmark more or less the water to be applied according to ambient conditions. However, the management objective would be to achieve a more accurate value according to the specific crop growth parameters. Many farmers also routinely use a pasture disc meter – otherwise known as a Rising Plate Meter (RPM) – to estimate the amount of pasture they have available. The quick and easy RPM method relies on measurements of height and compressibility of the pasture, calibrated to dry matter yield per unit area.

"It's probably the simplest way of determining how much biomass has been produced in the last week," says Truter. "So repeated measurements over time should allow you to deduce the water requirement of the pasture. It is imperative that the RPM be calibrated to the specific pasture as this will give you more accurate readings."

An alternative approach that the project team investigated is to use the Soil Water Balance (SWB) Model, which at its most basic level can generate site-specific irrigation calendars that farmers can print out and refer to for irrigation scheduling. Input on crop, weather, soil and irrigation management is required, but this is relatively uncomplicated because the model has various built-in datasets. For the crop input, farmers need only insert their crop type, the field size and date planted, while the minimum weather input involves simply selecting the nearest major weather station from a dropdown menu, or alternately entering the site's latitude, longitude and elevation.

Other weather parameters such as solar radiation, relative humidity and wind speed can be added, if available, to improve accuracy. The soil input entails a little more effort, as it includes soil depth (determined by digging profile holes at representative sites in the field), soil type (having soil samples analysed at a soil laboratory, or simply choosing between coarse sand, sandy, sandy clay loam or clay soil) and initial soil water content (selecting dry, medium or wet at a minimum, but ideally using soil water probes). Lastly, the irrigation management input includes the type of irrigation system (furrow, sprinkler, pivot, micro and drip), its delivery rate, as well as irrigation timing and refill options.

The final output – the irrigation calendar – recommends irrigation dates and amounts, which must be corrected by subtracting any rainfall that occurs. While the calendar tells the farmer when to irrigate, the optional use of wetting front detectors (WFD) – funnel-shaped tools inserted into the root zone that indicate when water has reached a specific depth – will tell him when to stop.

The SWB Model is available in a more advanced 'consultant version' for those who want to use their own inputs, such as different soils in different layers, or to simulate and display crop growth and soil water balance components. There is also a

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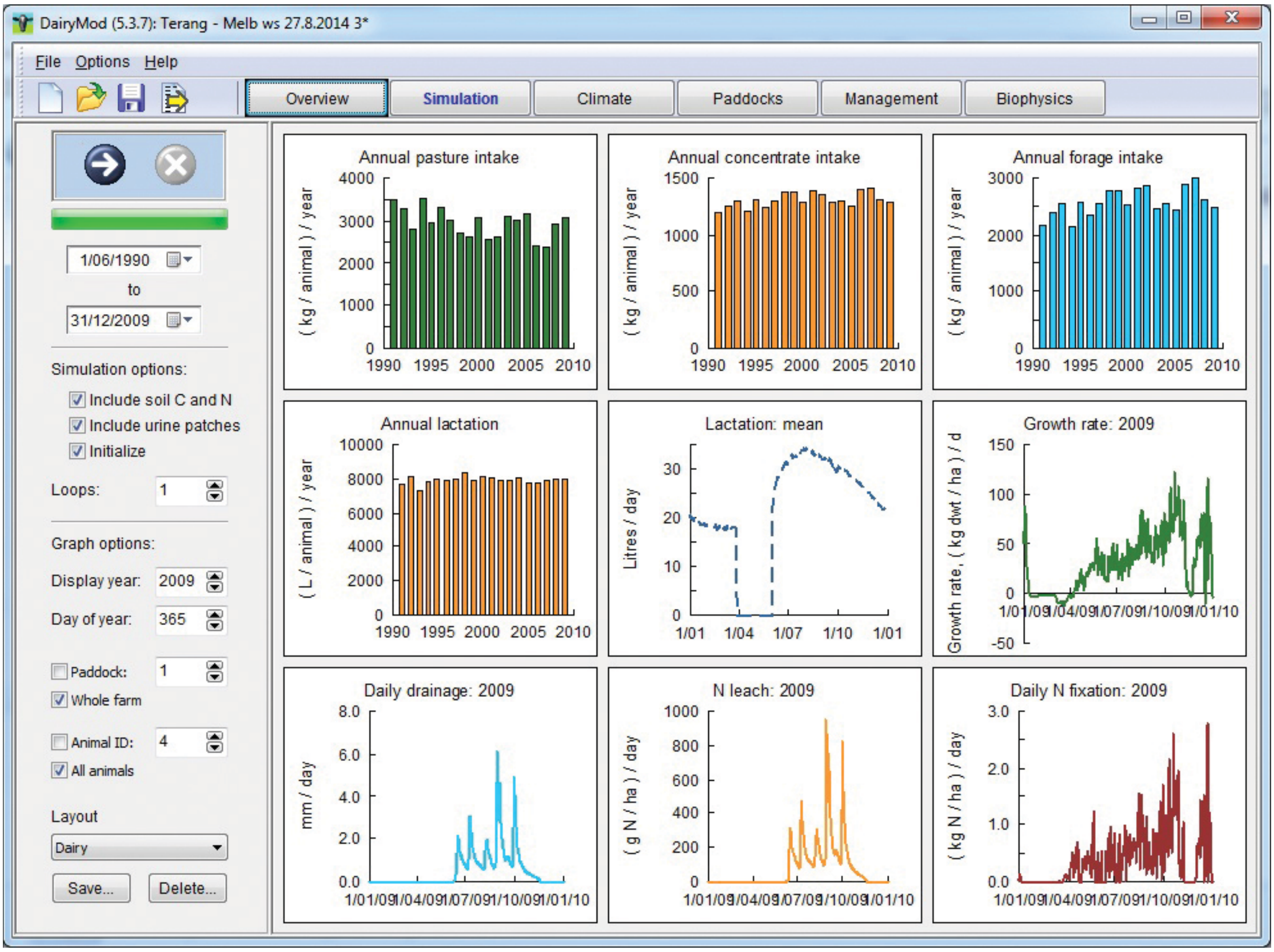
'researcher version' for complex simulations pertaining to specific research questions.

"The first prize, though, would be to use DairyMod," says Dr Truter. This is a biophysical simulation model for dairy systems that the project team tested and validated during their research. Developed by IMJ Consultants in collaboration with Dairy Australia and the University of Melbourne, the model has the ability to incorporate local weather data and to adjust specific parameters related to the soil, pasture growth and animal management factors.

"The model is available online for free downloading and registration with its developers, but it can only be used effectively if set up for the region in question," notes Dr Truter. "We would have to help the farmer set up the baseline dataset that the model requires as supportive information, and from there he or she could incorporate their own data to get a prediction of how best to irrigate."

"So the idea was that we collaborate more closely with IMJ Consultants to update any model development changes, house and run the model and build a comprehensive database for South African pastures, and then we will advise farmers on what minimum information they need – because, of course, the model is only as good as the information you put in!"

To order the project report, *Water use and crop parameters of pastures for livestock grazing management* (**WRC Report No. 2173/1/16**), and/or the technology transfer document, *Irrigation guidelines for mixed pastures and lucerne* (**WRC Report No. TT 697/16**), contact Publications at tel: (012) 671-9300; email: orders@wrc.org.za or visit: www.wrc.org.za to download a free copy.



A screenshot of DairyMod, a biophysical simulation model for dairy systems that the project team tested and validated during their research.

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Water security

Taking a fresh look at water in a time of scarcity

The world is running out of fresh water. Simultaneously, an increasingly volatile climate is raising the complexity of managing the water we do have. This creates a fundamental resource challenge on a global scale, which will require the adoption of a new paradigm relating to how water is managed. If human ingenuity and sober, long-term thinking prevails, water security could be preserved despite the challenges of climate change and increasing demand. If not, water scarcity could become more pervasive, and increasingly the source of conflict. The onus is on planners and water managers everywhere, to craft a water secure future, writes Dawid Bosman.

Throughout human history, man has had a very close relationship with water; it could be no other way, as water brought life, and in scarcity or excess, it took life away. Before the ancient Egyptians and Mesopotamians built the first primitive gravity dams around 4 000 years ago, early humans were vulnerable to the variances of water availability. The Romans brought better materials and cement to the art of dam-building some 2 000 years ago (although their primary contribution was mainly in aqueducts and sanitation systems). It was only in the 17th century that the Spanish brought significant advances in dam-building technology, with the advent of the first arch dams. This technology found its way to the New World colonies, and paved the way for water infrastructure over the next three centuries.

Population growth and a rise in living standards have been made possible by the management of water resources; dams offer protection against floods, and serve as reservoirs, to offer a sustained supply. Should perennial shortages occur, water can be transferred from one basin to the next. These developments have made the availability of water more predictable and manageable, allowing us to mitigate the effect of droughts and floods, and for humanity to grow and prosper.

During the last fifty-odd years man has developed the technology to remove the pathogens from wastewater, and the salt from seawater, to produce potable water. Today, humanity relies on water in countless ways to sustain a global population of nearly 7.5 billion people, in an unprecedented state of collective global prosperity. Our reliance on water is

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visible everywhere; beyond direct consumption and personal use, it is an essential ingredient in virtually every value chain of everything we use, from consumer electronics to clothes to energy. Water has become ***the*** essential common denominator.

Looking to the future, it seems inevitable that our relationship with water will be changing fundamentally. Two trends, mainly, will cause a shift in the tectonic plates: Human demand is outstripping the readily available supply, and the climate is changing, which is affecting water availability. (This is one indicator that we are living in the Anthropocene, the geological age that commenced when human activity began to impact global climate and ecosystems back in the 1760s.)

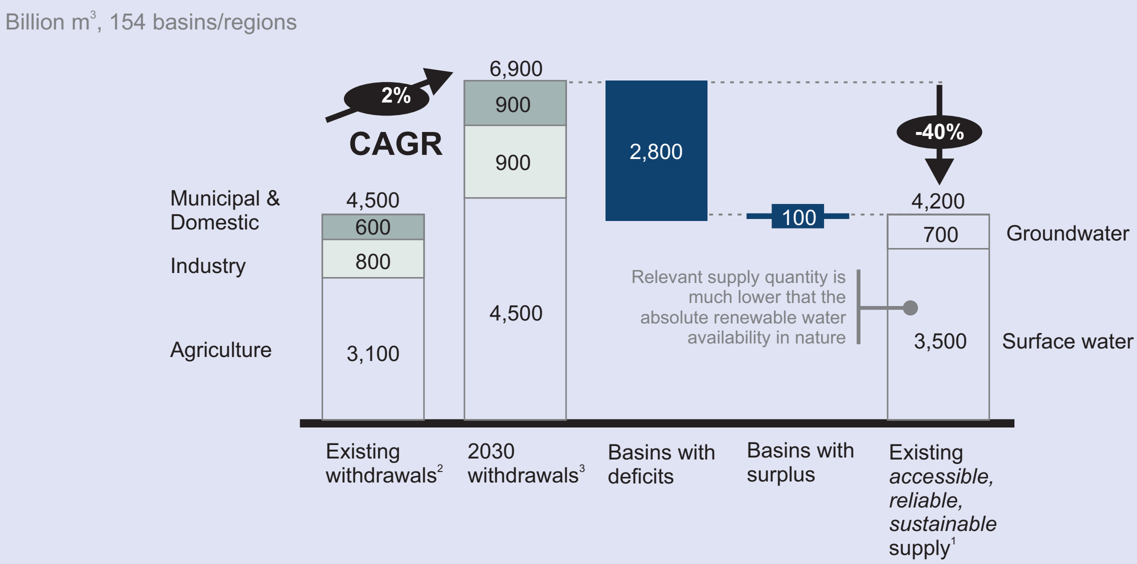
Dealing first with the matter of global water supply. Until now, humanity has been living off that 0.5% sliver of the Earth's water pie-chart; water that is both fresh and readily accessible, drawn from rivers, lakes and dams. This ease of access probably created the common perception that water should be cheap and plentiful; after all, it falls from the sky, and can be accumulated in great quantities, enough for all. This dispensation is not sustainable in the long term.

As humanity grows more populous and affluent, and the climate becomes less predictable, we start competing, rather unfairly, with other elements of the natural ecosystem who also depend on that tiny sliver of available fresh water; and when the well runs dry, human needs have always taken priority. And yet, the sea, that vast reservoir which contains 97% of the planet's water, and has 40% of human population living within 100 km of its shores, has barely been tapped into; less than 1% of current global water consumption is sourced from the sea. More about that later.

So, how much fresh water is there, and how much do we need? Perhaps the most comprehensive, recent analysis of global water security came from the 2030 Water Resources Group (2030 WRG), through their 2009 study 'Charting our Water Future'. Their assessment of the freshwater supply-demand balance, with a forward-looking view towards 2030, covering 154 basins around the globe, is captured in Figures 1 and 2 below. It describes a global resource challenge of massive importance, and significantly, it does not factor in the effect of climate change, and it assesses only the 0.5% of global water stock that is fresh.

Referring to Figure 2 : The 2010 withdrawals from global households, industry and agriculture amounted to 4 500 billion cubic metres (bcm or 1x10^{9} m^{3}), compared with the 90% reliable supply of 4 200 bcm, with environmental requirements already netted off. The 300 bcm deficit indicates that globally, human water needs are already encroaching on environmental needs.

Demand is then forecast through to 2030, upon the assumption of an average 2% compound annual growth rate (CAGR), based on population and economic growth projections, and the further assumption that there will be no progress in water use efficiency in this time. The latter assumption makes the projected "gap" of 2 800 bcm (per annum, by 2030) somewhat hypothetical; certainly, gains ***will*** surely be made in water efficiency, and additional water infrastructure ***will*** be built to increase the system yield across the 154 basins, so the actual deficit by 2030 should be less than 2,800 bcm. But what is not so obvious, and will require vast inputs of planning, investment and human ingenuity to rectify, is how much of the gap could be closed, and what needs to be done to achieve this.



1 Existing supply which can be provided at 90% reliability, based on historical hydrology and infrastructure investments scheduled through 2010; net of environmental requirements
2 Based on 2010 agricultural production analyses from IFPRI
3 Based on GDP, population projections and agricultural production from IFPRI; considers no water productivity gains between 2005-2030

SOURCE: water 2030 Global Water Supply and Demand model; agricultural production based on IFPRI IMPACT-WATER base case

Figure 1: The gap between supply and demand, by 2030.

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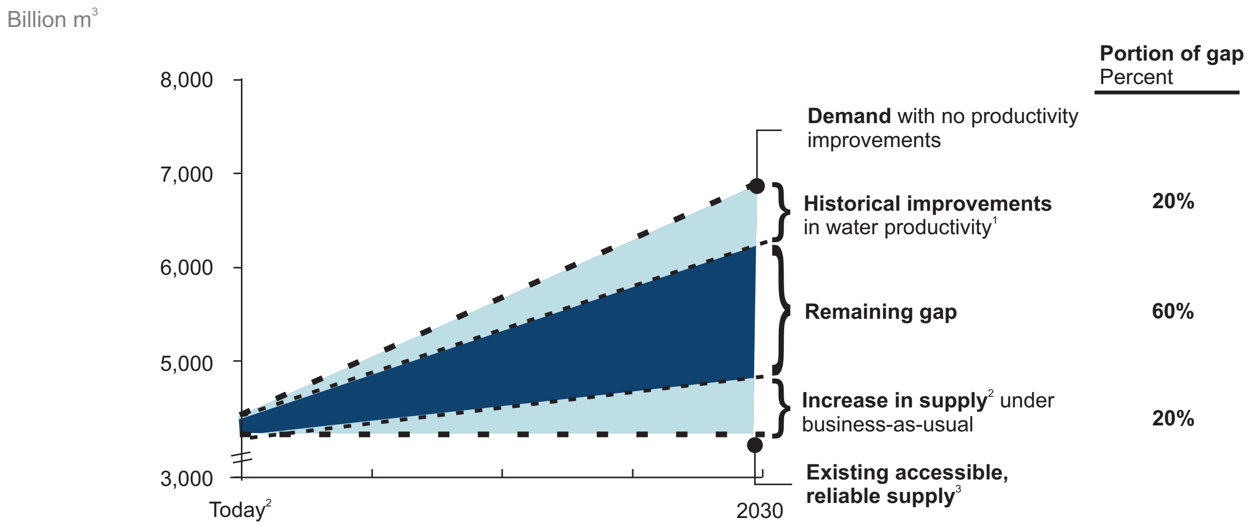

1 Based on historical agricultural yield growth rates from 1990-2004 from FAOSTAT, agricultural and industrial efficiency improvements from IFPRI
2 Total increased capture of raw water through infrastructure buildout, excluding unsustainable extraction
3 Supply shown at 90% reliability and includes infrastructure investments scheduled and funded through 2010. Current 90%-reliable supply does not meet average demand

SOURCE: 2030 Water Resources Group - Global Water Supply and Demand model; IFPRI; FAOSTAT

Figure 2: Closing the gap will require a whole new approach.

Referring to figure 2, if water efficiency (i.e. economic output for a given amount of water consumed) improves only at the historical rate, and if water supply grows due to similar levels of investment and similar projects as before, then only 40% of the gap will be closed. The remaining gap of 60%, quantified as 1,680 bcm per annum by 2030, will need to be addressed by measures and actions beyond the ordinary, according to the 2030 WRG study.

This headline-level finding is the sum of projected water balances across 154 basins, worldwide. With very few exceptions, planners in each basin or region will need to find an optimal balance of solutions that either increase water productivity, reduce water demand or increase water supply, specific to their local conditions.

Collectively, this will be a massive effort, and require an unprecedented focus on the water sectors of most countries, attracting human and financial resources. Water will, in its scarcity, need to be managed like the strategic resource it has always been.

Whereas the 2030 WRG study provides a clear view on water scarcity through to 2030, it did not deal specifically with the water challenges created by an increasingly volatile climate. The body of evidence is growing, indicating that in years to come, we will face an increasing severity and probability of both floods and droughts, in different parts of the world. The imperative will be on policy-makers and planners to not only apply the water supply and water efficiency solutions called for by the 2030 WRG study, but also pursue urban infrastructure design that is more resilient to climate extremes.

The importance of such resilience is clearly demonstrated by a few instances in recent years, when the water infrastructure of cities where unable to withstand extreme weather conditions:

In January 2011, the potable water supply of Brisbane, Australia was inundated by flood waters, following a record-breaking flood that claimed 38 lives and reduced the national GDP by about A$40 billion. Fortunately, and with a good measure of irony, a large-scale seawater desalination plant had been completed in nearby Gold Coast just months earlier, in response to a record-breaking 13-year drought. Being a closed system, the desalination plant was not affected by the flood, and over a period of nearly four months, provided much-needed potable water, between 40 and 90 million litres per day, into the regional water grid, thus averting a potential humanitarian and health crisis.

When a two-year drought ended late in 2015, the metropolitan area of Sao Paolo, Brazil, with 20 million inhabitants, was on the verge of running out of water - an ironic situation for the largest, wealthiest city in a country endowed with one eighth of the world's fresh water. But the confluence of the worst drought in a century, poor planning, population growth and extensive environmental degradation allowed by weak regulation, resulted in a situation so dire that water utility managers contemplated a warning to civilians to "flee from the city", when the crisis peaked. Whereas the water reserves have now been restored, households and businesses have lost confidence in the water utility and city management's ability to avoid a recurrence. The city still loses 31% of its water during reticulation, and an apparent obsession amongst planners with surface water resources leads to the more resilient and sustainable groundwater resources not being developed.

In April 2016, and again in February this year, the Chilean capital of Santiago suffered extensive water supply interruptions, leaving 4.5 million people in distress for several days. Again, the causes were a mix of poor planning, and weather extremes. An extremely hot summer brought extensive, barely controllable

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wildfires, promptly followed by excessive rainfall, also at altitudes where it usually snows. The result was extensive soil erosion and mudslides, which overwhelmed the water treatment facilities. Industry was interrupted, and households had to rely on water being trucked in from other centres. With Chilean water supply completely privatised, accusations are being levelled that under-investment in infrastructure had contributed to the vulnerability. A reservoir is under construction, which should improve the ability to withstand future, similar events, but is only due for completion in 2018. In the interim, the ability of the local authorities to deal with crises and environmental management, is being questioned.

In the midst of perhaps the worst drought in a century, the reserve in Cape Town's five major dams have dropped to 31%, as at 10 March, with conservation and demand management the only actionable defence against running out in another 115 days, unless ample rains arrive in the interim. Even though plans are underway for water reuse, groundwater development, a diversion scheme and large-scale seawater desalination, these solutions require longer lead-times, and could not avert the potential crisis. The impact, on inhabitants, investor confidence and politically, should a major metropolitan city (population 3.7 million) run out of water, will be unprecedented in South Africa. Similar incidents in recent years, such as Beaufort West (population 34 000) and Kroonstad (population 197 000), were on a much smaller scale, and may not be useful templates for the contingency planning befalling the local authorities.

The World Health Organisation (WHO) describes what can happen to a water supply system during weather extremes: "When the weather is abnormal or the climate is under pressure, water and wastewater services systems stand to lose much of their environment and health benefits, for two main reasons:

- They lose their ability to deliver the services required because of direct infrastructure damage (from floods, windstorms and tide surges) or from lack of water (e.g. when a cold spell turns water to ice);
- They become a significant source of chemical and biological contamination of ecosystems, water bodies and soil by means of their discharges and polluted overload."

The probability of extreme heat or rainfall occurring, which could exceed a city's resilience and compromise its water supply, is closely related to global warming, found a recent study by Dr Erich Markus Fischer of the Swiss Federal Institute of Technology. According to Fischer, future warming will result in a more volatile, dangerous environment, even if global average temperature increase can be contained within the 2º C limit to which governments have committed themselves.

This is echoed by the WHO, which has observed a 65% increase in annual, disastrous, weather-related events occurring in Europe from 1998 to 2007. The quantum of losses as a result of these events followed an even greater rate of increase. In essence, the likelihood of extreme weather events is generally increasing, as illustrated by Figure 3 below.

Most world leaders seem to understand the causal links underlying water security, coming from population growth and climate change. In recent years, a very high priority has been given to water security in the annual Global Risk Report of the World Economic Forum (WEF). The former Secretary General of the United Nations, Ban Ki-moon, articulated his sombre concern at the meeting of the WEF in 2008: "A shortage of water resources could spell increased conflicts in the future. Population growth will make the problem worse. So will climate change. As the global economy grows, so will its thirst. Many more conflicts lie just over the horizon."

Taking stock: The world is busy running out of readily accessible fresh water. This will compel us to find new sources of water, and improve the efficiency by which we consume water. Also, climate change is bringing an increase in the severity and frequency of both droughts and floods.

In response to this, we need to improve the resilience of our cities, i.e. the ability to withstand and recover from such extremes, as a result of sound, integrated urban planning. Cities of the future would need to be climate-independent, resilient to floods, droughts and heat waves. Coastal cities would also need to contend with storm-surges and rising sea-levels.

We already see such "best practices" being adopted by the more advanced and forward-thinking waters sectors. The manner in which Perth, Western Australia have drought-proofed itself through a diversification of water resources, including two large-scale seawater desalination plants, is exemplary. The dedication with which Singapore captures run-off for recycling, and the efficiency with which most of the southern and coastal regions of Israel desalinates seawater and recycles wastewater on a fit-for-use basis, are further examples.

Despite large-scale seawater desalination being a key component of urban resilience, there is still much of a debate, in other parts of the world, as to how the practice should be applied: Should desalination be seen as a response to periodic supply shortages (e.g. a drought or highly seasonal demand) only, or should it be seen as a structural, permanent adjustment to the water supply inventory, yielding a continuous supply? The debate may not yet be settled, but the need for urban resilience is adding substantial weight to the latter argument.

As it is, large-scale reuse and seawater desalination are rapidly growing into mainstream practices. Whereas surface water resources will probably continue to dominate for the foreseeable future, the multiple needs of (a) Adding a component of highly-assured water supply, (b) Preserving the ecological flow, (c) Improving the quality of water being indirectly reused, and (d) Preventing return flows from being released to the sea, are all emerging as key issues shaping the conversation.

Looking ahead, our infrastructure and urban design choices will need to reflect these challenges. The solutions may not be simple, and may require a systemic approach to deal with all the moving parts. But, with good fortune, thorough planning, hard work and innovation, perhaps we can avoid the dystopian future that Ban Ki Moon predicted nearly ten years ago.

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Hydropedology

The science of hydropedology – linking soil morphology with hydrological processes

An exciting new branch of science, hydropedology, offers exciting research opportunities in South Africa. Article by Johan van Tol, Pieter le Roux and Simon Lorentz.

Hydropedology is the relatively new, interdisciplinary research field which focuses on the interactive relationship between soils and water. Soil physical properties, such as the hydraulic conductivity and porosity, have an important impact on the occurrence and rates of hydrological processes. In turn, hydrological processes play an important role on the formation of soil morphological properties such as colour, mottles, macropores and carbonate accumulations.

Accurate mapping and the interpretation of these soil morphological properties can thus be used to conceptualise and characterise hydrological processes, including water flow paths, storage mechanisms and the connectivity between different flow paths. Most of these hydrological mechanisms and processes are very difficult to observe (let alone measure!) in the field because they are dynamic in nature with strong temporal and spatial variation.

Nevertheless, soil morphological properties are not dynamic in nature and their spatial variation is not random – making soil properties the ideal vehicle for predicting and conceptualising hydrological processes. One of the major contributions of hydropedology is the ability to conceptualise hydrological processes spatially i.e. not only one dimensional mechanisms, but a more holistic understanding of the hydrological functioning of landscapes (catchments or hillslopes).

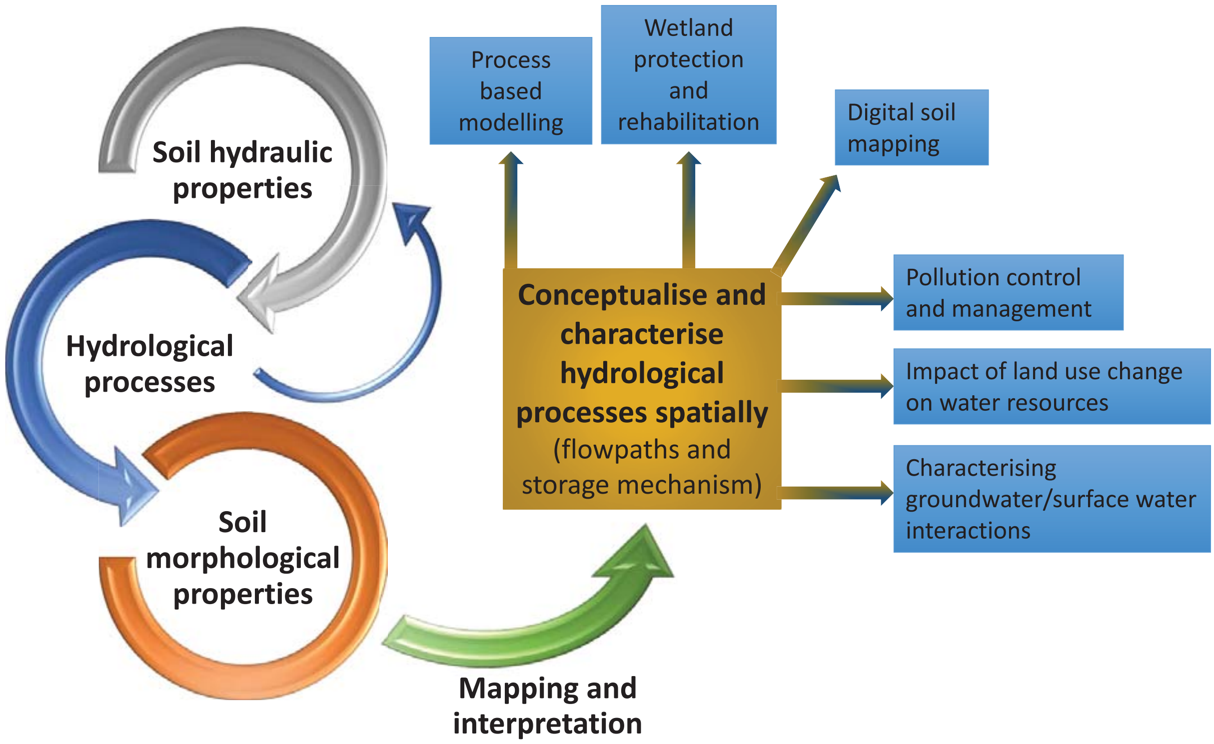

Figure 1: Hydropedology and some of the applications of hydropedological surveys.

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Hydropedological information is used in process based landscape water resource management. This includes, for example:

- configuration and parameterisation of distributed hydrological models;
- effective wetland delineation, protection and rehabilitation;
- understanding and controlling the fate of pollution in the subsurface;
- determining the impact of land use change (e.g. open pit mining) on water resources and
- characterising groundwater/surface-water interactions, including the important mechanism of low-flow generation.

In general, hydropedological information assists with effective water resource management, as required by the National Water Act through improved understanding and characterisation of hydrological processes.

Hydropedological behaviour of soil types

The hydropedological behaviour of different soils can differ significantly. For example in Figure 2a, the red colours of the top and subsoils of are typically associated with freely drained soils. Vertical flow into, through and out of the profile are the dominant hydrological pathway. These soils are termed ***recharge soils***, as they are likely to recharge groundwater, or lower lying positions in the regolith, via the bedrock.

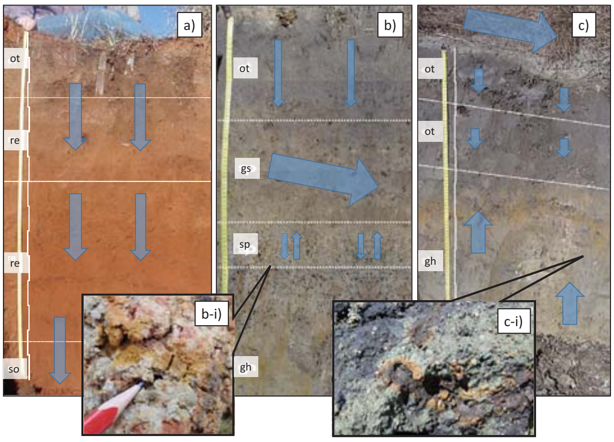

Figure 2: Different hydropedological soil types a) recharge soil, b) interflow soil and c) responsive soil.

In the second example (Figure 2b), lateral flow is likely to be dominant. These soils are termed ***interflow soils***. Lateral flow occurs due to differences in the conductivity of horizons. In Figure 2b the 'sp' is restricting downward movement and lateral flow occurs at the A/B horizon interface. The lighter colour of the 'gs' horizon is further support that lateral flow dominates. Lateral flow frequently occurs on soil/bedrock interfaces due to the permeability of the rock. Mottles (red, yellow and grey colours) in the 'sp' horizon (magnified in Figure 2b-i) is the result of a fluctuating water table.

In Figure 2c the grey colours of the 'gh' horizon and the dark colours of the topsoil horizon are indications that this profile is saturated for long periods of time. Because these soils are close to saturation, especially during peak rainy seasons, additional rainfall is unlikely to infiltrate the soils but will flow as overland flow (or surface runoff) downslope. These soils are termed ***responsive soils*** due to their rapid response to rain events. The same type of response can be expected on very shallow soils i.e. a small amount of rain can saturate the soil and additional rain will drain away as overland flow.

Hydropedology of hillslopes

For effective water resource management it is important to gain a holistic understanding of hydrological processes. Figure 3 presents a typical example of the hydropedological response of a hillslope. In the recharge zone, the dominant flow direction is vertical through the soil and into the fractured rock, from where it can recharge groundwater levels or downslope positions in the hillslope soils. Lateral flow at the A/B horizon interface or soil/bedrock interface dominate in the interflow zone. The responsive zone is fed by lateral flowing water from the interflow zone as well as via the bedrock from the recharge zone.

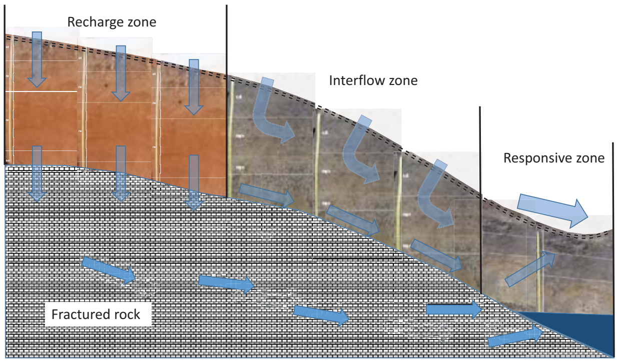

Figure 3: Typical example of hydrological flowpaths on different hydropedological soil types- hillslope hydropedological behaviour.

Although Figure 3 represents an oversimplification of a fraction of the complex hydrological cycle, the application of this information can make important contributions to effective management. Four scenarios are presented to support this statement.

1. Pollution: The fate of pollution will differ depending whether it was spilled on recharge, interflow or responsive soils. A spill on recharge soils is likely to end up in the groundwater or might arrive in the stream several months after the spill *via* flow through the fractured rock. Pollutants spilled on interflow zones will migrate downslope through the soil. Because this downslope migration will be in contact with the soil, and hence abundance of micro-organisms. It is possible that it may be transformed into non-toxic forms (depending on the pollutant). If a pollutant is spilled on the responsive zone it may travel quickly and unaltered to streams and other surface water bodies.

2. Conserving wetlands: Hydropedological information can aid in identifying the sources of water in order to preserve wetlands. If the recharge zone is the major source of water to the wetland i.e. the recharge zone is the hydrological

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driver of the wetland, care should be taken to restrict surface sealing (paving) of the recharge zone. If the wetland's water comes from an interflow zone, care should be taken to prevent obstruction of subsurface lateral flowpaths.

3. Hydrological modelling: Hydropedological information can assist in the correct configuration of distributed hydrological models. In many landscapes different landscape elements (or Hydrological Response Units – HRU's) are not connected in a simple cascading downslope way to one another. There might be areas which are disconnected from the stream or groundwater stores. In addition, deep infiltration from recharge soils at the crest of a hillslope, may re-appear as lateral flow water further down the slope. Hydropedological information can thus be used to ensure that the model configuration properly reflects the hydrological processes. This can be critical in simulating low flows, where vegetation may have access to near-surface water and thus limit contributions to streamflow.

4. Land-use change: Hydropedological information can support the understanding of the impact of land-use change on water resources. If, for example, the interflow zone is urbanised it may result in a build-up of water against foundations and the generation of return flow to the surface and overland flow which may cause erosion. Open pit mining close to responsive zones are likely to result in a draw-down of water levels and drying of wetlands. If such an open-pit intersects lateral flowpaths it will break the connectivity of flowpaths and cut the source of water to wetlands. Although the impact of land-use change cannot always be avoided, hydropedological information might aid in managing and protecting the hydrologic drivers of the ecosystem and thereby minimise negative impacts.

Hydropedological surveys

A hydropedological survey (in the context discussed above) is different from a conventional soil survey in the following aspects:

- Observation depth: the depth of observation in a conventional survey is 1.5 m, whereas the observation depth for the hydropedological survey is the depth to the soil bedrock interface.
- Classification: conventional soil surveys aim to classify soils in accordance with a specific classification system. In hydropedological surveys all morphological properties and all soil horizons are described, recorded and interpreted, with particular emphasis on the ambient and connected soil water environment. This include saprolitic (weathering rock) horizons and horizons which are not necessarily included in the hierarchy of the classification system.
- Observation density: Conventional soil surveys aim to capture the distribution of different soils in a particular landscape. Hydropedological surveys focus on the hydrological response of dominant hillslopes/transects.

Important to note is that hydropedological surveys cannot be used as a surrogate for mapping the agricultural potential (as required during most Environmental Impact Assessments) of an area. Conventional soil surveys (or other existing soil information) can also not always be used to infer the hydropedological response of an area, due to the differences between conventional and hydropedological surveys highlighted above.

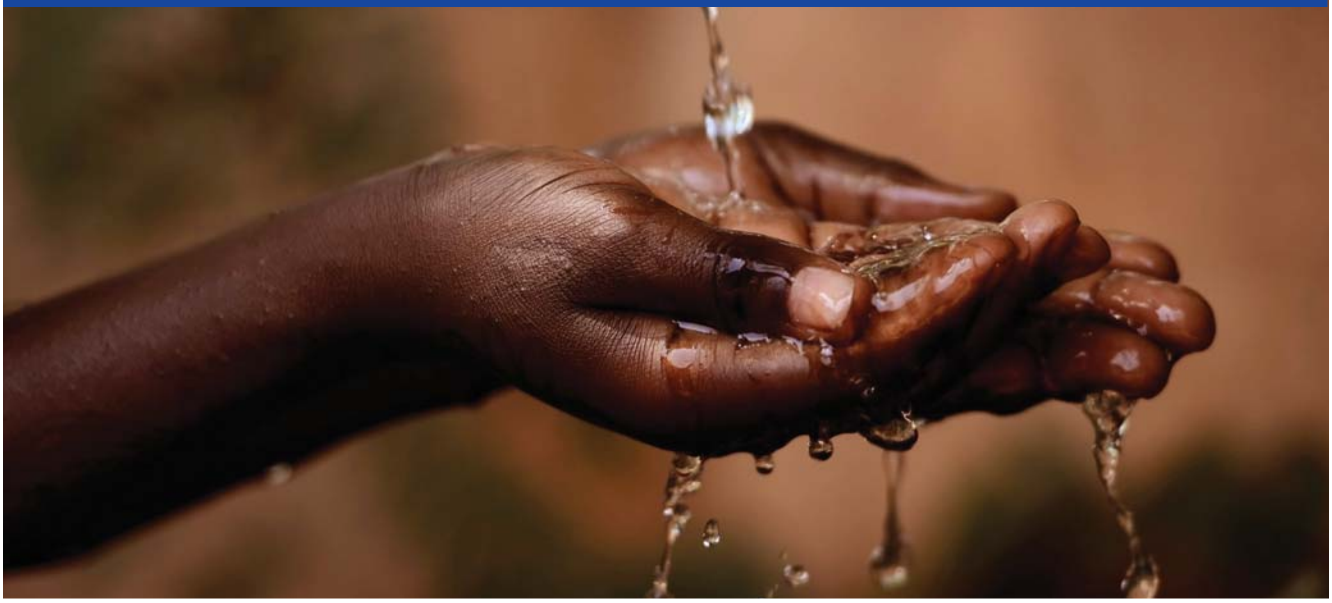
Hydropedological surveys do not replace detailed soil physical or hydrometric measurements but rather serves as a vehicle to identify representative sites for such measurements and to extrapolate these measurements to larger areas. Hydropedological surveys are also not a surrogate for hydrological modelling, but can contribute to the efficiency and accuracy of modelling exercises.

In conclusion, hydropedological surveys and the interpretation and application of hydropedological information can be a cost -and time effective approach to conceptualise and characterise hydrological behaviour of landscapes.

Water governance

Good practices for water use authorisation systems – Lessons from five countries

Across Africa, water permit systems are used as a tool to regulate and control water use. And yet, the implementation of these systems is not without challenges: they are resource intensive, and require regular updating, and compliance monitoring and enforcement. A study on and exchange of experiences by water authorities and researchers in Malawi, Kenya, South Africa, Uganda, Zimbabwe and elsewhere, identified both common challenges and different good practices in relation to the key functions of permit systems.



Across most of Africa, integrated water resources management (IWRM) has been introduced as the gold standard for managing water resources. A key tool in the IWRM toolbox is the use of permits or licences to authorise water use. These permit systems, however, derive, for the most part, from a long colonial history, and despite the changed intentions of post-colonial African governments, they have carried some of the negative colonial intentions with them into the present day.

A study in five countries (Malawi, Kenya, South Africa, Uganqada and Zimbabwe) shows that permit systems were introduced in these countries as far back as 1929 in Kenya, under the Water Ordinance, or 1927 under the Water Act in Zimbabwe.

National water legislation and water permit systems were introduced by the colonial governments to claim ownership of water resources, and to harness them in the interests of the white, colonial minority. Only Uganda escaped the imposition of a water permit system, with use of water being controlled under the land legislation instead.

Africans were excluded from the formal permitting systems, with a gradual but effective erosion of their rights to water over the colonial period, as colonial governments claimed more and more control over water resources to serve the colonial economy.

Since liberation, African governments have revived their water policy and legislation, with very different intentions from those of the colonial governments, focused, more recently, on sustainable and equitable development and poverty eradication. However, despite the laudable policy intentions, in practice, water permit systems risk continuing to serve as tools of dispossession and exclusion for large numbers of small-scale water users in rural areas who cannot all be reached individually by under-resources government agencies. The challenge is to

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reconfigure permit systems into appropriate and pro-poor water use authorisation systems.

Why water permit systems?

Permit systems, in general, have three main functions":

- Management: To regulate and control water use, to ensure sustainable water use and to reduce and resolve conflict over limited water resources.
- Information: To provide information to the regulator on the nature and amount of water use, as well as hydrological and geo-hydrological information; and
- Money: To support the generation of revenue from water users.

But have permit systems achieved the policy intentions behind them? Lessons from the five countries indicate that few of these policy intentions have been fully realised, and that, in practice, permit systems fail to reach small-scale users in rural areas, leaving them, de factor, outside the law. Equally, however, examination of permitting practices across the five countries reveals several good practices that could well be drawn on by other countries.

Alternative approaches

Across the five countries studied, there has been varied success in rolling out water permit systems, but nowhere has it been completely successful. In Kenya, by 2016, there were 4 194 water permits captured in the Permit Database (with many more surface water permits yet to be captured), up from 1 700 in 2013. In Malawi, by 2016, 2 042 licences had been issues, of which 1 881 were 'sleeping licences'.

On the other hand, in Uganda, 1 320 permits had been issued by 2016 and 10 799 in Zimbabwe. South Africa has the largest number of authorisations under the existing lawful use clause of the National Water Act (around 80 000) while just under 6 000 new licences have been issued under the Act.

In all of the countries, the number of water users with permits is considerably lower than the number who should be permitted, including (but by no means limited to) large numbers of small-scale rural water users. All five countries report challenges in issuing permits and in enforcing permit conditions, not least due to limited state capacity. Some interesting options in relation to management, information, and money present themselves as possible solutions to these challenges.

Taking a different approach

In Kenya, they have adopted an approach in which permit applications are categorised as A, B, C, or D, depending on the level of impact on the water resource. Different requirements and intensity of investigation are applied to permit applications, depending on the category. In Uganda, they have adopted a targeted approach focused on the large users that have the most significant impact on water resources – the so-called 80/20 principle.

In South Africa, general authorisations are used to enable small water users to legally use water without applying for a licence. In all of the countries, very small uses are exempted from the need for a permit. All of these approaches result in more streamlined systems, less administrative demands on the state, and less cost and time demands on smaller water users. They do not, however, sufficiently deal with the issue of small-scale water users in the rural areas. This is where the issue of customary law requires further examination.

A targeted approach will also make compliance monitoring and enforcement easier, focusing resources on the high impact users and those with a poor track record of compliance.

Role of customary law in protecting small-scale water uses for livelihoods

Except for Malawi, the water law of the five countries does not recognise customary water law as part of the legal system, and yet, in all give countries, customary law is still active in large parts of the rural areas. This raises whether the recognition of customary law would not be a useful addition to the tools for water use authorisation, on condition that water allocated under customary law has the same or higher legal protection as permitted water. Moreover, a Reserve could, in principle, be defined as including human rights for basic domestic and basic productive uses. This links to the idea of group management and protection of water resources and forms of organisation that can also play a useful role in the compliance monitoring and enforcement of permit conditions.

Information

Despite the intention that permit systems require users to provide hydrological, geo-hydrological and water use information to the state in order to support more effective management and development of water resources, in reality, they are a relatively weak tool in this regard in the five countries. This is due to several factors. Firstly, only a portion of water users have permits, so that any information received through this mechanism is also only partial, at best.

Secondly, as evidenced by the registration of water use in South Africa, information provided by water users, particularly information on water use, may be inaccurate and need verification. This begs the question as to how mechanisms such as remote sensing and aerial photography can be used to verify and complement the information provided by permitted users and through required hydrological and geo-hydrological assessments.

"Despite the laudable policy intentions, in practice, water permit systems risk continuing to serve as tools of dispossession and exclusion for large numbers of small-scale water users in rural areas who cannot all be reached individually by under-resources government agencies."

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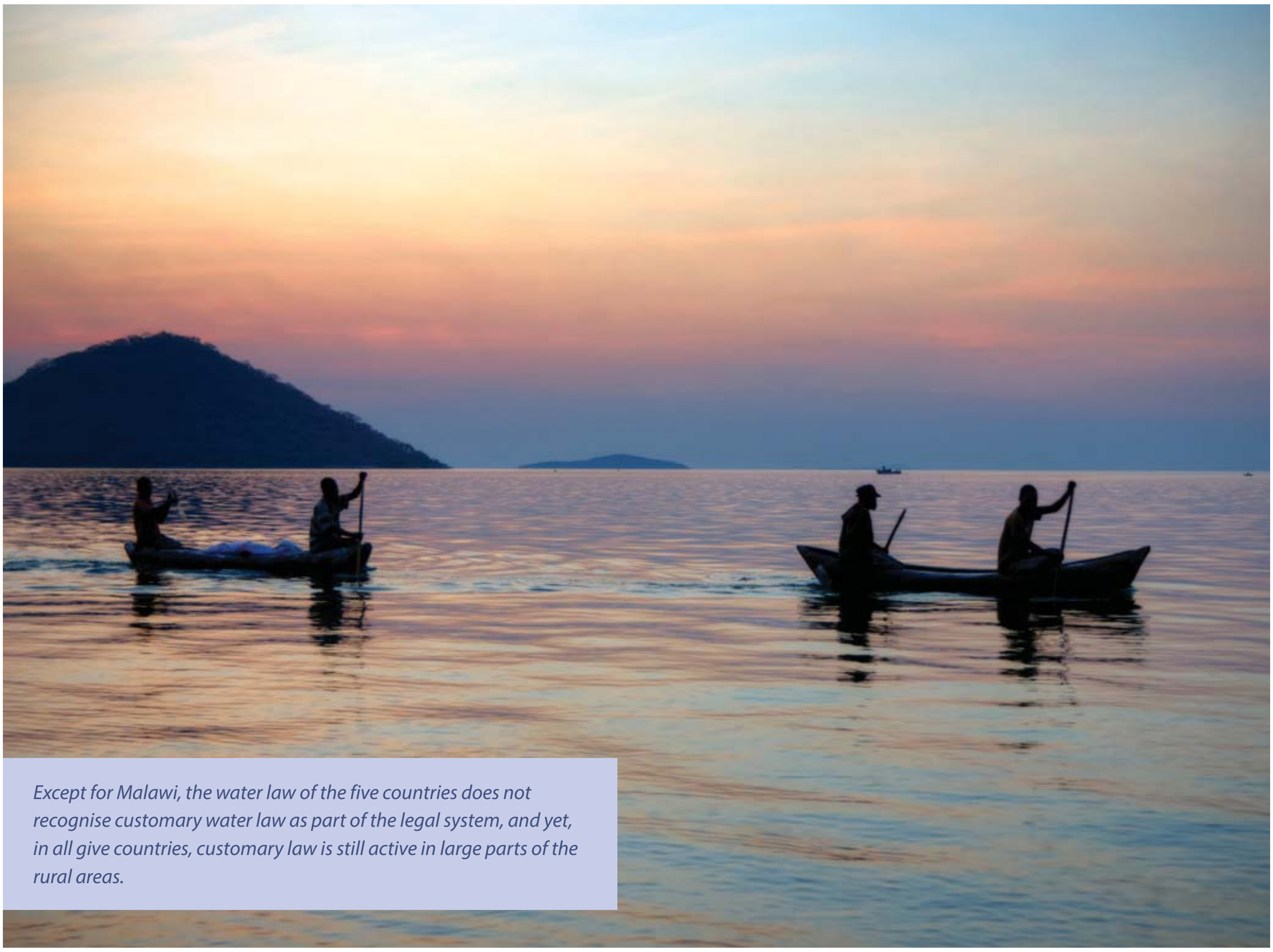

Except for Malawi, the water law of the five countries does not recognise customary water law as part of the legal system, and yet, in all give countries, customary law is still active in large parts of the rural areas.

Money

On the financial side, there are two key questions that need to be addressed around using permit systems to generate funds for water resources management. The first of these relates to the cost-effectiveness of billing systems. The act of billing a water user, receiving and banking the money, and taking action against defaulters, costs the state money. However, no one has done the calculations of what the minimum volume of water is to bill cost-effectively. From high level estimates, it would appear that in the case of small users, the state may well be paying more than they are collecting

In addition, the question of what water resources management (WRM) functions should be paid for by users, and by which users, needs further examination, particularly in the context of encouraging small-scale water use as a way out of poverty for millions of people across the five countries. For example, the exemption of small-scale users from paying water charges is an option that needs further exploration.

The other side of the coin is to ask what WRM functions should be paid for out of taxes, rather than water use charges, particularly in relation to using water for poverty eradication.

Despite the challenges faced by the five countries in implementing permit systems as part of a broader suite of WRM tools, there are also useful adaptations and good practices emerging. In most countries in Africa, water permit systems are still in the early stages of implementation, and the time is ripe for the sharing of knowledge and experience.

Without this, the risk of failure in the implementation of permit systems is real. This risk underscores the need for further robust study, and the documentation and sharing of best practices among officials, practitioners and researchers to reconfigure permit systems into realistic, fit-for-purpose regulatory tools that improve the water security of all, in particular, the most vulnerable, in Kenya, Malawi, South Africa, Uganda, Zimbabwe and elsewhere in Africa.

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Emerging contaminants

The drugs we wash away: What happens to antiretrovirals in the aquatic environment?

With increasing frequency countries are faced with a new set of chemicals that are contaminating the environment. These so-called 'emerging contaminants' hold potential risk to humans and/or the environment. The challenge is that, generally, little is known about the occurrence of these pollutants, the actual risks and the approach to formulate appropriate policy and legislation. The CSIR is increasing awareness and knowledge in this area through its study of antiretrovirals as an emerging contaminant. Article by Chavon Walters.

Increasing amounts of personal care products have been detected in the aquatic environment in recent years. Antiretrovirals (ARVs), used to treat human immunodeficiency virus (HIV), are regarded as emerging contaminants that have received increased attention due to their potential negative effects on the environment.

South Africa has more people living with HIV and AIDS than any other country, and therefore utilises more ARV compounds per capita. Approximately 2 150 880 people received ARVs in South Africa in 2012 versus the approximate 199 000 people on ARVs in Eastern Europe. As such, it is theorised that these compounds will be present in the environment to a much greater extent.

The environmental release of ARVs is of considerable concern due to potential ecosystem alterations and the development of viral resistances. Despite the high prevalence of HIV in South Africa and consequent high consumption of ARV drugs, few studies have to date reported on the presence of ARVs in the aquatic environment in South Africa. Traditional wastewater treatment technologies remain ineffective to treat complex and complicated chemicals.

The presence of pharmaceutical and personal care products have recently attracted the interest of researchers due to concerns regarding the occurrence of a wide variety of pharmaceuticals in the environment as a result of inadequate wastewater treatment. These compounds are, if not completely metabolised, excreted via faeces or urine. As such, they can enter the environment via discharges from wastewater treatment plants.

Pharmaceuticals such as ARV compounds (including zalcitabine, tenofovir, abacavir, efavirenz, lamivudine, didanosine, stavudine, zidovudine, nevirapine, indinavir, ritonavir and lopinavir) have been detected in treated and raw wastewater and rivers, and are therefore not effectively removed in wastewater treatment plants.

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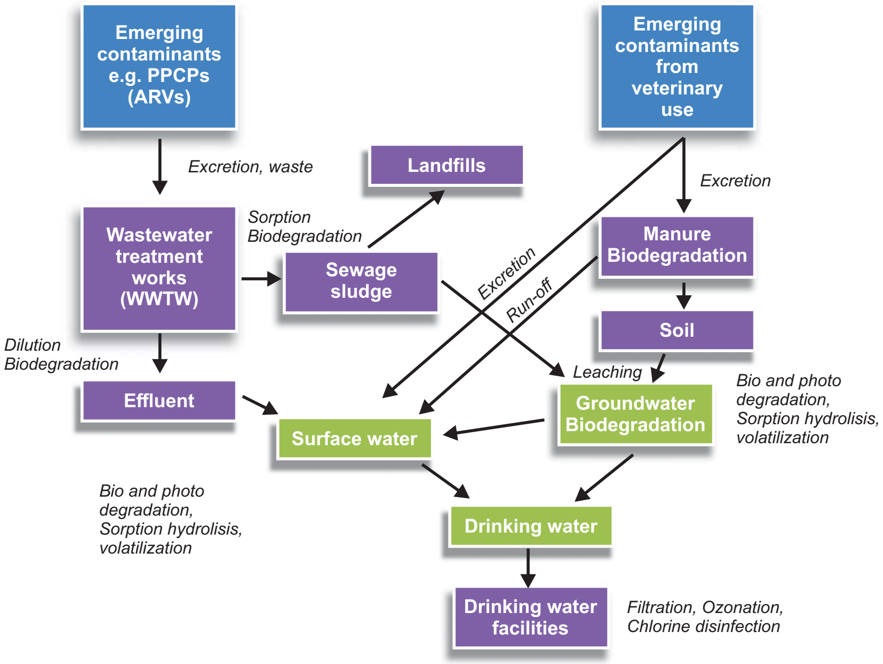

Figure 1. Pathways of emerging contaminants in the environment.

Past studies

Limited research has been carried out in South Africa to determine the presence of pharmaceutical and personal care products and their degradation products, and the few studies undertaken have focused only on a select group of these products. ARVs are an emerging class of pharmaceuticals and their studies are also limited.

In the first reported countrywide survey of South Africa's surface water for the quantification of ARVs, a 2015 study detected quantifiable concentrations of zalcitabine, tenofovir, lamivudine, didanosine, stavudine, zidovudine, nevirapine, and lopinavir in Pretoria, and zalcitabine, tenofovir, didanosine and zidovudine, in Bloemfontein.

Concentrations for ARVs were below the instrument level of detection in the Cape Town and Durban metropole regions. In a later study, published in 2015, the presence of nevirapine and efavirenz were detected in wastewater influent and effluent in Gauteng. In another 2015 survey, the presence of most ARVs were detected except efavirenz and saquinavir.

Nevirapine, zidovudine and tenofovir were quantified in the effluents of two wastewater treatment plants; stavudine, nevirapine, Ttenofovir, nelfinavir and saquinavir were detected in seven of 18 groundwater samples; while nevirapine and didanosine were detected in five and three drinking water samples, respectively. Transformation products formed during wastewater treatment processes, which are released into the environment, further confounds the effects of pharmaceutical and personal care products in the aquatic environment. Wood et al. (2016) reported on the resistance of nevirapine to degradation, which potentially substantiates its ubiquitous presence in South African surface waters.

Collectively, these studies have reported on the occurrence of various ARVs in various environmental matrices in South Africa. More sensitive and reliable analytical methods are required to detect previously undetectable compounds.

Current initiatives

As depicted, no data is currently available which reports on the occurrence and levels of ARVs in the Western Cape. An integrative team of researchers at the CSIR with expertise in freshwater, riparian, ecological river health, water chemistry and sediment, aquatic ecotoxicology, and water resource management are currently undetaking a study, with the aim to determine the environmental occurrence of the emerging contaminants (i.e. selected ARVs), and to characterise the sources, pathways and fate of these contaminants in the environment.

However, a greater number of ARVs could be detected if detection limits of analytical methods were significantly improved. As such, one of the major outcomes of this project is will be to develop the analytical capabilities to detect the presence of selected ARVs in surface water, wastewater (influent and effluent) and sediment/sludge.

The lack of information on the effects and concentrations of pharmaceuticals such as ARVs makes it difficult to be regulated and to manage the levels already existing in the environment. The usage and discharge of ARVs, and the discharge of insufficiently treated wastewater effluent, should be considered as important factors that influence the contamination levels of ARVs in different geographical areas. As such, the environmental and human health significance of chronic exposure to these chemicals remains unclear. Special attention should be given to the transformation products.

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Stormwater

Stormwater harvesting could help South Africa manage its water shortages

Despite its potential as an alternative water supply, stormwater remains grossly underutilised in South Africa, writes Kirsty Carden and Lloyd Fisher-Jeffes from the University of Cape Town.

In 2016, South Africa experienced one of the worst droughts in decades. Many towns and cities across the country were left with compromised water-supply systems and limited food production. This placed pressure on an already fragile economy.

South Africa must find ways to adapt to and mitigate water insecurity threats. These can be from droughts, climate change, but also from increases in water demand through urbanisation, population growth and rising standards of living. Towns and cities need to start operating within the limits of their existing water resources.

To avert a future water crisis, the country needs to seek alternative sources of water supply and reduce its reliance on conventional surface water schemes such as dams and reservoirs.

Stormwater harvesting is the collection and storage of rainfall runoff in open ponds or aquifers. It has been identified as one alternative water resource that could supplement traditional urban water supplies. Stormwater harvesting is different to rainwater harvesting. Rainwater harvesting is the collection and storage of runoff water from an individual property with private use – usually from the roofs of buildings.

Stormwater harvesting can improve water security and increase resilience to climate change in urban areas. It can also prevent frequent flooding and provide additional benefits to society – such as creating amenities and preserving biodiversity.

There is a significant variation in rainfall across South Africa, and most parts of the country are well placed to harvest stormwater. For example, Cape Town obtains roughly 400 million m^3 of water annually from its supply reservoirs. But more than three times this amount falls onto the city every year as rain that becomes stormwater.

Stormwater potential

A recent study of the Liesbeek River Catchment in Cape Town found that stormwater harvesting had the potential to reduce

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the total current residential potable water demand of the catchment by more than 20% if the stored stormwater was used for purposes such as irrigation and toilet flushing. For such a reduction to take place, the vast majority of residents would be required to make use of harvested stormwater. This would likely necessitate changes to the regulations related to the supply of water in the city.

There has only been one large-scale example of successful, long-term stormwater harvesting in South Africa. This is in the town of Atlantis on the country's west coast. This low rate of adoption of stormwater harvesting is likely due to a range of socio-institutional challenges. These include resistance to innovative approaches, fragmented and underfunded water management institutions, a lack of political will, and a shortage of capacity required to operate and maintain the harvesting process. There are, however, signs of increasing interest of utilising stormwater as a resource in the country with a number of smaller-scale schemes being undertaken.

There are several international examples of large-scale stormwater harvesting. One of the most comprehensive is in Singapore where it has been shown to be a useful high-quality water resource. Other initiatives in the US and Australia highlight that harvested stormwater is used for a range of purposes, including irrigation, toilet flushing, commercial and industrial uses.

How they work

Stormwater harvesting schemes all make use of some form of storage system. Some make use of retention ponds with permanent water storage. Others make use of detention ponds; these are normally dry except following large storm events when they temporarily store stormwater to reduce downstream flooding.

Detention or retention ponds are used to store runoff volumes. This results in the reduction of downstream flows, and decreased flooding. Stormwater can infiltrate into the ground from these ponds, or it can be intentionally injected into boreholes so that it can be captured and stored in aquifers. This is a process known as managed aquifer storage.

There are further opportunities for stormwater managers to actively manage the systems using real-time control. This can be done in a way that, prior to a predicted storm event, the storage is partially emptied, resulting in an increase in the flow rates in the river ahead of the storm, but a decrease in the peak flow during the storm, which could prevent flooding. In this way, additional storage capacity is created for stormwater harvesting purposes.

Few and far between

Stormwater and higher-quality treated municipal effluent in Atlantis are used to recharge the aquifer beneath the town for later extraction through boreholes. The scheme has successfully ensured a consistent supply of water for the town over the last 37 years. Approximately 30% of the town's groundwater supply comes from the artificial recharge scheme.

But research shows that it should also be seriously considered as an alternative water source in other areas. In Cape Town most of the harvestable stormwater is only available during the wet winter months when the reservoirs are typically filling in any case. If it were properly captured it could be used as a way to reduce normal demand during this time.

This can be done by increasing the rate and level to which these reservoirs fill up to ensure an increase in the availability of water during the dry summer months.

Additional benefits

Stormwater harvesting can have spin-off benefits too in terms of protecting natural assets such as parks, wetlands and ponds. This, in turn, has benefits for biodiversity as corridors to support indigenous vegetation within an urban area are created. There is also potential for these systems to provide water treatment functions through naturally filtering and biologically treating polluted urban stormwater.

For example, the positive amenity created by stormwater harvesting in the Liesbeeck catchment was estimated at between R2 million and R7 million a year in 2013. This was calculated by the public's willingness to pay for a change in the quality or quantity of an environmental good or service like recreational use, added property value, water treatment, or flood alleviation.

Stormwater harvesting offers an alternative water-supply source. It is almost entirely untapped in South Africa and could ensure improved water security for towns and cities across the country. Stormwater could be treated to potable standards like in Singapore. But it may not be economically feasible, and it may be preferable to use the stored water for non-potable purposes such as irrigation and toilet flushing.

Stormwater harvesting appears to be financially and technically viable in South Africa, but it would depend on whether all sectors of society would be willing to use harvested stormwater, and for the required municipal policy and regulatory processes to be put in place.

Catchment management

Market mechanisms to nudge better management of the world's watersheds

Management of the world's critically important watersheds is usually undertaken through state regulation, or through publicly funded initiatives. Much of the analysis of the effectiveness of watershed management is therefore done through a similar lens. But what about market mechanisms as a way to incentivise good watershed conservation, and repairing of damaged ones? Article by Leonie Joubert.

This was the question posed to resource economist, Prof Edwin Muchapondwa, based at the University of Cape Town's Environmental Policy Research Unit (EPRU), when he was commissioned by the United Nations Environment Programme (UNEP) to lead a global review of the subject. The take-home message of the report: market-based incentives are a good complement to existing approaches to drive watershed management, but will not replace regulation or public funding, and are not a 'panacea'.

"In our review of case studies from around the world, we found that market-based incentives are not a replacement for regulation," explains Prof Muchapondwa. "But we did find that regulation needs to apply to market incentives in order to make them complement the regulatory approach."

They can be an important way to make environmental management more efficient, and can also be a means to raise revenue to assist the state with various levels of implementation, which is critical for either regulatory or market incentives to work in the case of watershed management.

Healthy watersheds are recognised as being critical to the function and wellbeing of communities, societies, and industry. And yet, according to the UNEP report, water that is needed for human consumption, wildlife, industry and recreation are all impacted by activities that occur within the watershed.

Market-based activities – mining, agriculture and agro-forestry, and infrastructure development, for instance – are often drivers of the kind of environmental extraction that erodes these watersheds, the authors note. This is particularly true when the environmental costs are externalised from the pricing of those activities. In spite of this, there is not enough public funding set aside globally to ensure adequate investment in watershed management.

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The consequences of degraded watersheds can undermine development agendas, on the other hand.

"(T)he share of water resources protection in the annual average government budget on national water investments during the period 2003 (to) 2011 for 13 pilot countries under the United Nations water country briefs initiative was just 4.5%," states the report, titled *Use of Market-based Incentives in Watershed Management: Driving the Green Economy through involving Communities & the Private Sector*.

Prof Muchapondwa was commissioned to lead the review process owing to his experience in the use of economic incentives, particularly in the arena of natural resources such as wildlife in southern Africa.

The report uses a series of case studies gathered from around the world, in order to draw lessons on the use of market mechanisms in watershed conservation.

"The kind of market mechanisms we looked at include using pricing, market transactions, or other mechanisms typically associated with markets, in the context of managing watersheds," explains Prof Muchapondwa. "We know already that market-based incentives can be used to signal the necessary types of land-use and watershed management practices. These incentives can be positive or negative; they can either provide rewards for 'desired practice', or impose costs for 'undesirable practice'."

The response to incentives can either be through the private sector responding to policy-altered market conditions, or through local and central governments introducing market-based policy instruments, which can be aligned to a state's long-term sustainability goals.

The study reviewed four South African case studies: Anglo American's efforts in eMalahleni, about 140km east of Johannesburg, where acid water from old mines is cleaned up to standards safe for human consumption; South African Breweries' contribution in tackling the availability of water to hop farms located in the Gouritz watershed near Mossed Bay; Sasol's support for sustainable watershed management in Emfuleni in Gauteng; and better water management by irrigation farmers in the Orange-Riet river canal.

"Alone, these case studies don't necessarily tell us much, which is why we don't go into the specifics of the cases in the report," notes Prof Muchapondwa, "but together with the other global cases, they tell a clear message."

Complementing regulation, not replacing it

The report finds that market-based incentives can work effectively to complement traditional government responses to governing watershed management, such as environmental regulations in the form of zoning, permits and quotas, bans, and setting standards. Used together, they can achieve greater conservation and environmental protection for these important parts of a country's water resource management.

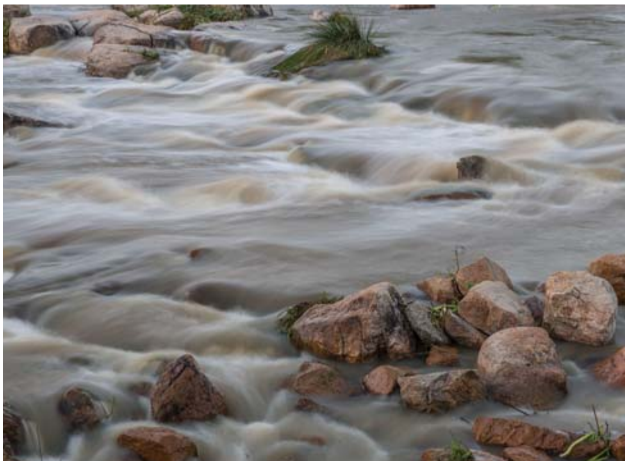
In analysing cases from around the world, Prof Muchapondwa and his team found that the most effective use of market incentives were in situations where cases had well defined problems, well-defined rights and responsibilities associated with property arrangements, where there was single and controlled environmental degradation, or where the links between cause and effect were well-established. They can also work well when stakeholders have a shared sense of the value of ecosystem services.

Two key hurdles to the effectiveness of market incentives emerge in the review. In many cases, the benefits of good watershed management – such as flood control and water quality – are enjoyed as a common good by sectors of society that won't need to pay for the benefits. This could undermine the willingness of those who are required to pay for the measures.

A second problem is a situation where an externality, such as a pollution source, is not easily priced by the market without government regulation. "Landholders upstream can affect water quantity and water quality downstream through their decisions on land management practices," states the report, "but they have little incentive to consider those impacts because they are not directly affected."

In light of this, Prof Muchapondwa and his co-authors found that market mechanisms must be designed to compel free-riders to pay for these sorts of environmental damages, which could be funded by the state through a system of taxation.

To access the full report, Visit http://bit.ly/2pZucxr



Healthy watersheds are recognised as being critical to the function and wellbeing of communities, societies, and industry.

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Water KIDZ

Grey water is great water!

We all know that South Africa is a water scarce country and that we should be saving water in any way we can. But did you know that there is a wonderful source of water right under our noses?

Water from the shower or bath makes for excellent greywater.

No matter how conscientious we are – everyone has to use water, and not just for drinking purposes! We also need water for washing, cooking, and doing the laundry. The upside is that much of this water can be reused. It is estimated that as much as 60% of the wastewater produced by an average household can be reused as greywater.

The water left over in a basin, and from showering, bathing, and laundry is known as greywater. (Greywater does not include water that has come into contact with poo, such as toilet water and from washing diapers – this is known as blackwater, and is not safe for reuse). The problem is that our modern sewerage systems do not distinguish between black water (which needs to be treated) and greywater, which can be reused.

While greywater or slightly used water might seems dirty – it might contain traces of food, dirt, grease or cleaning products – it can still be used for various things. Aside from the obvious benefits of saving water (and money on your family's water bill), reusing your greywater keeps it out of the sewer system (thereby reducing the chance that it will pollute receiving rivers and streams). As South Africa has so little water to go around, we have to all do our part to reign in our water use and reuse water any way we can to ensure that there remains enough for everyone – including the environment.

Greywater can be reused in three main ways:

- By collecting small quantities of greywater in a bucket from the bath or shower and reusing it to irrigate lawns and gardens.
- By asking a plumber to install a system that redirects greywater from the shower, bath and laundry for use in the garden or lawn
- Or installing a system to treat greywater. This treated water can be used above ground for lawns and gardens, to flush toilets and in washing machines. This kind of system needs to be installed by a plumber and requires approval from the local municipality.

You don't have to be an engineer or a plumber to reuse greywater. The easiest way to reuse greywater is to reuse it on the garden. Greywater can help most plants thrive. The water from the bath, shower or laundry will probably contains soaps and detergents. These contain salts, and nutrients (phosphorous and nitrogen), which help plants grow. Reusing greywater directly in the garden means we are adding these nutrients to the soil.

Collecting greywater doesn't require a specialised system. For example, you could easily use your old pet water to give your plants a drink before refreshing the animal's water bowl. The

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same goes for the old water in your fish tank. Fishbowl water also has the added benefit of nutrients from fish waste. By placing a container in the shower you can collect water while you wash! If you have to wait for your bath or shower water to heat up before you use it, you can catch this water and use it to flush the toilet.

In the same way used water can easily be collected from washing machines as they have a drain pipe exiting the back of the washer. Water can be easily be removed from the drain to the sewer and placed into collection buckets.

There are some common sense rules when using greywater. If someone in your house has an infectious disease, it's best not to reuse the greywater until that person gets healthy again (you don't want to be spreading viruses and bacteria around). Never mix greywater with food or drinking water, and don't store greywater for long periods of time (it will start to smell).

Greywater is best used on laws and ornamental plants, but can also be used for vegetable gardens (just as long as it doesn't touch the edible part of the plant.

Greywater will not solve our water crisis. But it can certainly help to ensure each drops reaches just a little further.

The nutrients from greywater can help plants grow.

Sources
www.survivopedia.com/reusing-grey-water/
www.mygreenlife.com.au
www.howstuffworks.com

Greywater Dos and Don'ts

- Don't drink or play with greywater (don't let pets drink it either)
- Do wash your hands after watering with greywater
- Don't use greywater on vegetable gardens if the crop is to be eaten raw or uncooked
- Don't use greywater that has faecal contamination (i.e. from washing nappies etc.)
- Don't store greywater for longer than 24 hours

When freshening up your dog's bowl use the old water on nearby plants.

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Successful irrigation knowledge sharing event held

The Water Research Commission hosted another successful workshop of the Network on Irrigation Research Extension for Small-scale Agriculture (NIRESA) on 2 March 2017. The workshop, which included various stakeholders, was held at the University of Pretoria. The theme for this year's workshop was 'The role of water footprints in the agricultural sector' and included two presentations of WRC reports. The first project is one the water footprinting of selected vegetable and fruit crops produced in South Africa, while the second project is investigating the water footprints of selected field and forage crops. Participants were generally impressed to see how the water footprinting theme is being championed by the WRC and its strategic partners. The workshop also included a site visit to two experimental sites of the University of Pretoria. Established in 1996, NIRESA is aimed at facilitating the exchange of ideas and practices between researchers and advisory agents in different agricultural disciplines.

Workshop participants visited experimental sites at the University of Pretoria.

Participants in the NIRESA workshop.

THE WATER WHEEL

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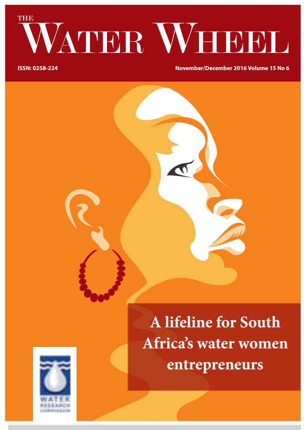

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WATER RESEARCH COMMISSION

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