

THE
WATER WHEEL

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**Are we taking
care of our
estuaries?**



**WATER
RESEARCH
COMMISSION**

17th WaterNet/WARFSA/GWP-SA Symposium on Integrated Water Resources Management: Water Security, Sustainability and Development in Eastern and Southern Africa

Jointly convened with the International
Association of Hydrological Sciences (IAHS)
and the University of Botswana

Gaborone International
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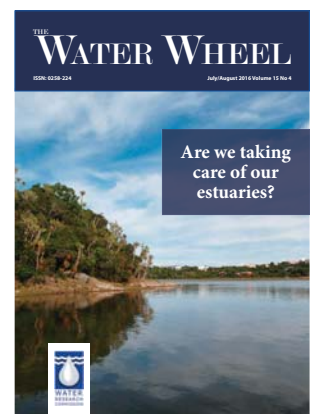
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South Africa's estuaries are well protected under South African water law, but how well protected are they in practice? See story on page 12



WRC CEO, Dhesigen Naidoo



Fluid Thoughts

The 2016 youth project

June 16, 1976 was a landmark day in South Africa's history. Like the Sharpeville massacre in 1960 stimulated a new global dialogue and mobilised the international community against the Apartheid state, 1976 was a point of inflection in the struggle inside the country. It revealed to South Africans and the world not only the acute inhumanity of the Apartheid project, but the youth provided a new dimension of the war against what is arguably the cruelest social engineering project in modern history.

Looking back, the narrative is an interesting one. The 1976 project had a short-term project objective for the learners, first in Soweto, and then rapidly catching fire in the townships around the country. That was to eradicate the terrible 'Bantu education' system, a grossly unjust and disempowering education system for Blacks, the legacy of which we still have to deal with up to today. On the back of that short-term objective, we have seen in the late 1970s into the 1980s, a rapid acceleration and intensity of the fight against Apartheid as the medium-term outcome. Even the desperate measures adopted by the state apparatus that included the 'total onslaught' campaign could not stem that tide. The long-term impact was the achievement of a political democracy in South Africa.

Forty years on we are in the midst of a new student-led revolution. The short-term objective – reform and the transformation of South Africa's higher education system. It is high energy, the narrative does not seem completely converged and it is uncomfortable for many. However, this rise of the youth in the 40 anniversary year of 1976 has the real possibility of catalyzing the next stage of our democratic journey, that is, the achievement of the socio-economic revolution. A socio-economic revolution that does not yet have a defined vector. If supported correctly we can help the youth to tailor the socio-economic model for growth based on the fundamentals of a knowledge economy. We have the real opportunity to work toward the longer term impact of an inclusive, diversified, resilient and successful economy. It hinges on what we do today.

"The character of our partnership with today's youth will to a very large extent determine the quality and impact of that leadership, and in turn the kind of country the next generations will inherit."



Bongi Maposa presenting the Amadrum developed by the CSIR

Focusing on South African youth's role in water

In celebration of the 40th anniversary of the Soweto uprising and the role that young people have played in shaping the history of South Africa, the Water Research Commission (WRC) held a series of special events during youth month.

The first was a special dialogue on youth and water entrepreneurship, focusing on stimulating innovation among the nation's youth to contribute to a resilient, enterprising and capable water and sanitation sector. The dialogue aimed to inspire youth entrepreneurship in the water and sanitation sectors, and several roleplayers discussed ways for the youth to participate in the water economy. The dialogue also showcased a number of new innovations in the South African water sector, allowing innovators to pitch their ideas in a 'Dragon's Den' kind of scenario to potential investors.

The second event was a youth empowerment workshop titled 'Going with the franchising flow' – Creating jobs while improving water and sanitation conditions in schools through innovative operation and maintenance. Held in Ivory Park, Gauteng, this workshop focused on sharing experiences of franchisees undertaking school sanitation maintenance in the Eastern Cape. This initiative, based on years of research on water and sanitation franchising opportunities by the WRC in collaboration with the CSIR and partner such as Ambanz'abantu and Impilo Yabantu, has seen the successful rollout of franchises to clean up the sanitation facilities of 500 schools in the Butterworth region.



*Manjusha Sunil, Manager
for the Water Programme*

The WRC, in recognition of this possibility, and as part of its contribution to the national transformation project is expanding its youth-directed activities and programmes. These range from school level interventions with Waterkidz, the SASS and citizen science initiatives to increased support for university students in WRC projects run out of our Research and Development branch. We have added the further dimension of increased support for innovation and business development in our Innovation and Impact branch under the banner of Youth and Water Entrepreneurship. This is building on already successful efforts of individual support that has resulted in some amazing new solutions and some very encouraging start-ups.

The youth are indeed the leaders of tomorrow. The character of our partnership with today's youth will to a very large extent determine the quality and impact of that leadership, and in turn the kind of country the next generations will inherit. We have had the benefit as the current generation of leadership of being able to stand on the shoulders of the giants that came before us. It is time to start making our shoulders available to tomorrow's leadership – our youth.



Letters and Opinion

Cape Flats school delighted with WRC career materials

The Water Research Commission received the following letter from David Kapp at Belthorn Primary School on the Cape Flats after they were sent some educational material (career guides, comic books, water cycle posters) from the Publications department:

And here I do the Oliver Twist, asking for one or more of your Career Guide! On Monday a Grade 7 youngster calls on me in the school's library, to say that there is a "delivery" for me. I am over-whelmed at all the "stuff": Career Guides, Water Cycle posters and pollution educational magazines!

Some youngsters and I carried the boxes to the school's library. I carry the Career Guides to next door where the Grade 7 class is. Their teacher / educator, Mr Joemat, is overwhelmed too. I ponder

on each of our 30 or so Grade 7s getting a Career Guide – we are thinking, too, of the learners "behind" them, next year and the year thereafter. Mr Joemat suggests we have a career session together in the library one day, when his class can peruse the guides (I've just thought that that could happen with the Grade 6s and Grade 5s too!). So, that (hopefully) is what is going to happen.

We have in the meantime passed on a set of the resources to each educator. Greg Hodges (he once of the Naturalist Society!) took a photo or two of our future Social Worker, Lathi-Tha Solomon (on the right). Again, I struggled to prise the Career Guide away from her, so I said she should hang on to it! Her teacher quite excitedly read out to the class the piece on "Social Worker" in the Career Guide. He waxed lyrical too!



Again, thank you very much.

*David Kapp, Belthorn Primary School,
Cape Flats*



Water Diary

Geology August 27 to September 4

South Africa is hosting the 35th International Geological Congress in Cape Town. The event is aimed at, among others, contributing to the advancement of fundamental and applied research in the geological sciences and to provide a space where ideas and information can be exchanged across the geoscience disciplines. Visit: www.35igc.org

World water October 9-13, 2016

The IWA World Water Congress will take place in Brisbane, Australia with the theme 'Shaping our water future'. Visit: <http://www.iwa-network.org/event/world-water-congress-exhibition-2016/>

Municipal engineering October 26-28

The annual conference of the Institute of Municipal Engineering of Southern Africa (IMESA) will be held at the East London Convention Centre. The theme is 'Siyaphambili – Engineering for the future'. Enquiries: Debbie Anderson, Tel: (031) 266-3263; Email: conference@imesa.org.za; www.imesa.org.za



Global

SA professor wins international hydrology award



Director for the Institute of Water Research at Rhodes University, Prof Denis Hughes, has become only the second South African to be awarded the 2016 Volker Medal of the International Hydrology Prize, awarded by the International Association of Hydrological Sciences (IAHS).

According to IAHS President, Hubert Savenije, Prof Hughes has made

outstanding contributions to promoting the science and practice of hydrology in the sub-Saharan region, as well as having an excellent international reputation through his contributions to the fields of hydrological modelling, environmental flow requirements and uncertainty quantification in the assessment of water resources available.

Specifically remarkable are his following outstanding contributions, among others:

- A long-term contribution to improved application of hydrological models in the diverse climate conditions of sub-Saharan Africa
- The development of uncertainty approaches to hydrological modelling and the promotion of the concepts of uncertainty in both scientific hydrology and water resources practice.

- The development of a range of methods to support the determination of environmental flow requirements, some of which have been applied in many different parts of the world.
- The promotion of improved cooperation between hydrology research institutions within the southern Africa region and encouraging its young scientists to contribute to the international research community.
- The supervision, training and mentoring of a large number of young African scientists, leading to an increase in the number of PhD graduates in the region.

Prof Hughes obtained his PhD degree from the University College of Wales in 1978. He moved to the Hydrological

Research Unit (HRU) at Rhodes University in South Africa in 1980 and has remained at Rhodes ever since. He was instrumental in forming the Institute for Water Research (IWR) in 1991, a multi-disciplinary research institute focusing on hydrology, freshwater ecology and environmental water quality.

Prof Hughes was an active member of the UNESCO Southern Africa FRIEND project and was a local organiser of the 2002 International FRIEND conference held in Cape Town. He was part of the review committee for the sixth edition of the WMO Guide to Hydrological Practices that was published in 2008 and he also contributed to the third UN World Water Development Report of 2009.

Prof Hughes has always placed a strong emphasis on the development of post-graduate students. His research programme graduated 15 PhD's and 12 MSc's from different parts of sub-Saharan Africa, including the Democratic Republic of the Congo, Lesotho, Mozambique, South Africa, Swaziland, Tanzania and Zimbabwe. These contributions are significant in a region where there are relatively few research hydrologists available to provide supervision support for post-graduate research studies.

Prof Hughes strongly promoted his perspective on practical hydrological modelling within the IAHS PUB decade, as well as during the planning for the Panta Rhei decade.

During the mid-1990s South Africa began to introduce new water legislation that included the so-called 'Ecological Reserve' - the local terminology for a proportion of the natural flow regime of rivers that should be preserved to ensure environmental sustainability of water resources. Prof Hughes was a pioneer in developing relatively simple desktop approaches to determine the ecological reserve, designed for rapid assessments in data scarce situations. This excellent work is a clear illustration of the importance that Prof Hughes has always placed on the parallel developments of research and practical implementation of hydrological and water resources science.

Prof Hughes served as a vice-president of the IAHS International Commission on Surface Water from 2003 and assumed the position of Vice President of IAHS during 2009 until 2015, with special responsibilities for promoting hydrological sciences in developing countries. He continues to play a role as a member of the IAHS Working Group for

Representation of Developing Countries. He served as IAHS National Representative for South Africa from 2000 to 2011, after which he assumed the responsibility of chairperson of the Professional Advisory Committee to the South African National Council for Natural Scientific Professions (SACNASP) for the Water Resources Science field of practice. He has also served on the South African Committee of the International Hydrological Programme (IHP) of UNESCO.

In summary, over the last 35 years, Prof Hughes has made substantial contributions to the interface between science and practice in the specific fields of hydrological modelling and environmental flow assessment. He has also made very real contributions to academic and research capacity building within the sub-Saharan Africa region.

On the basis of these contributions it was the great honour and pleasure of the IAHS to award the 2016 Volker medal to Prof Denis Hughes: "For outstanding contributions and leadership in the fields of hydrological modeling, water resources assessment and capacity development in sub-Saharan Africa".

All eyes on aquaculture at regional meeting

One might find it strange for an irrigation association to focus on aquaculture, but for the Southern African Regional Irrigation Association (SARIA) it is all about sustainably uplifting the region's poor communities.

The theme for this year's annual workshop and steering committee meeting, which took place in Lilongwe, Malawi, in February, was 'Rural fresh aquaculture'. The meeting was attended by representatives from Malawi, Zimbabwe, Lesotho, Botswana, Madagascar, Swaziland, Congo, Zambia and South Africa. Also present were representatives from the United Nations Food and Agriculture Organisation (FAO).

SARIA's vision is to strengthen

research, communication, training and development of appropriate science and technology in irrigation and drainage for gender balanced poverty eradication and economic development to improve the livelihoods of the inhabitants of the member countries.

A highlight of this year's meeting was the presence of the Minister of Agriculture and Irrigation in Malawi, Allan Chiyembekeza, who took time out of his busy schedule to attend the first day of the workshop. He indicated the willingness of the Malawian government to support SARIA activities and shared a brief situation overview on the experiences and challenges faced by the irrigated sector in Malawi, including erratic rainfall patterns, and prolonged dry spells

which affect food production.

Other sessions looked at the status of irrigation as well as that of aquaculture in Malawi.

Fish farming started in Malawi in 1906, but only took off around 1990. There is an increasing integration of crop farming with aquaculture. Large and small fish farmers make up a total area of production of 276 ha. Around 6 700 fish farmers produce around 4.7 t of fish annually.

700-year-old African soil technique could help mitigate climate change

A farming technique practiced for centuries by villagers in West Africa, which converts nutrient-poor rainforest soil into fertile farmland, could be the answer to mitigating climate change and revolutionising farming across Africa.

A global study, led by the University of Sussex, which included anthropologists and soil scientists from Cornell, Accra, and Aarhus universities as well as the Institute of Development studies, has for the first time identified and analysed rich fertile soils found in Liberia and Ghana.

They discovered that the ancient West African method of adding charcoal and kitchen waste to highly weathered, nutrient poor tropical soils can transform the land into enduringly fertile, carbon-rich black soils which the researchers dub 'African Dark Earths'.

From analysing 150 sites in northwest Liberia and 27 sites in Ghana, researchers found that these highly fertile soils contain 200 to 300% more organic carbon than other soils, and are capable of supporting far more intensive farming. Prof James Fairhead from the University of Sussex, who initiated the study, said: "Mimicking this ancient method has

the potential to transform the lives of thousands of people living in some of the most poverty and hunger stricken regions in Africa.

"More work needs to be done, but this simple, effective farming practice could be an answer to major global challenges such as developing 'climate smart' agricultural systems which can feed growing populations and adapt to climate change."

Similar soils created by Amazonian people in pre-Colombian eras have recently been discovered in South Africa – but the techniques used to create these soils are unknown. Moreover, the activities which led to the creation of these anthropogenic soils were largely disrupted after the European conquest.

Encouragingly, researchers in the West Africa study were able to live within communities as they created their fertile soils. This enabled them to learn the techniques used by the women from the indigenous communities who disposed of ash, bones and other organic waste to create the African Dark Earths.

Dr Dawit Solomon, the lead author from

Cornell University, said: "What is most surprising is that in both Africa and in Amazonia, these two isolated indigenous communities living far apart in distance and time were able to achieve something that the modern-day agricultural management practices could not achieve until now.

"The discovery of this indigenous climate smart soil-management practice is extremely timely. This valuable strategy to improve soil fertility while also contributing to climate-change mitigation and adaptation in Africa could become an important component of the global climate-smart agricultural management strategy to achieve food security."



Aussie scientists find global threat to agriculture from invasive species

New CSIRO research into global impacts of invasive species has found that sub-Saharan African countries are most at risk, while China and the USA pose the greatest threat.

The research, which has been published in the *Proceedings of the National Academy of Sciences*, examines the worldwide distribution of nearly 1 300 invasive pests and pathogens, international trade flows, and each country's main agricultural crops, to determine potential invasion risks and impact.

According to CSIRO, this is the first analysis of invasive species' threat to global crop production on a country-by-country basis, calculating the total potential cost

of these species invading each of the 124 countries.

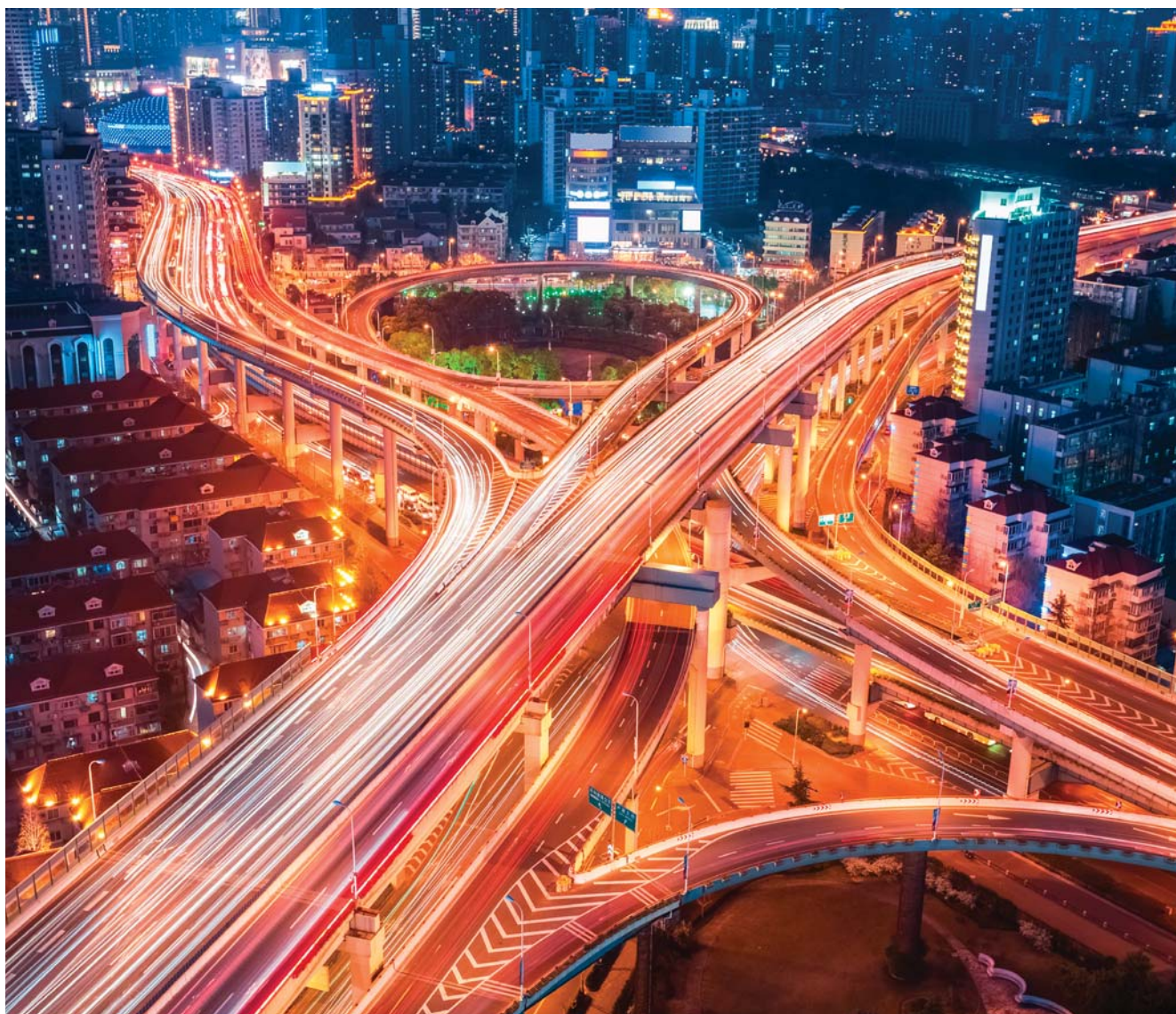
Senior researcher, Dr Dean Paini, said the research found that most vulnerable countries were located in sub-Saharan Africa. "These countries generally do not have diverse economies, making them disproportionately more dependent on agriculture. As a result, any threat from invasive species can potentially have a greater relative impact on these countries." The study also determined which countries present the greatest threat to the rest of the world given the scale of agricultural export and the invasive species already established. The USA and China posed the greatest threat as a source of invasive species, however, this

is not surprising given the high number of pests already present, the scale of their agricultural export industries and their role as regional food hubs with an extensive network of trade partners.

As trade volumes continue to increase and more trade connections are made between countries, the pressures from invasive species will only intensify. "This research provides insights that will enable the first steps towards the management of invasive species at the global scale," concluded Dr Paini.

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Visit: www.pnas.org

Cities make us forget what's great about nature



Modern cities have lots to offer, but what does their lack of nature cost us?

That is the question explored in a recent perspective piece in the journal *Science*. Its authors discuss the growing tension between an arguably necessary role urban areas play in society and the numbing, even debilitating aspect of cities that disconnect humans from the natural world.

Children in large cities are growing up having never seen the stars, reports co-author Peter Kahn, a professor in the University of Washington psychology department and School of Environmental and Forest Sciences. "As we build bigger cities, we are not aware how much and how fast we are undermining our connection to nature – the wellspring of our existence."

Kahn, with co-author Terry Hartig of Uppsala University, in Sweden, point to research that shows the emotional and mental strain that mental strain cities can have on people. Mental illnesses and disorders are common in urban areas,

and while many factors share the blame, reduced access to nature is a contributing cause, Kahn says. "There is an enormous amount of disease largely tied to our removal from the natural environment."

There are steps cities can take to introduce nature into the urban core, including requiring buildings to have windows that open to allow in fresh air and natural light; incorporating more rooftop gardens and urban agriculture; and creating spaces within and around buildings to touch, see and smell native plants.

Thoughtfully designed cities with nature can offer both the stimulation and energy of an urban area and meaningful interaction with a psychologically restorative natural environment. The authors conclude: "Thus, cities designed well, with nature in mind and at hand, can be understood as natural, supportive of both ecosystem integrity and public health."

Source: University of Washington



New WRC reports

Report No. 2268/1/15

Understanding estuarine processes in Umfolozi/Umsunduzi/St Lucia estuary from earth observation data of vegetation composition, distribution and health

The Umfolozi/Umsunduzi/St Lucia estuary faces a number of threats as a result of human interference over several decades. This study explored the utility of earth observation data consisting of remote sensing and other ancillary data to provide information on the spatial distribution on the estuary vegetation types and condition.

Report No. 2342/1/16

The role of environmental ethics in social-ecological systems and water resource management

This project on the role of environmental ethics in social-ecological systems and water resource management arises out of the fact that we are increasingly confronted by the complex and interwoven nature of the complex situations in which we, as humans – indeed, as all life on earth – find ourselves. Our location and role (as humans), as integral components of social-ecological systems, including our particular and far-reaching powers to impact upon those systems, is critical to the functioning and well-being – and indeed, the potential survival – of those systems. This project was concerned to arrive at the conceptualisation of an approach to, a framework for, environmental ethics, which is appropriate to water resource management in South Africa.

Report No. TT 643/15

Moving from integrated water to integrated natural resources management (INRM): A proposed framework for INRM at the district scale in South Africa



This project builds on the outcomes of the Aframaison project that presents an approach centred on five key elements considered necessary to facilitate improved integration in natural resource management (NRM). The project focused on developing practical tools and guidance to integrate these elements in NRM practice. The elements are: an ecosystem services foundation; integration at the Meso-scale (district municipal level); an appropriate institutional structure; tools and instruments to ensure a long-term management view; and effective stakeholder management.



Report No. TT 641/15

Monitoring, management and communication of water quality in the direct reclamation of municipal wastewater for drinking purposes

Water scarcity is recognised as a major challenge for countries on a worldwide basis in their endeavour towards sustainable life for humankind and the environment. Existing water sources are increasingly coming under stress due to growing water demand on a global scale. Water resource managers and planners are forced to look at other, unconventional water sources such as desalination (of seawater and brackish groundwater), water reuse and rainwater harvesting. This project documented the status of water reuse for potable purposes; developed standardised methodology for water reuse; and developed proposed water quality monitoring programmes and guidelines for water reuse.

Report No. KV 349/15

Aquatic plants of South Africa for pharmaceutical and cosmeceutical usage

The study of medicinal properties of indigenous South African aquatic plants is a relatively understudied field. Wetlands support a great diversity of plant species and some of those plant species have traditionally been used by communities as a source of medicine, food and building materials, providing that these plants can be applied to a variety of aspects in everyday life. Through this study, the research question, do indigenous South African aquatic plants have the potential to be effective alternative treatment for skin hyperpigmentation, acne and periodontal disease, was answered.

Report No. 2235/1/15

Using satellite data to identify and track convection over Southern Africa

Nowcasting is the science of anticipating the ordinary and severe weather events in the next few hours. Radar systems provide the most useful information about the intensity, movement and characteristics of severe weather events, but these data sources are expensive to obtain and require extensive maintenance. The aim of this study was to test a new nowcasting tool, 'Rapid Development Thunderstorms' or RDT over the South African and Southern African domain to show the possible benefit of this product in data-sparse regions.

Report No. 2186/1/15***Connectivity through allochthony: Reciprocal links between adjacent aquatic and terrestrial ecosystems in South Africa***

An important aspect of the dynamics of nutrients and pollutants in natural systems is captured in the concept of allochthony, founded on the observation that nutrients and energy in a variety of forms are transferred between adjacent habitats, communities and ecosystems that are not routinely considered as connected. Different forms of nutrients and energy move across the conceptual boundaries of habitats via organisms' activities or physical processes such as wind or water currents, and these transfers can represent important food subsidies. Such cross-partition ecological subsidies can augment the nutritional condition, biomass and biodiversity of communities, particularly where local production (or autochthony) alone may be inadequate to support local food webs. This study explored organic nutrient fluxes in relation to a primarily lotic (i.e. flowing) aquatic system at the scale of a hydrological catchment.

Report No. KV 348/15***Investigation of the viability of selected indigenous wetland plants to support entrepreneurship and job creation in South Africa***

Typha capensis (Cape Bulrush or Cattail) is an indigenous wetland plant that occurs across the country. It acts as a pioneer species in degraded wetlands, which means that fairly dense populations of *Typha* occurs in various degraded wetland systems across the country. This short-term study investigated the business case for using *Typha* as a green building material, therefore creating economic opportunities and jobs in poor peri-urban, rural and urban communities of South Africa.

Report No. 2340/1/16***Developing an elementary tool for ecological reserve monitoring in South Africa's Freshwater Ecosystem Priority Areas (FEPAs): A pilot study in the Koue Bokkeveld***

Extensive research and development has gone into methodologies aimed at determining the Ecological Reserve in South Africa, i.e. into quantifying the volumes, timing and frequency of flows required to support ecosystem processes in local rivers. Considerably less attention has been accorded its operationalisation, with some managers alleging that Reserve determination methodologies have been developed in a vacuum without any serious consideration for their practicability. This study was undertaken in response to the need to develop simple tools to monitor the Reserve that can be broadly applied in rural catchments with limited water resource management capacity and monitoring, a decentralised water storage and transfer infrastructure, but which have a high conservation and biodiversity value, i.e. Freshwater Ecosystem Priority Areas (FEPAs).

Report No. 2138/1/16***An investigation into the presence of free living amoebae and amoeba resistant bacteria in drinking water distribution systems of health care institutions in Johannesburg, South Africa***

Free living amoebae (FLA) are ubiquitous in natural and man-made water systems. Certain FLA, including *Acanthamoeba* and *Balamuthia* species are known human pathogens and are

carriers of amoeba resistant bacteria (ARB) known to cause serious, potentially fatal infectious diseases. The importance of drinking water quality supplied to and distributed through public healthcare facilities, with special reference to FLA and certain ARB, has not been studied previously. The study attempted to provide a general overview on the presence of these organisms within water distribution systems of three public health care institutions in Johannesburg, South Africa, and also briefly highlight the potential human health risk implications.

**Report No. TT 654/15*****Energy use reduction in biological nutrient removal wastewater treatment plants: A South African case study***

The aim of this project was to investigate feasible practical aeration energy conservation measures that can be implemented at biological nutrient removal activated sludge plants that not only result in energy use reduction but also ensure final effluent compliance with discharge regulations; thus satisfying both the primary objective of wastewater treatment as well as energy conservation. Two biological nutrient removal activated sludge plants were selected as case studies, namely Zeekoegat (owned and operated by the City of Tshwane with a design capacity of 85 ML/d average dry weather flow and utilising fine bubble diffused aeration) and JP Marais (operated by the East Rand Water Care Company, with a design capacity of 15 ML/d and utilising surface aeration).

Report No. 2157/1/16***Groundwater yield-reliability analysis and operating rules for data***

Water supply systems that obtain water from groundwater reservoirs require operating rules/strategies to regulate the competing water uses, ensure the beneficial use of water and also account for groundwater reserve. Management strategies are also required to address the unique characteristics and roles of groundwater. Groundwater yield-reliability analysis is required when deriving operating rules. Operating rules provide statements on water to be allocated from a given resource at a given time. The study concluded that since groundwater can meet domestic demand at the highest recommended reliability level, its development for use or integration with run-of-river and rainwater would improve on the livelihoods of residents of Siloam Village. An earlier study had shown that run-of-river and rainwater improves yield and reliability up to 1:25 (96%) for a period of 9 months, which is below the recommended level of assurance of supply of 1:100 (99%).

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Estuaries

Protecting nature's nurseries – Study highlights importance of natural flow to estuaries

Estuaries, those unique interfaces between marine and freshwater environments have also been highly impacted by human activities upstream. A completed study by the Nelson Mandela Metropolitan University (NMMU) and funded by the Water Research Commission has confirmed the uniqueness of estuaries and highlighted the importance of continuous monitoring and cooperative governance to address impacts and improve estuarine health.

Article by Petro Kotzé.



The Bloukrans estuary is one of the estuaries for which ecological water requirement studies have been completed.

All photographs courtesy NMMU

South Africa's National Water Act of 1998 is hailed internationally as a ground-breaking piece of legislation, in particular because it protects the right of our waterbodies' survival. Yet, the implementation of this law is often fingered as a problem, still leaving integral ecosystems open to exploitation.

However, a recently published study has pointed out how far we've come with the protection of some of our most sensitive ecosystems, namely estuaries. As the interfaces between the marine and freshwater environments, estuaries are complex, dynamic and productive ecosystems. These systems provide numerous ecosystem services, including erosion control,

provision of food, support for fish nurseries and provision of recreation and tourism opportunities. Consequently, they are the most heavily utilised and threatened ecosystems worldwide. "People are easy to criticize the work that has been done, but the bottom line is that we've done a lot, and the results are now contributing to inform estuary management plans and other pieces of national legislation," says Prof Janine Adams of the NMMU. Prof Adams was the project leader of the recent assessment of completed Ecological Water Requirement studies for South African estuaries. The project also entailed a documentation of estuary responses to changes in freshwater inflow. In addition to the WRC, the project was co-funded by the

Department of Water and Sanitation and the National Research Foundation.

Prof Adams has already walked a long path with estuaries throughout her career. "It's a theme I've been working on since my doctoral studies, and it has continued from there," she says. Some of the work she has been involved in has been formalised in the National Water Act of 1998, and it is now being continued, not only by her, but by the students she has helped train throughout the years. She was thus in the ideal position to oversee the collection and interpretation of the unorganised body of work, in order to keep stock of what has been done in the past. "As a scientist I've been involved with much of the work, so I'm familiar with a lot of it." The researchers found that we are doing much better than what many may think.

How far have we come?

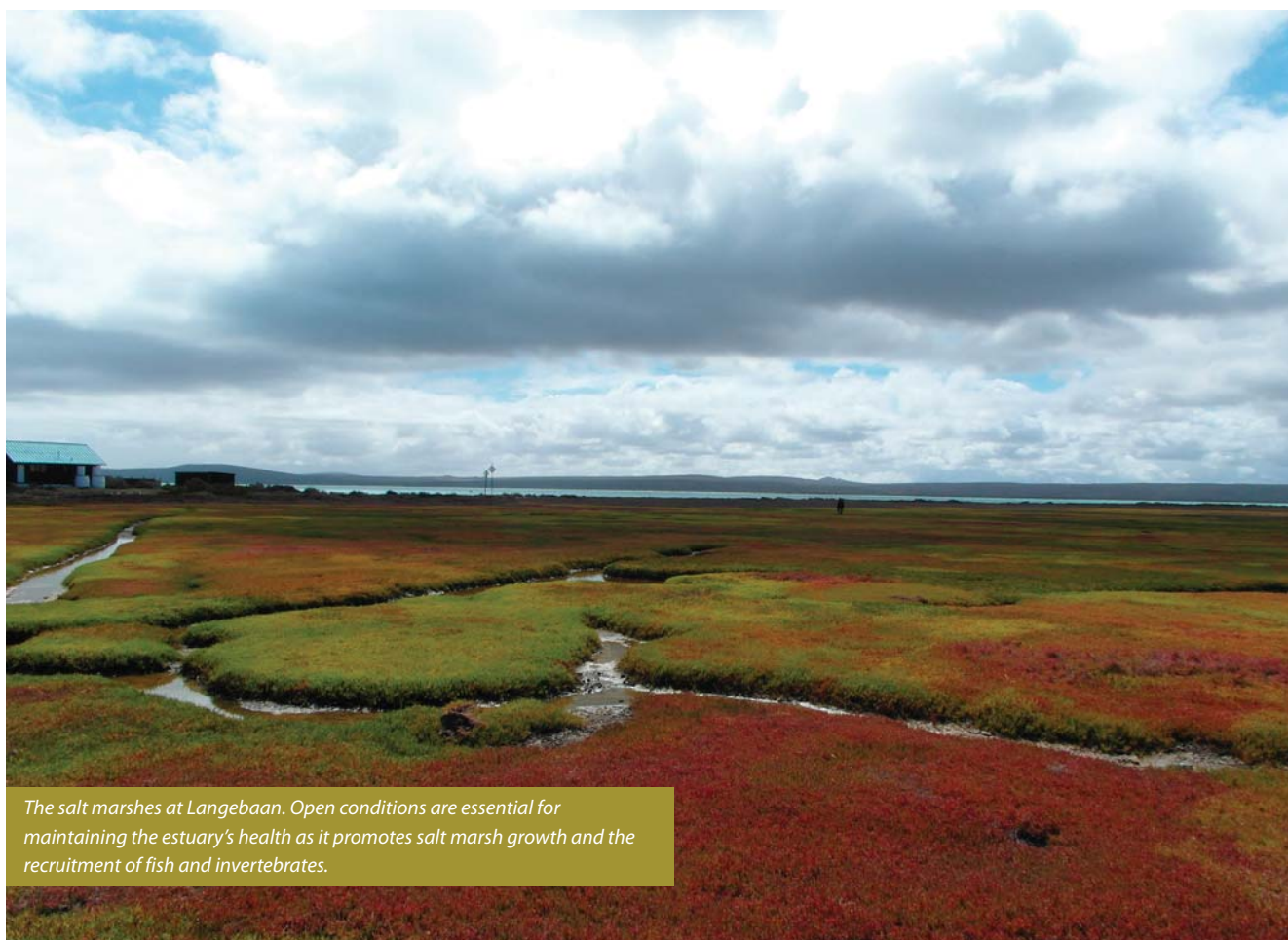
The mentioned Act requires the classification of all water resources in order to be able to secure water for its protection. Classification is accompanied by resource quality objectives that establish goals for the quality of the relevant water resource.

The Ecological Reserve, in turn, relates to the quantity and quality of river inflow required to protect the aquatic ecosystem of the water resource, which vary depending on the class of the resource. Because the classification process may take time, the Act allows for the preliminary determination of the Reserve. To this end, the Department of Water and Sanitation

developed methods for the preliminary determination of ecological water requirements (EWRs). For estuaries, these preliminary methods include the determination of the present ecological status, ecological importance, the recommended ecological category, a recommended ecological flow scenario and ecological specification and monitoring programmes. The present ecological status data set informed the 2012 National Biodiversity Assessment.

South Africa supports close to 300 functional estuaries, which vary in type due to the differences in topography, fluvial and marine sediment supply. Our estuaries range from permanently open tide-dominated systems to permanently open river-dominated systems, temporarily open/closed systems, estuarine lakes and estuarine bays. Most of these are small systems, and over 70% have restricted inlets due to strong wave action and high sediment availability.

Because each estuary is unique, both due to its characteristics and how it responds to freshwater inflow, the EWR of each has to be calculated individually. According to the report findings, South Africa has been a forerunner in the development and application of methods to assess the EWRs of estuaries, which in essence, ensure the protection of aquatic ecosystems and maintain ecosystem services. The EWR (or, Ecological Flow Requirements) quantifies the water regime (quality, quantity and timing) required to ensure the adequate functioning and future persistence of estuaries.



The salt marshes at Langebaan. Open conditions are essential for maintaining the estuary's health as it promotes salt marsh growth and the recruitment of fish and invertebrates.



Researchers from Nelson Mandela Metropolitan University worked with colleagues at the South African Institute for Aquatic Biodiversity to undertake sampling at some of the estuaries.

“Estuaries are sensitive to a reduction in freshwater inflow, which is the main driver of their dynamic, variable nature.”

The assessment found that studies have been conducted on 40% of South Africa’s estuaries, although some studies are still ongoing. The majority (69%) of studies were completed as low confidence desktop or rapid levels. The classification of the Mvoti-Umzimkulu Water Management Area assessed 22% of South Africa’s estuaries. Furthermore, the EWRs of half of South Africa’s permanently open estuaries have been determined. Only three comprehensive Reserve determinations have been completed.

“In most cases the environmental flows have not been implemented, but the point of the report is that we have made progress,” explains Prof Adams. Furthermore, the studies have alerted everyone to the existence of stressed catchments, and it has provided awareness that there isn’t water left for development in these catchments anymore, she notes.

Prof Adams stresses that it is important to give the Department of Water and Sanitation credit for that. “They have taken the time to do this, and they have put a lot of money and effort into understanding EWRs; knowledge that everybody is now benefiting from.”

These lessons and information are now being used in estuary management plans; essentially applying the requirements of the National Water Act into practice to the benefit of all.

Estuary responses to changes in freshwater inflow

Water quality and ecological functioning of estuaries closely reflect human activity, not only along the estuarine sector itself, but also within its entire upstream catchment.

The study pointed out that freshwater abstraction for human activities threatens the health and provisioning of ecosystem services supplied by aquatic ecosystems. “Estuaries are sensitive to a reduction in freshwater inflow, which is the main driver of their dynamic, variable nature. Input of discharge from waste water treatment works and agricultural return flow can result in increased freshwater inflow to estuaries.”

Though the findings paint a negative picture of the impact of human activities on the health and sustainable future of estuaries, Prof Adams point out that all is, by far, not lost. Inversely, pointing out the negative impacts of freshwater abstraction from estuaries help to highlight the impact of development, and how and when it should be managed and mitigated.

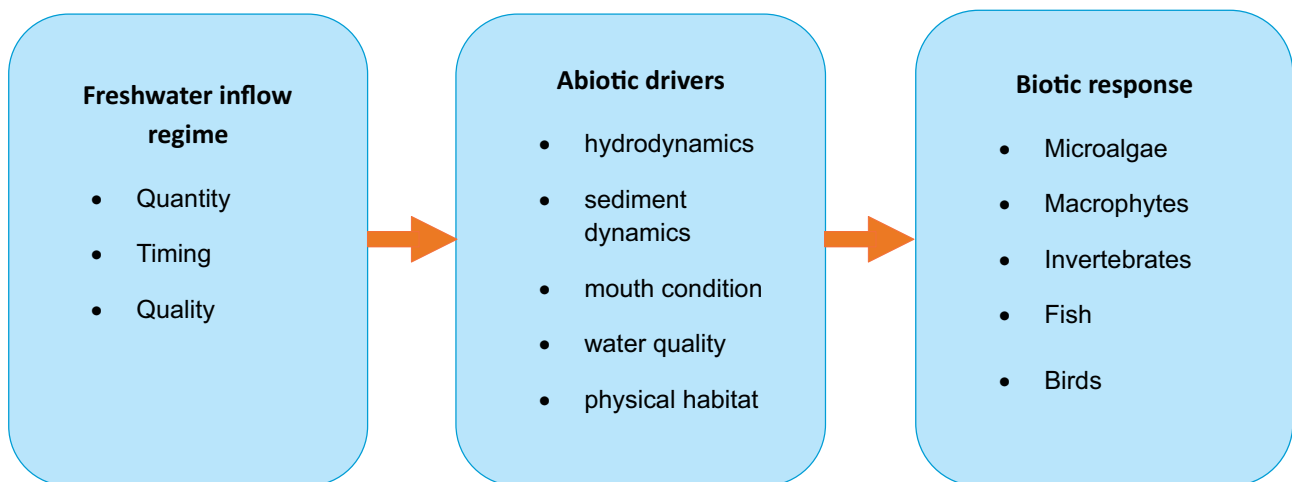
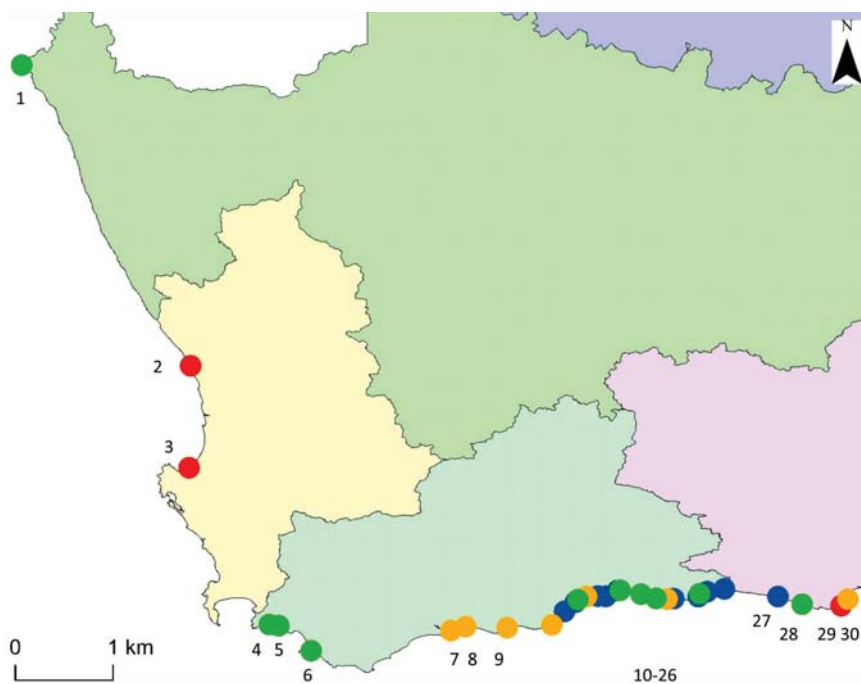


Figure 1: Conceptual model of freshwater inflow effects on estuaries.



1. Orange	8. Duiwenhoks	15. Maalgate	22. Noetsie
2. Olifants	9. Goukou	16. Gwaing	23. Piesang
3. Berg	10. Gouritz	17. Kaaimans	24. Matjies
4. Palmiet	11. Blinde	18. Wilderness	25. Bloukrans
5. Bot	12. Hartenbos	19. Swartvlei	26. Groot
6. Uilkraals	13. Klein Brak	20. Goukamma	
7. Breede	14. Great Brak	21. Knysna	

Figure 3: Ecological water requirement studies completed for estuaries on the west and south coast of South Africa (blue indicating desktop assessments, green: rapid, yellow: intermediate and red: comprehensive).

Key lessons learnt

The researchers have identified twelve key lessons from the estuaries' assessments:

1. Each estuary is unique in terms of its EWR.
2. Water can be released from dams to supply the EWR, but cannot mimic the entire natural flow regime.
3. Floods are needed to flush out and reset estuaries.
4. Increased flow, for example wastewater input or agricultural return flow, increases mouth breaching resulting in unstable conditions in temporarily open/closed estuaries.
5. Deterioration in water quality is a growing concern.
6. The importance of groundwater input to South African estuaries is unknown.
7. The offshore marine environment also has an EWR, but this does not form part of the current legal framework.
8. A catchment to coast integrated water management approach is necessary to ensure connectivity.
9. Co-operative governance is required to address non-flow related impacts and improve estuary health.
10. Field and long-term data are needed for high confidence EWR assessments.
11. Monitoring must take place in a strategic adaptive management cycle.
12. The tools developed to determine the EWR of an estuary are now being used to meet other legislative requirements

She lists a good example as the St Lucia Estuary. This highly important estuary had the lowest Present Ecological Status of the estuarine lakes assessed. Studies have found that, aside from a reduction in flow, developments such as the drainage and canalisation of the uMfolozi swamps, the construction of weirs and an overall reduction in bird habitat on a national and international scale have contributed to its poor health.

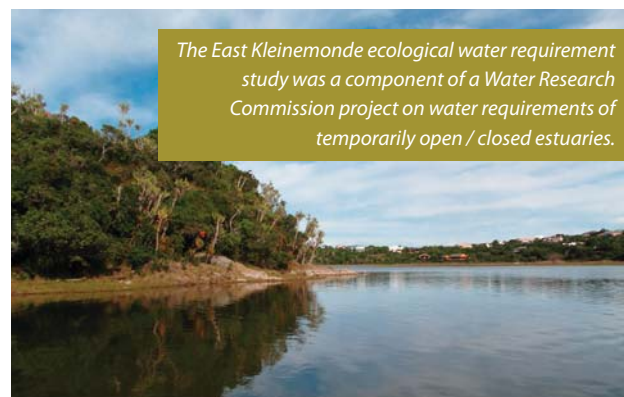
In 2004, an ecological water requirement study highlighted the urgency of reconnecting inflow from the uMfolozi to the St Lucia Estuary. This is now taking place; in 2016 with the aid of GEF funding, iSimangaliso Wetland Park Authority appointed a contractor to remove dredge spoil impeding uMfolozi flow into Lake St Lucia. Scientists have shown that further removal of dredge spoil, inflows of freshwater from uMfolozi and an increase in the connectivity with the sea will improve the ecological health of St Lucia. However, at the same time there should be no further abstraction of freshwater from the uMfolozi and St Lucia catchments as these inflows are necessary to maintain the health of this nationally important estuarine lake.

"As a scientific community we said that the St Lucia Estuary needs water from the Umfolozi River, and this is now being done after our recommendations," notes Prof Adams. She also points out that public perception of the importance of estuaries has increased concurrently over the years, and that the public's

involvement is increasingly helping to help safeguard these sensitive ecosystems' futures. Already, she says, there are many examples along the coast where this is happening.

Going forward

The researchers have come to the conclusion that South Africa's holistic approach to determine EWRs for estuaries is at the forefront of methods internationally. According to the final report, "the procedure is well documented and soundly embedded in an understanding of the structure and function of South Africa's estuaries."



The East Kleinemonde ecological water requirement study was a component of a Water Research Commission project on water requirements of temporarily open / closed estuaries.



Hippos at the mouth of St Lucia, one of South Africa's most important estuaries.

Furthermore, a learning-by-doing approach has ensured that the methods used to assess the EWRs of South Africa's estuaries have improved over time. The use of multidisciplinary scientific teams and panel workshops are integral to the method and are a strength. A potential weakness that has been identified is the failure to support the process with adequate data.

Prof Adams points out that for her, going forward; water quality is one of the major issues that will have to be dealt with. However, "we are lucky that in South Africa, guidance is provided by national legislation, resulting in work that is done as part of a coordinated effort towards the same goal – something that is rarely the case in many other countries." Another benefit of working in South Africa is that we can link science and policy closely together.

There are many negatives in the country but, there are also some positives, she says, and the work that has been done on estuaries in South Africa is one of them. "Look at this body of work that we now have, and credit for the DWS also needs to be given for this," Prof Adams concludes.

- To access the report, *Assessment of completed ecological water requirement studies for South African estuaries and responses to changes in freshwater inflow (Report No. KV 352/15)* contact Publications at Tel: (012) 330-0340; Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.



Eutrophic conditions, harmful algal blooms and fish kills affect the aesthetic and recreational value of estuaries which can reduce eco-tourism opportunities. Here, algal blooms at Mhlangankhulu Estuary can be seen.

School sanitation

Rural school sanitation – On the path to hope and dignity

With its latest report and guideline on rural school sanitation the Water Research Commission (WRC) hopes to put this essential service on the path to sustainability.

Article by Sue Matthews.



According to its presentation to the Portfolio Committee on Basic Education on 3 May, the Department of Basic Education aims to provide 265 schools with sanitation facilities during the 2016/17 budget cycle, via its Accelerated Schools Infrastructure Delivery Initiative (ASIDI). This adds to the more than 400 schools provided with sanitation facilities between the launch of ASIDI in 2011 and the middle of 2015.

The effort is commendable, but it's not going to make a significant difference, given that the Department reported last

year that 6 783 of its 23 589 education sites had only the most basic of pit latrines, which are not considered an adequate form of sanitation. And even where new toilets are provided, they may deteriorate to an unsafe and disgusting state in a matter of weeks or months if not managed effectively.

This is a key finding of a recent Water Research Commission (WRC)-funded project on rural school sanitation conducted by Partners in Development, a Pietermaritzburg-based firm established by David Still. Researchers visited 130

schools in Limpopo, KwaZulu-Natal and the Eastern Cape, where they interviewed staff, conducted focus groups and surveys with learners, and inspected the sometimes shocking toilet facilities. The project has culminated in the publication of a guideline document, co-authored by Bobbie Louton and David Still, entitled *Building and managing school toilets that protect learners' rights*.

In the opening paragraph, they explain how poor sanitation violates the right of learners to safety, health and dignity.



Dignified school sanitation plays an important role in ensuring learner health.

"Toilets that are not maintained in a safe condition pose a threat to the lives of learners. Filthy conditions undermine health, spreading infections which compromise cognitive development and result in absence from school. Degrading and frightening experiences in the toilet undermine learners' psychological wellbeing, compromising learning and their ability to thrive academically and socially. Learners who avoid using the toilets because of the conditions there may find themselves unable to concentrate in class, or may leave school to find a more acceptable toilet elsewhere. Girls who find it too difficult to manage their periods in the school toilets may routinely stay home when they are menstruating, compromising their education."

Yet the researchers' interviews with 113 school principals revealed that many lacked a clear understanding of the role sanitation plays in education and of their own responsibilities in this regard. To address this, the guidelines include a 'Bill of Children's Rights for Sanitation', which spells out how the rights of children apply in the context of school toilets under the following themes:

1. Safety: Children have a right to toilet facilities that are structurally safe and free from threats.
2. Health: Children have the right to

toilet facilities which minimise the spread of disease.

3. Dignity: Children have the right to toilet facilities which support their privacy, security and comfort.
4. Special care for special needs: Children with special needs, such as small children, menstruating girls, and children with physical or other challenges, have a right to assistance from staff and accommodation from the school.

Of course, many principals fail to recognise how dire the situation is because they themselves grew up without decent toilet facilities at school. They may feel helpless to rectify the often overwhelming problems because they lack the necessary funds or organisational skills, and those that do try quickly become disheartened by destructive learner behaviour negating their efforts. Support or intervention is needed from the departmental level, but staff there experience similar obstacles and can more easily adopt an 'out of sight, out of mind' approach. The guidelines make for uncomfortable reading on this issue.

"For those of us who grew up using desperately horrible school toilets ourselves, we may find ourselves accepting, on some level, that the state of much of rural school sanitation is an unfortunate but unchangeable reality. Confronted with vandalism, theft and misuse of the toilets by learners for illicit activities and sometimes acts by which learners degrade their learning environment themselves – such as writing on the walls with faeces – it can almost seem that terrible toilets are a fit punishment for those who are co-creators of the disaster."

"We can forget that not every learner has treated the toilets badly, and that the majority should not be punished collectively for the misdemeanour of a few. We can forget that users of toilets are not just the big, unmanageable children who attract attention but are also small, weak and vulnerable children who need to be protected. We can forget that even the vandalisers, drug users and bullies are still children to whom we have a sacred duty to protect and nurture, and who have the same rights to safe, healthy toilets that uphold their dignity and meet their needs as any other child."

The authors note that in many cases routine inspections are not conducted by departmental officials, and principals are not held to account for the safety and health status of their toilets. This means there are neither carrots nor sticks to motivate circuit managers or principals in ensuring that sanitation is kept to an adequate standard.

Without proper monitoring and maintenance of infrastructure, some forms of sanitation can fail with deadly consequences – as the tragic case of six-year-old Michael Komape, who drowned in excrement in a pit latrine at his school in Limpopo in January 2014, so starkly illustrated. Even with so-called 'VIP' latrines, which government departments consider adequate for school sanitation, an unstable cement slab, broken pedestal or loose seat could result in a learner tumbling into the foul pit below. Because far from being designed for very important people as the name suggests, the acronym stands for 'ventilated improved pit', which simply means there is a ventilation pipe fitted with a screen to help remove odours and trap flies.

The project team found in their research that 54% of VIP users indicated they had felt afraid of falling into their school toilet. The guidelines therefore suggest ways in which VIP toilets could be modified to make them safer, such as adding parallel bars below the pedestal, putting handles on either side of the toilet seat, and offsetting the pit behind the pedestal. Since smaller children are particularly at risk, lower toilets with smaller holes and seats should be provided for them.

"Toilets that are not maintained in a safe condition pose a threat to the lives of learners. Filthy conditions undermine health, spreading infections which compromise cognitive development and result in absence from school."



Partners in Development

Poor rural sanitation facilities threaten not only the health but also the safety and dignity of learners.

Alternatives to VIP toilets, such as low-flush and pour-flush designs, are also reviewed, but as the authors note: “Each technology comes with its pros and cons and associated requirements. To date there is no silver bullet and no one-size-fits-all technology.”

Guidance is given on many other aspects of school sanitation too, including design principles, location and layout of ablution blocks, handwashing facilities, choice of components, beneficial use of urine and faeces, and options for sludge treatment and disposal.

The final chapter of the guidelines provides a model for managing school sanitation effectively. The authors start by re-emphasising the primary obstacles to effective management:

- a lack of ‘will’ (the knowledge and values that create vision which in turn produces drive and commitment)
- a lack of ‘skill’ (the knowledge and expertise to be able to assess, plan, develop tools, implement, monitor and evaluate independently)
- a lack of funds to pay the ‘bills’ incurred in running toilets well.

“To overcome these obstacles, managers at both school and department levels need to be trained and developed to put in place the ‘will’ that provides the drive for good management. While the capacity of schools needs to be developed to

manage well, this transfer of ‘skill’ needs to be done over a longer period with significant partnership and support from the department. Training in administrative skills needs to be accompanied by the provision of administrative tools – standards, criteria, protocols, procedures as well as monitoring checklists, reporting forms and training materials. Schools with adequate capacity can adapt these and improve upon them, but schools without must at least have a minimum framework provided to work within. The department needs to support the school with adequate funds and financial tools to pay the ‘bill’ for good management.”

The guidelines outline the respective roles of education officials (with sanitation-specific support structures advocated at national, provincial, district and circuit levels), the principal and the school governing body. They also suggest creating positions at the circuit level – possibly funded jointly by the Department of Basic Education, the Department of Health and the Department of Water and Sanitation – for Health and Safety Officers, responsible for training, supervision, monitoring and reporting for a cluster of schools.

In addition, a staff member at the school should be appointed as Health and Safety Manager, tasked with training and supervising the Health and Safety Officer, who would implement the programme on a day to day basis. The Health and Safety Officer would be responsible,

for example, for cleaning the sanitation facilities and restocking toilet paper and soap, monitoring learners’ behaviour and teaching them good hygiene practices, assisting those in need and reporting any issues that need attention.

The role of the learners themselves is also discussed, but the authors stress that they should not be given any sanitation-related duties that could compromise their health or their time in the classroom. They should not be required to clean contaminated areas of the toilets – even as punishment – but they could be involved with cleaning windows and walls, or periodic painting work.

Partners in Development has now been allocated further funding by the WRC for a two-year follow-up project to pilot the sanitation management model with 10 schools in KwaZulu-Natal, in collaboration with the provincial Department of Education. Based on lessons learned and feedback received from stakeholders, the model will be refined if necessary and then more widely promoted, along with a management handbook, in the hope that it will be adopted by education departments and schools across South Africa.

The final report and guide will be available later in the year.

Freshwater ecosystems

New tools developed to help restore our rivers

The Water Research Commission (WRC) has funded the development of a comprehensive River Rehabilitation Manual to enable more effective protection and management of watercourses.

Article by Sue Matthews.



A rehabilitation project to arrest headcut erosion in the Elandsbloof River involves the construction of five gabion weirs, together with landscaping and re-vegetation of the gully sides.

It began as a short, two-metre-deep erosion gully in the rivercourse, after a small dam for watering horses was washed away during a flood in 2003. By 2015, the gully had extended almost a kilometre upstream and deepened to 13 m in places, destroying a stretch of palmiet wetland up to 600 m long and 100 m wide. The sediment washed away had smothered another section of the wetland downstream and created temporary islands that diverted flow into the river bank, causing further erosion and threatening the adjacent farmland.

This disturbing account is one of 24 case studies included in the River Rehabilitation Manual, the final output of a WRC-funded project to develop national guidelines for river rehabilitation. The Manual is made up of three separate volumes, comprising the Guidelines themselves, a Technical Manual and the Case

Studies. Most of the case studies are of sites in the Western Cape, reflecting the home base of the project team members – Liz Day of the Freshwater Consulting Group, Hans King of the provincial Department of Agriculture and Mark Rountree of Fluvius Environmental Consultants – but the problems, rehabilitation objectives and lessons learned are relevant countrywide.

In the case study above, dealing with headcut erosion in the Elandsbloof River between Caledon and Hermanus, the main lesson learned is that action should have been taken as soon as the damage became apparent. The provincial Department of Agriculture considered undertaking rehabilitation work in 2004, but this was conditional upon the then landowner removing alien vegetation from the river banks so that indigenous wetland plants could re-establish. Since an agreement could not be

reached, the department spent the limited funds it had available for such work in other areas.

A decade later, the situation had reached crisis proportions and the rehabilitation work required was considerably more expensive. Fortunately, the department was able to use national disaster relief funding allocated for a flood-aid scheme to construct five gabion weirs in the gully, with the aim of halting the erosion and stabilising the river downstream. However, the project was frustratingly delayed while the necessary environmental authorisations and water licences were obtained, highlighting the need to fast-track these applications so that degradation of irreplaceable resources can be contained.

Options for addressing headcut erosion are discussed in detail in a chapter of the Technical Manual entitled 'Managing river downcutting (incision) and gulleys'. Likewise, a chapter on managing lateral erosion of river banks provides a comprehensive overview of indirect interventions – such as protecting the banks by using groynes to redirect water flow – and direct interventions in the form of bank reshaping or stabilisation.

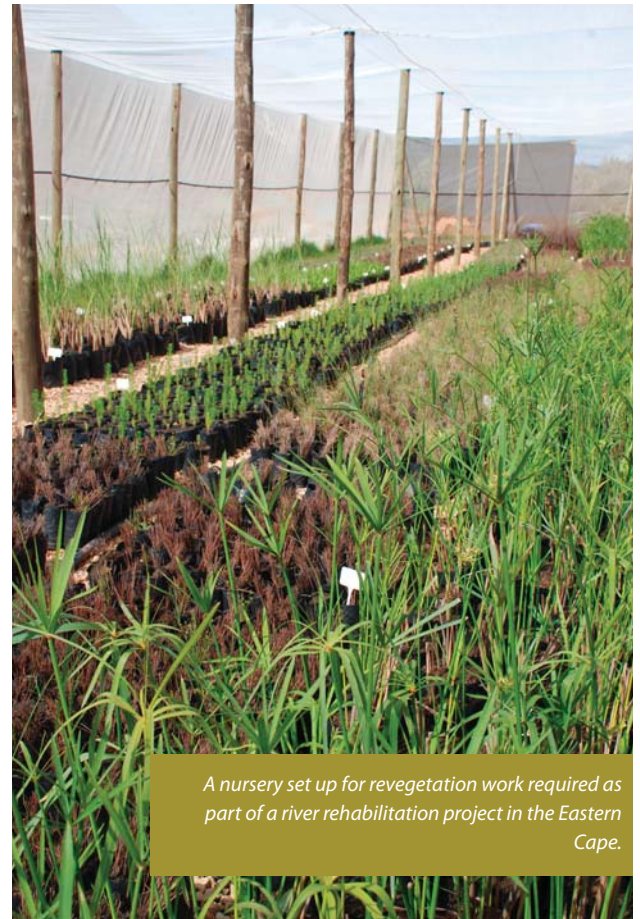
While bank reshaping involves landscaping combined with revegetation and/or erosion control mats, bank stabilisation options include concrete grass blocks, flexible armouring, riprap or retaining walls. The chapter covers various options for retaining walls, from rock-filled gabion baskets and Loffelstein blocks to the considerably less effective and less desirable use of materials such as tree stumps and tyres. The advantages and disadvantages are listed for each option, and there is a summary table rating them in terms of cost, ecological benefits, legal authorisations, technical limitations and cautions.

Generally, informal structures and 'soft' or 'greening' options involving revegetation, either on its own or in combination with geotextile mats or groynes, are only suitable for addressing small eroding areas in low-energy rivers and where failure would have limited consequences. With increasing risk, flood volumes and flow velocities, 'hard' engineered solutions need to be considered.

"When I first started out in river rehabilitation work more than 20 years ago, I naively thought we could green everything if we just planted it properly," says Liz Day. "But there are times when we need significant engineering intervention if the greener options are going to have any chance of success. The hard options can stabilise the bank to the point that we can start working on habitat quality and the softer aspects."

She points out, however, that hard options are only as good as their design, and there are plenty of examples of massive structural failure, as well as unforeseen impacts such as accelerated incision downstream due to sediment starvation.

By the same token, efforts to 'soften' hard structures – for instance, opening up a section of canal to landscape the banks and create wetland habitat – can also backfire. The case studies include examples from urban areas that have become degraded through neglect, vandalism, littering, eutrophication and alien plant invasion. While the intention may have been to provide



A nursery set up for revegetation work required as part of a river rehabilitation project in the Eastern Cape.

Credit: Sue Matthews

'green open spaces' with conservation and amenity value, changes at the site over time may not be appreciated by the local community.

Dense reedbeds are often viewed as a threat to safety and security because they pose a fire hazard and can shelter criminals, plus the large quantities of pollen and fine seed they release can be a nuisance and a hayfever trigger. And then there's the croaking frogs and the whining mosquitoes, which often preclude a good night's sleep!

"We need to think more carefully about how to integrate people into natural systems," says Day. "If not enough space is left between people and riverine or wetland systems, it's not great for the system – and it's not great for the people who live there either!"

Even in rural areas, the lack of an adequate buffer zone between rivers and human activities is detrimental to both, and is often the main driver of rehabilitation projects. This is well illustrated by a case study on the middle reaches of the Buffeljags River near Swellendam.

Historically, the river flowed as a braided system over a broad floodplain up to two kilometres wide, but agricultural development has since confined the river to a channel as narrow as 20 m. The resultant increase in flow velocities during floods, combined with deliberate removal of indigenous plants and invasion by black wattle, has had the effect of accelerating erosion.

At the site in question, rapid erosion of the outer bank at a river bend was threatening to cause financially crippling losses of orchards planted rather too close to the bank. It was also contributing significantly to the river's increased sediment load, which would encourage meandering of the watercourse, placing farmers downstream at risk.

The Western Cape Department of Agriculture therefore implemented rehabilitation works in 2012, when four groyne structures of rock-filled gabions were built along the bend to deflect the water away from the outer bank and create a protected zone for revegetation. The structures performed well during subsequent flood events, and the river channel has been successfully re-aligned.

"Certainly it would be better for the resilience of the system if the farmlands were pulled back, but most of the floodplain has been taken over by crops and that inevitably degrades the system," says Day. "Structures like groynes, to my way of thinking, are really a last resort in a system where we accept that the river needs to be permanently managed in an altered state. They allow us to prevent further degradation, make the best of what we've got, and start establishing a new level of ecosystem function."

Clearly, it is important to differentiate between changes caused by normal, natural processes of erosion, deposition and vegetation succession resulting from floods or landslips and subsequent recovery, versus lasting or ongoing damage that warrants rehabilitation. The Guidelines therefore recommend using historical records – such as anecdotal evidence, old maps, aerial photographs, Google Earth imagery and data from flow gauges and water quality monitoring – to develop an understanding of the natural condition and dynamics of the river

reach before planning a rehabilitation effort or deciding on its objectives.

Of course, bridges, weirs and dams in the watercourse, adjacent land-use practices as well as catchment-wide changes have impacts in terms of erosion, sediment load, flow regimes or water quality that are usually beyond the control of individual landowners downstream.

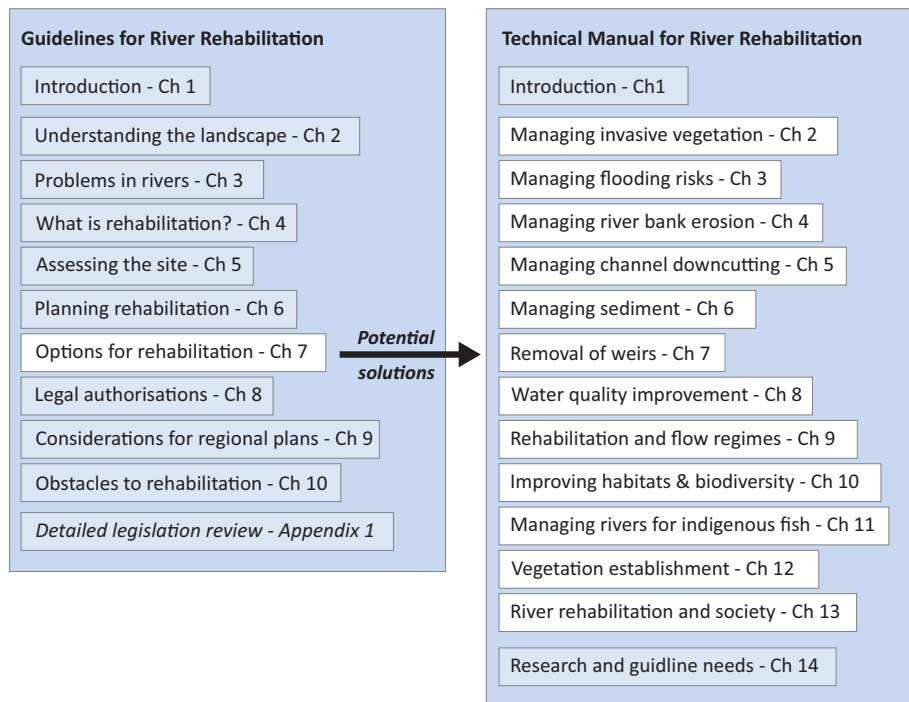
Invasion by alien vegetation is a particularly widespread problem, with a range of insidious effects, and the topic is comprehensively addressed in all three volumes of the River Rehabilitation Manual. The authors point out, however, that in some cases alien-clearing results in more severe and longer-lasting negative impacts on riverine ecosystems than the invasive vegetation itself.

Rehabilitation does not need to result in restoration of a system to its natural state. Such an objective is often neither achievable nor even desirable in some contexts.

Rehabilitation can simply be about improving some aspect of river function or condition to a more sustainable and/or more natural state.

The progression of erosion on a bend in the Buffeljags River and subsequent recovery after groyne construction in 2012. From left to right: 2004, 2011 and 2016.





Alien trees that have been felled but left in the watercourse can be washed downriver during floods, leading to blockages that damage infrastructure and increase bank erosion and riverbed scour. In addition, large areas of denuded land following alien-clearing are prone to erosion, increasing the sediment loads of adjacent rivers.

Planting cleared areas with indigenous vegetation is one means of addressing the latter, and since it is also an important part of many other rehabilitation initiatives, the chapter on vegetation establishment in the Technical Manual was contributed by landscape architect Megan Anderson, who also provided many of the illustrations.

But the authors note in their recommendations for further research that more work is needed before quantitative guidelines on using plants in river rehabilitation can be compiled.

“We’ve got very little data to back up how far we can go in using plants as erosion stabilisers,” notes Day. “For engineering interventions there’s quite a lot of data about velocities and roughness coefficients, and how hard options should be designed accordingly, but when you’re talking about using root structures in soils, for example, we just don’t have enough data to be able to sign off with confidence that in any particular scenario, planting with species x, y and z will be adequate.”

During the course of the project, a first step towards quantifying conditions for using vegetation for erosion control was provided by Prof Chris James and an MSc student, Megan van der Haar, of the Witwatersrand University’s School of Civil and Environmental Engineering. They developed guidelines for using plant roots to control slip failure on river banks, but these relied on functional trait classes developed for Northern Hemisphere conditions and plant species, so adaptation to South Africa was at a relatively low confidence level.

Prof James co-authored a number of chapters in the Technical Manual, while freshwater fish specialists Bruce Paxton and Dean Impson contributed the chapter about managing rivers and dams for freshwater fish. A detailed overview of legislation applicable to river and wetland rehabilitation activities was compiled by Samantha Braid and Clarissa Molteno, with the recommendation that the provincial environmental authority and regional catchment authority be contacted prior to undertaking any rehabilitation activities, to ensure that the most up to date requirements are adhered to.

Braid was the author of an earlier guideline entitled *Tools to determine enforcement-driven rehabilitation objectives on urban river reaches*, published by the WRC in 2014. That guideline focused specifically on enforced rehabilitation, when a regulatory body issues an Administrative Notice – such as a directive, compliance notice or court order – instructing a perpetrator to rehabilitate a river reach to remedy an illegal or non-compliant activity and the resulting disturbance.

The WRC Research Manager for both projects, Bonani Madikizela, notes that there are also commonalities with earlier WRC-funded research projects to develop guidelines on water sensitive urban design and the implementation of sustainable drainage systems, or SuDS, for stormwater management. Many of our urban rivers are little more than stormwater conduits, and the River Rehabilitation Manual includes case studies on efforts to improve their water quantity management, water quality treatment, amenity value and biodiversity.

In its latest open call for proposals, the WRC has budgeted R900 000 for the 2017/18 financial year for the thrust ‘Ecosystem rehabilitation, remediation and restoration’, which falls under KSA 2: Water-linked Ecosystems. The River Rehabilitation Manual is sure to prove an informative reference for future researchers, as well as a vital resource for anybody planning to implement a rehabilitation project.

Irrigated agriculture

Monitoring soil salinity and waterlogging using satellite images

The high cost of measuring waterlogging and salt-affected soils, as well as inconsistencies in data collection and reporting methods, have resulted in incomplete and often contradictory information on the extent and distribution of salt-affected and waterlogged soils. A new study, funded by the Water Research Commission (WRC) and led by the Agricultural Research Commission (ARC) and Stellenbosch University, examined the potential of various data sources and techniques for monitoring the affected areas.

Karen Grobler reports.



All photographs courtesy Agricultural Research Council

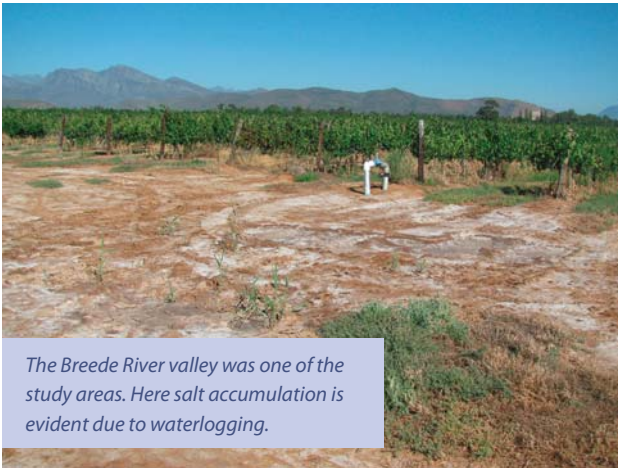
The consequences of incorrect management or incorrect selection of irrigation areas can be disastrous, causing irrigation areas to become waterlogged and/or salt-affected, thus making them unfit for continued sustainable irrigation. It is clear from available information that the extent of degradation varies considerably between irrigation schemes in South Africa and also over time within the same irrigation scheme.

Since the late 1980s no national effort has been made to determine the extent of waterlogging and salt accumulation across irrigation schemes in South Africa. Indications are that soil and water quality are declining and these problems are

in fact escalating. Quantifying the extent of waterlogging and salt accumulation is crucial to identify soils for drainage and reclamation.

Traditionally, soil salinity has been measured by collecting soil samples on-site for analysis. However, these methods are time-consuming and costly since dense sampling is required, and remote-sensing data and techniques are more efficient and cost-effective.

A recently completed WRC project by researchers from the ARC and Stellenbosch University sought to determine the



potential of various data sources and techniques for monitoring waterlogging and salt accumulation. The purpose of this study was to develop a method to detect potential areas of salt accumulation or waterlogging so that in-field monitoring can be performed.

Various data sources and methodologies were investigated, which included:

- land cover mapping;
- bare soil analysis (i.e. direct approach);
- vegetation monitoring (i.e. indirect approach)
- terrain analysis;
- within-field anomaly detection; and
- decision tree analysis.

In developing a suitable methodology, the researchers applied the various data sources and techniques and compared them to reference data to determine their potential.

The researchers applied the techniques within three main strategies:

1. Using a **direct remote-sensing** approach to detect salt accumulation. Researchers used a satellite image with a very high spatial and spectral resolution to investigate the relationship between known affected areas – as determined by electrical conductivity (EC) measurements – and a range of image features.
2. Using an **indirect remote-sensing** approach to monitor salinity levels by investigating vegetation response to saline conditions. Two different data sources were evaluated in two different areas.

The first series of experiments used a very high resolution satellite image (WorldView-2 satellite imagery) to detect changes in vegetation response within a lucerne field, while the second series of experiments used high resolution images (SPOT-5 imagery). Two dissimilar irrigation schemes – Vaalharts and Breede River – were used, to determine how the techniques are influenced by variations in how different types of crops respond to saline conditions.

3. Investigating the relationship between **terrain data** and

waterlogging and salt accumulation. Statistical analyses were done to find continuous relationships between terrain features derived from 3D representations of the terrain's surface (digital elevation models).

Each technique was assessed in terms of its accuracy to find a solution for quantifying and monitoring waterlogging and salt accumulation at a national level.

Field verifications of the various satellite images were done at nine irrigation schemes – Vaalharts, Loskop (Olifants River), Vredendal (Olifants River), Makhathini, Sundays River, Tugela River, Limpopo River, Douglas (Vaal and Orange River) and Breede River.

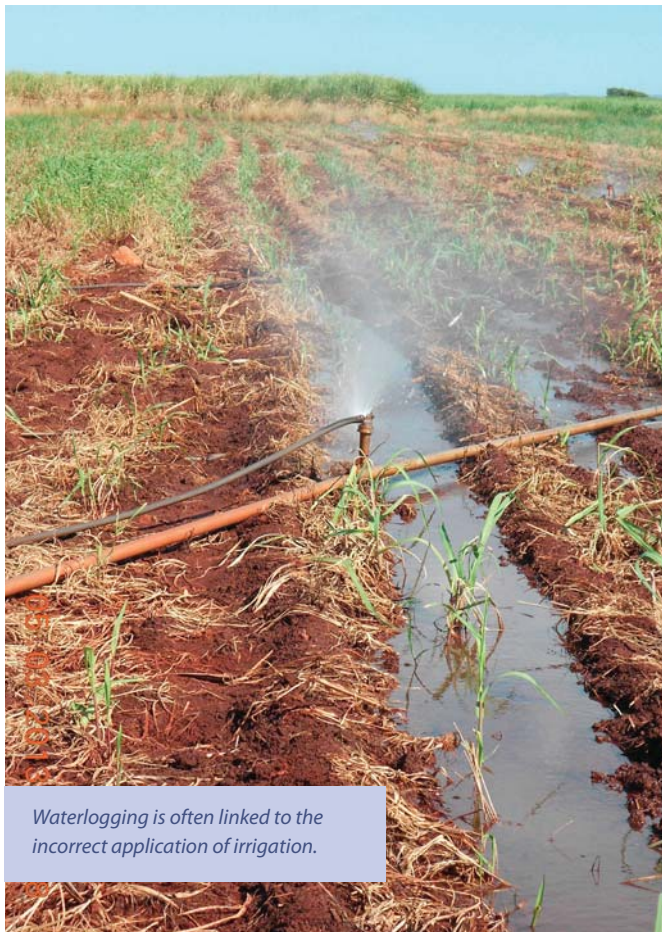
Soil samples were taken at the observation points for analysis and quantification of the salt content. In addition, historical soil maps and reports were also used to identify problematic areas and to compare the change in salt-affected and waterlogged soils over time.

Bare soil analysis

For the direct remote-sensing approach a WV-2 satellite image was used as it had the highest possible spatial and spectral resolution available at the time of the analysis. Although such imagery is too expensive it helped to establish a "best scenario" option. Researchers could also compare how less expensive imagery might perform.

Eye in the sky – learn the lingo

- **Remote sensing:** The science of obtaining information about objects or areas from a distance, typically from aircraft or satellites.
- **World View-2 satellite:** WorldView-2 (WV-2), launched in October 2009, is a high-resolution, multispectral commercial satellite, owned by DigitalGlobe. Operating at an altitude of 770 km, WorldView-2 provides black and white (panchromatic) and colour (multispectral) digital imagery.
- **SPOT-5 satellite:** SPOT-5 is a high resolution satellite that was launched in 2002. It is owned and operated by Airbus Defence and Space and collects image data. The satellite captures both black and white and colour digital imagery. SPOT-5 was decommissioned in 2015.
- **Spatial resolution:** The pixel size of an image representing the size of the surface area (i.e. m²) being measured on the ground, determined by the sensors' instantaneous field of view.
- **Spectral resolution:** The wavelength interval size and number of intervals that the sensor is measuring.
- **Temporal resolution:** The amount of time (e.g. days) that passes between imagery collection periods for a given surface location.



Waterlogging is often linked to the incorrect application of irrigation.

Researchers found a number of significant relationships between image features and salt accumulation. However, the use of satellite imagery was found to be unreliable as it grossly overestimated salt accumulation. This was attributed to the inconsistencies in the visual appearance of salt-affected soils as in many cases there was no visible evidence of salt accumulation.

Another factor that complicates the detection of salt accumulation when bare soils are observed is the soil disturbance caused by actions such as ploughing, that can alter the soil surface. But, the main limitation of this approach is that a small proportion of fields in irrigation schemes are bare at any given time. The implication is that multiple analyses will be required to map an entire irrigation scheme, which will be costly.

Vegetation monitoring

The indirect remote-sensing approach was evaluated in the Vaalharts and Breede River irrigation schemes. A satellite image of a lucerne field at Vaalharts was used for evaluating vegetation response to saline conditions.

Several experiments were also done to investigate the effect of reduced spatial and spectral resolution, testing the hypothesis that very high spatial resolution is required for monitoring waterlogging and salt accumulation.

The results showed that there are significant and strong

relationships between electrical conductivity and several features considered. Generally the strength of these relationships diminished as the spatial resolution was reduced.

The researchers concluded that the high cost of WV-2 imagery does not make it a viable option. The result shows that slightly lower resolution imagery might produce comparable results.

As crops differ in their response to saline conditions, an additional series of experiments was done to investigate how these variations will affect the results. These experiments were done in the Vaalharts and Breede River study areas using slightly lower resolution satellite imagery (SPOT-5).

It was found that the spectral response of affected crops differed considerably between the two study areas, which tended to produce many false positives.

The researchers recommended that various factors have to be considered when selecting a specific source of satellite imagery for a classification project. The spatial, spectral and temporal resolutions are important factors, as is cost.

Terrain analysis

The final set of experiments investigated the capability of elevation data to model salt accumulation. Vaalharts and Breede River were again chosen as the study areas and various elevation models, derived from aerial photography, were used as primary data sources. However, the researchers concluded that the use of elevation data is ineffective and unreliable. Most of the methods evaluated either underestimated or overestimated salt accumulation.

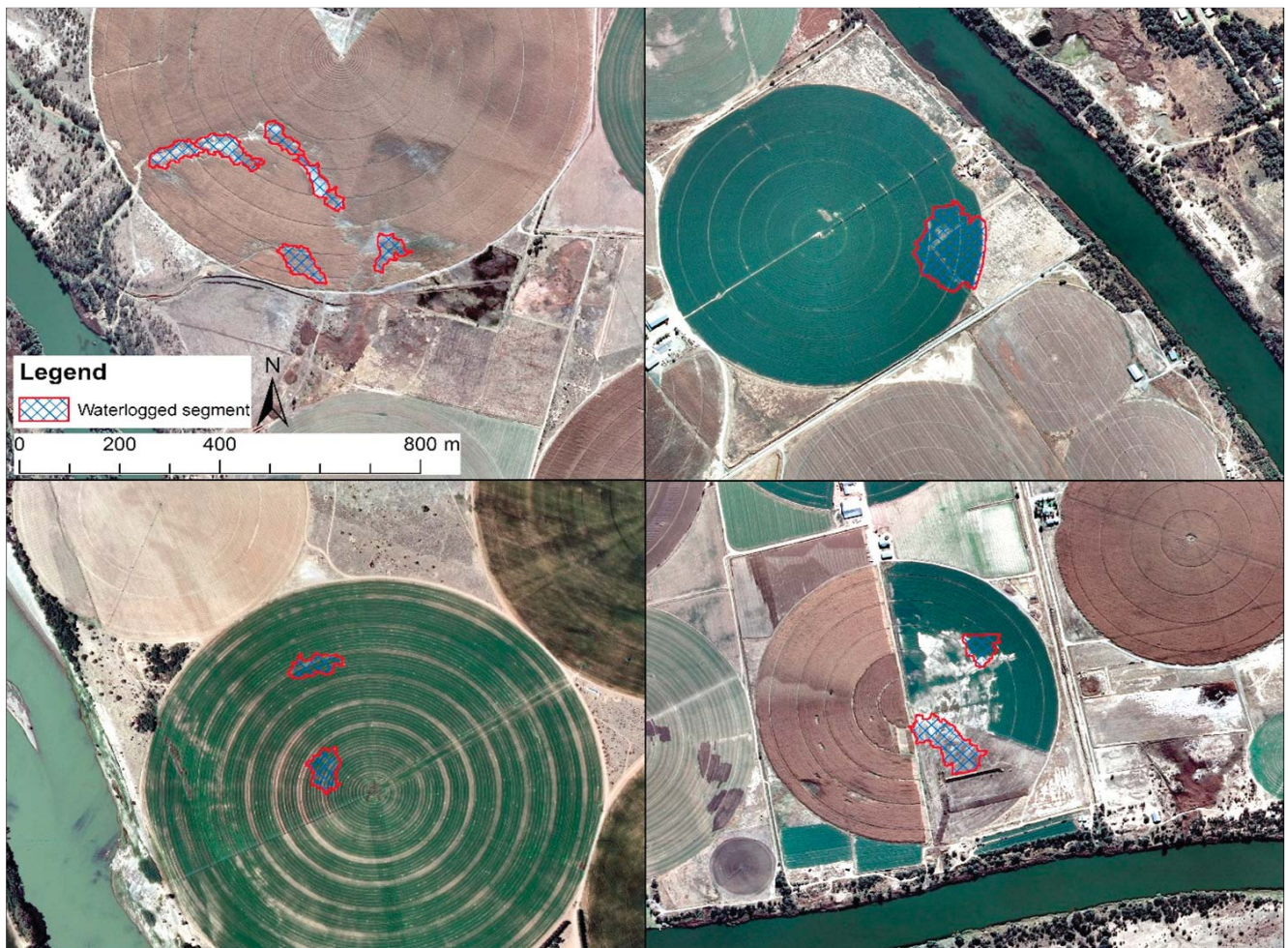
Within-field anomaly detection

The within-field anomaly detection (WFAD) method was used to produce maps of areas that were likely to be affected. This technique is based on the principle that in many cases dissimilar areas indicate waterlogging and salt accumulation. Affected areas are seen as spectrally different compared to the rest of a field, either because of a reduction in biomass or due to specific species of vegetation occurring in fallow fields.

The researchers found that although WFAD is very successful in identifying salt-affected and waterlogged areas, its main limitation is that it cannot discriminate such areas from anomalies that are caused by other factors (e.g. drought, flooding, soil compaction, disease, inadequate fertiliser application).

The researchers concluded that the WFAD method is a scoping mechanism that can direct attention to areas that are likely to be affected by salt accumulation and/or waterlogging and recommended that these areas should preferably be visited to investigate the probable causes.

On average, 3,3% of the areas considered were found to be affected and this figure was adjusted to 6,27% to include abandoned fields. If this figure is applied to the 1,5 million hectares under irrigation in South Africa, the area that is



Using various remote sensing techniques it was determined that approximately 94 050 ha of South African farmland is affected by waterlogging and salinisation.

About salt, soil and water

Soil salinity: An excessive accumulation of salts in the soil profile that causes a decline in agricultural productivity.

Waterlogging: The lowering in land productivity through the rise in groundwater close to the soil surface. Waterlogging is linked with secondary salt affected soils, both the result of incorrect irrigation management.

salt-affected and waterlogged on South African irrigation schemes is 94 050 ha.

The answer lies in a combination

The occurrence of salt accumulation and waterlogging in generally small patches in South African irrigation schemes poses unique challenges and will require a robust modelling strategy.

The researchers concluded that none of the methods stood out as being the ultimate solution, with each having some kind of

limitation. The direct and indirect remote-sensing approaches show the most promise as they can be applied to high resolution, multispectral satellite imagery.

The researchers emphasised that no model based on remotely sensed data will ever replace in-field monitoring. It is consequently likely that the solution lies not in one technique but in a combination of methods.

The conclusion made in this project is that this science is still in an experimental phase, and great strides still need to be made before such an application can be operational.

The researchers suggested that in order to find the best combination of methods for monitoring waterlogging and salt accumulation, each of the most promising techniques must be evaluated in a South African context to better understand their individual strengths and limitations.

- To access the report, *Methodology for monitoring waterlogging and salt accumulation on selected irrigation schemes in South Africa (Report No. TT 648/15)*, contact Publications at Tel: (012) 330-0340; Email: orders@wrc.org.za; or Visit: www.wrc.org.za to download a free copy.

Biodiversity protection

National Biodiversity Assessment – Testing the integrity of our freshwater ecosystems



The current, nationwide drought has not only underlined the importance of water to South Africans, it has also emphasised the need to protect our freshwater ecosystems. The Third National Biodiversity Assessment – to be completed in 2018 – is assessing the threatened status and protection level of South Africa's freshwater and estuarine ecosystems.

Article by Heidi van Deventer, Lara van Niekerk, Lindie Smith-Adao, CJ Poole, Jeanne Nel, Chantel Petersen and N Collins.

Intact freshwater and estuarine ecosystems sustain food and water security to many people and organisms in South Africa. Degraded ecosystems, on the other hand, result in an increase cost for water filtration and purification as a result of eutrophication and chemical pollution or because of an increase in suspended solids, and in general can result in a loss of income and sense of aesthetics and value. In fact, in light of the recent drought, the President of the Republic of South Africa, President Jacob Zuma, issued a Cabinet Statement on 9 June 2016 that "Team South Africa is encouraged to participate in the cleaning up of rivers, streams and wetlands on 18 July, as part of South Africa's annual Mandela Day activities."

But how do we know how we are faring as far as the general health of our freshwater systems are concerned? Securing the ecosystem services that freshwater and estuarine ecosystems provide, requires a proper inventorying, assessment and monitoring of these ecosystems over time.

A National Biodiversity Assessment (NBA) recognises the need to efficiently conserve a representative sample of ecosystem types and species in a natural or near-natural state as well as the ecological processes that allow them to persist over time. The assessment of the Ecosystem Threat Status as well as the Protection Levels of these ecosystems is essential for sustaining the benefits of these ecosystems and reducing the risks of losing ecosystem services.

The NBA of South Africa evaluates the status and changes in ecosystems at regular intervals and serves as the primary informant of National Biodiversity Framework, prepared and gazetted by the Department of Environmental Affairs (DEA) under the National Environmental Management: Biodiversity Act (10/2004); and of the National Biodiversity Strategy and Action Plan, prepared by DEA under the International Convention on Biodiversity.

The NBA2018 is currently under way, preparing for the

assessment across four environments comprising freshwater, estuarine, marine and terrestrial. In the first National Spatial Biodiversity Assessment only the quaternary main-stem rivers were assessed, whereas the 2011 assessment included main-stem rivers, their tributaries and wetlands.

For the estuarine ecosystems, the 2004 assessment evaluated estuaries based on available data, while the 2011 assessment developed a national health assessment method and a National Estuaries Biodiversity Plan for nearly 300 systems. Pressures such as flow modification, pollution and habitat destruction are systematically evaluated as part of the assessment.

The NBA2018 will include a focus on the status and genetic diversity of species, alien invasive fauna and flora, and impacts of climate change (Figure 1). Where possible, trend analysis will ascertain whether changes in the status of ecosystems or species occurred over time.

Realms→		Realms			
Themes↓					
Assessment of Biodiversity	Describe the range of Benefits of Biodiversity	Terrestrial	Freshwater (Wetlands & Rivers)		
	Describe Biodiversity			Estuarine	
	Ecosystem				Marine & Coastal
	Species				
	Genetic				
	Describe Pressures on Biodiversity and their Trends over time				
Assess the Status of biodiversity (Ecosystem Threat Status and Protection Level)					
Determine the Trends in biodiversity Threat Status over time					
Describe the range of Responses to Biodiversity Pressures					

Figure 1: Components of the National Biodiversity Assessment of 2018.

Any biodiversity assessment is dependent on the foundational data gathered during an inventory of the characteristics of the different ecosystem (Figure 2). The NBA2018 team is currently finalising the update of information related to the National Freshwater Inventory and attempting to address the tremendous underrepresentation of wetlands in the National Wetland Map.

For freshwater and estuarine systems, the classification system for wetlands and other aquatic ecosystems in South Africa will be used, which distinguishes between inland and marine aquatic ecosystems at the highest levels and further divides ecosystems into types at the lower levels. Similarly, information is also being collated on estuarine features and variables that will enable the refinement of the typing of South Africa's estuaries.

The NBA2011 stressed that a major gap was the lack of reliable information on the occurrence and state of South Africa's freshwater wetlands. Therefore, a major focus of the NBA2018 will be to improve on the occurrence, typing and condition assessment of the wetlands of South Africa.

As part of the inventory and classification process, artificial wetlands will be removed from the typing prior to dividing the natural wetlands into seven functional types including rivers, floodplain wetlands, depressions, channelled and unchannelled valley-bottom wetlands, wetland flats and seeps at Level 4A of the classification system. Further divisions include the regional settings and four landscape types (benches, slopes, plains and valleys) at Levels 2 and 3 respectively.

A situation assessment is currently being finalised that identifies various data sources that have been published since the 2011/2 projects for inclusion in the National Freshwater Inventory. The initial results show that less than 12% of the country's surface area has fine-scale wetlands data. These fine-scale data would be used and categories cross-walked to the national classification system with guidance from the respective ecologists.

Wetland occurrence will be predicted for data-poor areas from a model developed by Dr N. Collins from the Department of Economic, Small Business Development, Tourism & Environmental Affairs of the Free State. The ability to predict the occurrence, type and condition of wetlands will be investigated in a project funded by the Water Research Commission (WRC), project K5/2546, with the project lead being Namhla Mbona (SANBI). The WRC Research Manager on this project is Bonani Madikizela.

South Africa has a great diversity of river ecosystems which will be represented by classifying the 1:500 000 river network into subtypes. These river ecosystem types can be regarded as coarse-filter surrogates of biodiversity, conserving the diversity of many common and widespread species, and their associated habitats. They are components of rivers with similar physical features such as climate, flow and geomorphology which under natural conditions, are expected to share similar biological response potential.

They will comprise of distinct combinations of Level 1 ecoregions, flow variability descriptions and slope categories. Specifically, delineation will include 31 Level 1 ecoregions and four slope categories (mountain streams, upper foothills, lower foothills and lowland rivers). For the NBA2011 flow variability was broadly described using two categories: permanent (perennial and seasonal rivers) and not permanent (ephemeral rivers) from the Department of Rural Development and Land Reform: National Geospatial Information. During NBA2018 the team is attempting to improve upon these descriptions.

For the NBA2018 Estuaries component data have been collated from a number of regional-scale studies: WRC K5/2187 Desktop provisional EcoClassification of the Temperate estuaries of South Africa (Orange to Mbashe), Mvoti to Mzimkulu Water Management Area (WMA) Classification, the Gourits WMA Reserve, the Usutu WMA Reserve; the Lower Orange WMA Reserve, and a Desktop assessment of the Ecological Condition of South Africa's Temperate – Subtropical Transition Zone Estuaries based on a Provisional EcoClassification.

All but four estuaries (Thukela, Siyaya, Mhlathuze/Richards Bay, Nhlabane) have been systematically re-assessed in the last five years, with the decline in condition of the Thukela Estuary being the key unknown as a result of the major barrage recently constructed just upstream of the estuary. In addition, the CSIR, in partnership with the Nelson Mandela Metropolitan University (NMMU) and the Oceanographic Research Institute, is collating habitat data on all the estuaries in the country as input to a revised classification system.

To be included in the updated classification system is the large number of micro-estuaries currently excluded from assessment



The National Biodiversity Assessment will include an increased focus on South Africa's wetlands.

and planning processes. Information on the micro-estuaries are being collected by the South African Institute for Aquatic Biodiversity (SAIAB), NMMU, Ezemvelo KZN Wildlife, the Department of Agriculture, Forestry and Fisheries (DAFF) and the CSIR.

Building on the NBA2011, the CSIR in partnership with a range of institutions have compiled a National Estuary Management and Monitoring register. The register links management measures (e.g. Estuary Management Plans and Freshwater flow requirement studies) and monitoring activities to the key parameters being evaluated as part of estuary health assessments, as well as the present and desired future state of South Africa's estuaries.

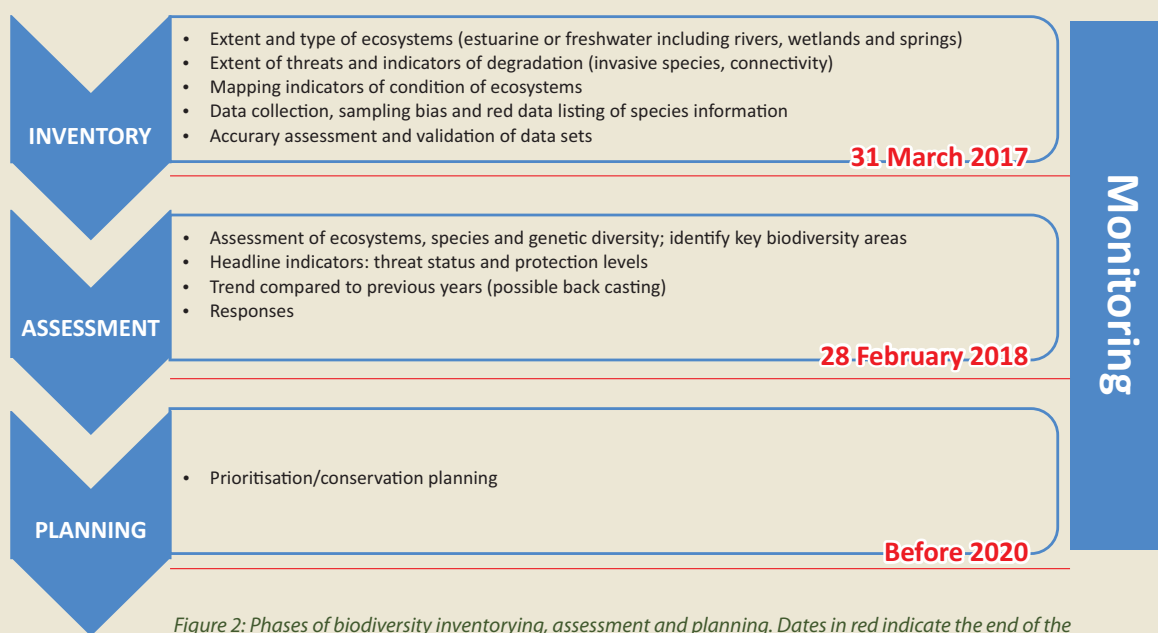


Figure 2: Phases of biodiversity inventorying, assessment and planning. Dates in red indicate the end of the phase for the NBA2018, though the update and validation of data may continue for the next NBA2025.

The sampling bias and red data listing for a number of freshwater species will be done by the SANBI under leadership of Domitilla Raimondo. The freshwater component will consider fish, wetland dependent birds and frogs, damsel and dragonflies (Odonata) and possibly wetland vegetation.

Freshwater invertebrate data available from the Department of Water and Sanitation (DWS, <https://www.dwa.gov.za/iwqs/rhp/naehmp.aspx>) will be considered, which includes the representation of amphipods related to groundwater. Key species experts from other organisations have been identified to partake in the assessments, including the SAIAB, the Albany Museum and experts from universities.

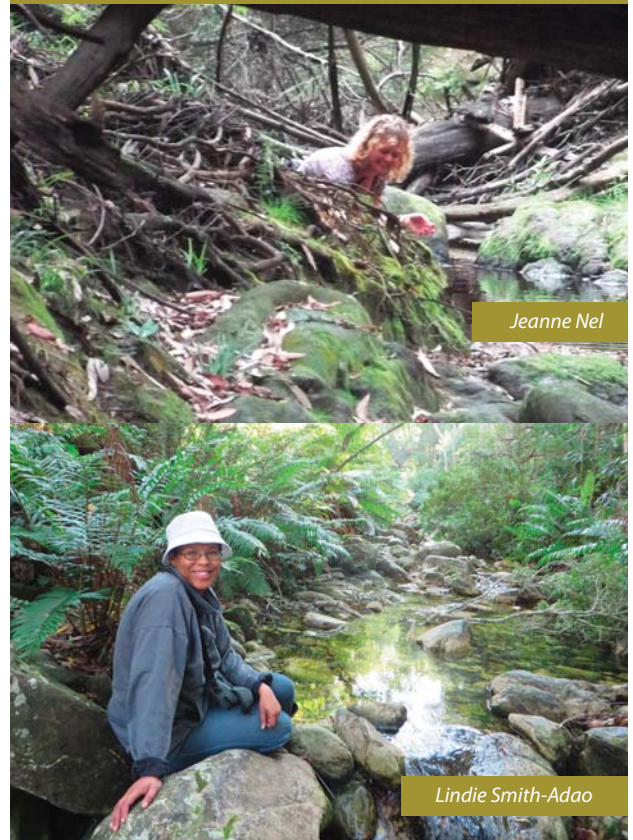
The feasibility of trend analyses will also be investigated as well as priority indicators and keystone species for the next NBA (approximately 2025). From an estuarine perspective, mangroves and saltmarsh will be a key group of species that will be assessed in the NBA2018 by NMMU and SANBI.

Similarly, exploited estuarine-dependent linefish species will be evaluated in by SANBI and DAFF.

Anguillid eels are a group of more intriguing fish species, and add information on the connectivity between marine, estuarine and freshwater ecosystems. Eels are catadromous, migrating from the marine ecosystems where it breeds at abyssal depths of ocean gyres, through estuaries to riverine ecosystems. The occurrence of the species indicates ecosystem health or intactness in certain regions. Damming of rivers, poor water quality, invasive alien fish and pathogens in rivers and estuaries negatively impact the habitat of this species.

Similar to the previous two assessments, SANBI and the CSIR will partner in the NBA2018, with the CSIR particularly focusing on the freshwater and estuarine environments. Scientific and technical assurance will be provided by the Estuarine, Wetland and River Ecosystem Classification Committees and communication is planned at various conferences and meetings. A temporary web map viewer (<http://gsdi.geoportal.csir.co.za/projects/national-biodiversity-assessment-of-2018>) has also been created to allow people to view the freshwater ecosystem types and provide corrections and feedback to the team. More permanent viewers for the freshwater and estuarine components will be communicated in due course.

Team members that are working on the freshwater and estuary sections of the National Biodiversity Assessment 2018 are Jeanne Nel, Lindie Smith-Adao, Heidi van Deventer, Lara van Niekerk, Chantel Petersen and Namhla Mbona.



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Heidi van Deventer



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Water and society

Groundbreaking study examines Islamic legal view on water reclamation

New research published by the Water Research Commission (WRC) offers valuable insights into Islamic jurisprudence on wastewater proclamation, reports Jorisna Bonthuys.



In a country with growing water scarcities, the perceptions of local water users about reclaiming waste water is becoming increasingly important. Every drop counts and it will do even more so in the future, especially with increasing demands on resources from different user groups and the emerging realities of climate change.

The idea to reuse and recycle water is also gaining traction in a number of municipalities faced with water resource constraints. Yet many local authorities are not aware of public perceptions around reclaimed water use. What are water users' perceptions about these plans?

In a WRC-funded study – the first of its kind – in-depth analysis was recently conducted into Islamic *fiqh* (jurisprudence) on

water. This refers to the method of discovering legal provisions from specific evidence, in this case from Islamic law or Sharia.

Although the results are of particular interest and relevance to Muslim end-users as well as the municipalities that serve them, it also has relevance for other water user groups in the country, the researchers say.

The need for the research was recognised after a public protest in 2012 following eThekweni (Durban) municipality's controversial toilet-to-tap proposal. The march was largely led by Muslim residents who handed in a petition to the municipality in response to plans to augment its potable water supply with reclaimed wastewater. This was called 'toilet water' by some residents.

At the time the idea of purifying wastewater from KwaMashu and elsewhere and then blending it with conventionally treated water was reportedly considered controversial by local residents. Many Muslim users, in particular, considered it unclean and un-Islamic, and turned to religious jurists and scholars to find out if it was permissible or not.

Social science researcher, Hamed Deedat, an activist and researcher in the water sector, decided to undertake an investigation into the matter. She collaborated with well-known Islamic scholars and academics Prof Abdulkader Ismail Tayob and Azizur Rahman Patel on this study. Prof Tayob holds a Research Chair at the University of Cape Town (in Islam and Religious Values). Deedat, employed at COSATU's research arm called NALEDI, says they wanted to look more closely at the significance of water and water purification in Islam.

The perception of many Muslim users was that reclaimed water is unclean, hold impurities and is therefore impermissible for drinking. This perception was inferred on reclaimed water without ascertaining its potential of being restored to its pure form (or *tahaara*). Since both researchers and local clerics themselves had not investigated this matter, the perception was based on opinion.

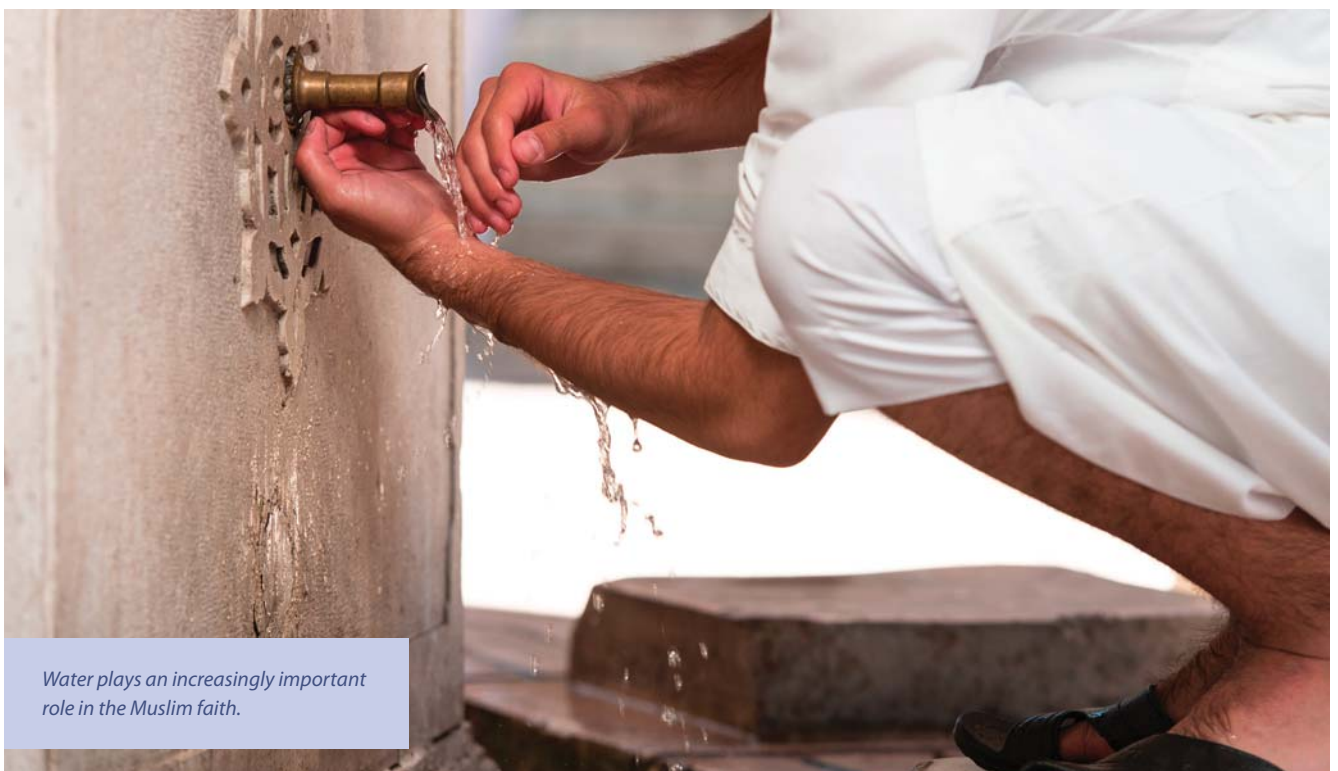
Says Deedat, "Rather than looking for a yes or no answer (on water reclamation), we wanted to delve deeper into the ethical, moral and cosmological universes of Islam on the significance of water and water purification. What does Islam say about water purification? Is reclaimed water permissible for potable use in accordance with Islamic jurisprudence and ethics? These were some of the issues we hoped to get clarity on."

The researchers were interested in lessons from the values and practices developed by Muslim jurists on water and water

purification, given contemporary challenges. They also wanted to know how Muslims outside South Africa addressed the question of water reclamation in recent times.

The WRC-funded study consisted of different components, including a literature review of wastewater use and practices in Islamic countries (see sidebar). The researchers prepared preliminary reports looking at water management and reclamation practices elsewhere. These documents were circulated to religious leaders from Cape Town, Johannesburg and Durban for their comments and suggestions. These leaders play a significant role to guide Muslim water users in masjids (mosques) and other community settings around the country. The issues covered in the reports were also discussed at a meeting with ten representatives of religious bodies to deliberate their findings.

The insights gained into Islamic jurisprudence on the subject were "groundbreaking", says Deedat. "The (local) scholars supported the findings that as per jurisprudence indirect potable use is acceptable. While there were some who held a dissenting view, they also supported greater efforts to curb wastage and leaks in water-supply systems at the municipal level." The scholars agreed on the necessity for pure water, and for some process of purification needed for cleansing "ritual" purposes such as ablution (*ghusl*). They also agree that impurities that change the quality of water should be removed and that a high degree of dilution is considered to be a form of purification (as long as the characteristic of the water does not change). They were also generally in agreement that water reclamation met the minimum requirements for the ritual purification. "Reclaimed water from which impurities were completely removed such that the natural qualities of water (taste, smell and sight) were restored, could be used for ablution facilities in mosques," the report states.



Water plays an increasingly important role in the Muslim faith.

Water reclamation in Muslim majority countries

The treatment of wastewater has become a necessity in many Muslim countries. This is evident in a recent report on Islamic jurisprudence and reclaimed water funded WRC. "The availability of resources, and forward planning has put some countries in a lead. But is also clear the demands will be increasing in the next few years, and the treatment of wastewater cannot be postponed any further," the report states. "The threat of water shortage, and particularly water that is suitable for agriculture, and direct human potable use, is as acute as elsewhere in the world."

Water reclamation practices are very common in a number of Muslim majority countries, some already doing it as far back as 1965. This is mostly the case for agricultural purposes. More recently, reclaimed water has become a valued water source for urban irrigation and indirect potable use, the report states. The re-use of municipal wastewater plays an increasing role in meeting water demands.

Within in the Arab world Tunisia, Jordan and the Gulf countries are considered leaders in the area of water reclamation and reuse. These countries all have very limited water resources, acting as catalyst for many innovative water solutions. By 2008, it was reported that wastewater use constituted 10% of Jordan's total water supply with close to 85% of its treated wastewater reused. In Saudi Arabia, the United Arab Emirates, Kuwait, Qatar, Bahrain and Oman about 40% of treated wastewater is used to irrigate non-edible crops and fodder, and for landscaping. In the United Arab Emirates approximately 20% of the wastewater produced in urban areas are being reused.

Most of the Muslim majority countries have so far decided on water reclamation practices on the basis of need, demand and economic viability, explains Hamed Deedat, one of the researchers involved in the WRC study. "It is clear that those countries that face lower rainfall, urbanisation and high population growth face greater challenges in reusing water and reclaiming water."

Water reclamation and purification were not considered prohibited practices as such. The scholars were supportive of the goals of water management and conservation strategies. The purity of water for potable use could not be limited to considerations of purification practices, but had to look at the broader challenge of offering pure water for human consumption. "It was felt that water reclamation was in principle desirable and allowed," the report states.

The scholars also raised concerns about water management in the country. They were concerned about the health risks associated with both wastewater and reclaimed water. Such risks were equally important from the religious ethical principle of removing harm. "More directly, they felt that communities should be directly engaged in better local and municipal practices of



water management. The group also proposed some practical steps to support water recycling in the Muslim community, including at local masjids," explains Deedat.

They felt that greater attempts should be introduced to reduce or eliminate wastage. Currently, an estimated 24% of South Africa's water is wasted through leaks and poor infrastructure. They called upon religious leaders to lead by example and introduce water saving and recycling measures. This included an interesting observation that the requirements for *tahaara* water (fit for ritual purification) was provided by water reclamation.

Islam and water

These conclusions have a direct impact on the assessment of water purification systems in contemporary societies, Deedat explains.

Up to now the use of wastewater in Islamic countries were limited to agriculture and recreational uses and not for the purposes of potable use (see sidebar).

Saudi Arabia is unique among Muslim countries to have a juridical opinion (*fatwā*) from the state's Council of Leading Scholars in 1978 that wastewater purification was permissible for water reuse in agriculture and recreation. Other Islamic countries were making use of wastewater for irrigation (noting the nutrient content of the water) without hesitation.

Furthermore, this *fatwā* was issued before the restrictions pertaining to health risks were brought in by the World Health Organisation and the United Nations' Food and Agriculture Organisation that has required some level of wastewater treatment before use on agriculture, for example, for citrus fruit.

Apart from the citation of this Saudi *fatwā* and a report conducted by the International Development Research Centre in 2001 the literature has been silent on the jurisprudence aspect, offering more focus on perceptions. "Perhaps this is since potable use was not a consideration before, and that technologies to reclaim water to guarantee health safety and purification requirements were non-existent initially," Deedat explains. "Municipalities across the world were also slow on the uptake

of the use or potential use of this technological advancement. Saudi Arabia for example has opted for sea water desalination despite the costs, and has never considered wastewater reuse in this way."

Currently, purification practices dominate the discourse of water in Muslim communities. The main ethical concerns of water use are according to the research related to personal hygiene and state of purity, particularly in relation to prayer, physical and spiritual purification are interlinked. Water occupies pride of place at the beginnings of books of law.

While Muslim jurists have classified water and impurities extensively, the main framework of the juridical tradition was also shaped before industrialization and modern scientific threats. This bears strong relevance today given the levels of pollution and decay of our fresh water resources in South Africa but also globally, the report states.

Yet the Islamic jurisprudence tradition treats water as a precious resource and this is regardless of the abundance or scarcity of the resource and guards against polluting it. As such the juridical foundations seemed to be applicable to modern contaminants that threaten natural water use, the report states. "The basic methods of purification conform to the goals of modern water reclamation and provide a basis of supporting water reclamation for general human use," it says.

Water futures and Muslim users

It is clear that the process of water reclamation as an artificial process complies with the requirements as per Islamic jurisprudence for water being restored from its state of impurity (*tahur*) to a state of purity (*tahara*), the report highlights.

It also emphasizes that water is not a neutral resource, but shaped by cultural and religious values and practices. "The success or failure of water management will not only depend on the implementation of new technologies to a vital and strategic resource," the report states.

Deedat believes this study therefore paves the way for "much needed engagement" around water management issues between municipalities and Muslim end-users. "This research has ramifications beyond South Africa's borders, particularly in parts of Africa and the Middle East as it provides new insights into Islamic jurisprudence on the subject," she says.

The scope of this research should now be expanded to many communities and cultures that share water in the country, she believes. "A detailed map on the cultural value and significance of water would be invaluable for water management in South Africa," she says. "Such projects would support local water management practices. More significantly, they will lead to greater insights on how to enhance water management and water use at a local level."

Similar processes with other distinct water user groups in the country could provide valuable insights that could support and improve democratic water management processes, she believes. This is particularly relevant for municipalities who are considering reclamation as part of their water management

strategy.

The main contribution of this research lies in underlining the religious significance of water not just for Muslims but for all users in the country, Deedat believes. "A bottom-up approach to reuse and reclamation in the local context remains critical for communities to realise their right to clean water," she says.

According to Dr Sudhir Pillay, WRC Research Manager, the research also presented a detailed framework for understanding the ethical and juridical significance of water and its re-use from a religious context. "Further, the study showed that religious leaders could stimulate local communities to improve water management in their area," he says

Deedat believes the reaction from the people of Durban in general, and the Muslims in particular, should be placed in a wider context of water research and the cultural and religious significance of water. "Water resonates deeply in the daily lives of Muslims in South Africa and beyond," she says. Seeing that the project limited itself to solicit the views of religious leaders, future projects should find ways of engaging with end-users of water, Deedat concludes.

"We wanted to delve deeper into the ethical, moral and cosmological universes of Islam on the significance of water and water purification."

Direct or indirect reuse of water

The reuse of water can either be direct or indirect. With indirect re-usage, the treated wastewater is discharged into natural surface or groundwater sources. The water is then abstracted downstream for further treatment prior to it being used for the next process. Indirect reuse of wastewater is commonly used where treated effluent from a wastewater treatment plant is typically discharged into a river. Downstream, a water treatment plant abstracts this water and treats it to potable standards. This is called indirect potable reuse. Direct potable reuse has for instance been implemented in Windhoek (Namibia) since the 1970s. A country like Singapore treats wastewater to potable quality directly as well, but only a small fraction of this water is added into the water distribution system. Despite South Africa being the 30th driest country, it currently reclaims only 4% to 5% of the water it uses.

- To obtain a copy of the report, *Islamic jurisprudence and conditions for acceptability of reclamation of wastewater for potable use by Muslim users* (WRC Report No. 2360/1/15) contact Publications at Tel: (012) 330-0340; Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.

Service delivery

Steady rise in service delivery but quality concerns remain

While the percentage of South African households that have access to basic water and sanitation services is growing steadily, challenges remain to serve the country's most far-flung, rural communities. This is according to the results from the General Household Survey 2015, released by Statistics South Africa (Stats SA) in June.



Stats SA has been undertaking annual household surveys since 2002. All nine provinces are covered. The surveys are an omnibus household-based instrument aimed at determining the progress of development in the country. It measures, on a regular basis, the performance of programmes as well as the quality of service delivery in a number of key service sectors in the country.

The General Household Survey covers six broad areas, namely education, health and social development, housing, household access to services and facilities, food security and agriculture. According to Stats SA, the findings of the General Household Survey provide a critical assessment of the levels of development in the country as well as the extent of service delivery and the quality of services in a number of key service sectors, including access to and use of water and sanitation.

Access to water

Important to readers of this magazine, the General Household Survey reports that nearly 90% of South African households currently have access to safe water supply. As with most services in South Africa, access is proportionally higher in some provinces compared to others. The Western Cape has the highest number of people with access to piped water, namely 99.2%, followed by Gauteng (97.7%), the Northern Cape (96.5%) and the Free State (96.1%). 'Piped water' is defined as water supplied either in the home, in the yard, or off-site.

In comparison, the Eastern Cape and Limpopo are struggling to reach all of its constituents. In the Eastern Cape, 75% of households have access to water, with the figure dropping slightly compared to the previous household survey, when a water access percentage of 79% was reported. Similar results are reported for Limpopo, where water access has dropped from 80% in 2014 to 79% in 2015 (the date of the latest survey).

All the metropolitan areas reported access rates that are considerably higher than the national average. A significantly high proportion of households have access to piped water in the City of Cape Town (99.5%), Mangaung (99%), Nelson Mandela Bay (98.9%), the City of Johannesburg (98.5%) and Ekurhuleni (98.5%). The City of Tshwane (95.6%) recorded the lowest percentage of households with access to water in 2015 in a metropolitan area.

It is encouraging to note that almost half of the South African population now enjoys access to piped water inside their homes (45.8% of households). A further 27% of households access water inside their yards, while another 14% rely on communal taps. The household survey further reports that 2.7% of South African households rely on water from their neighbours' taps.

Although generally households' access to water improved, 4.4% of households still have to fetch water from unsafe sources such



About 4.8% of households reported experiencing blockages in their municipal system.

as rivers, streams, stagnant water pools, dams, wells and springs. While the proportion of people with access to safe water has been growing steadily since the first household survey in 2002, payment for services is decreasing. In 2015, only 43.9% of households were paying for water, compared to 62% in 2002. The latest household survey also includes a perception of the quality of services households are receiving from water service authorities. The survey reports an inverse relationship between the perceived quality of services and the number of water service interruptions households are experiencing.

The provinces with the lowest percentage of households that reported interruptions with water services, namely Western Cape (3%), and North West (6.6%), also reported the highest satisfaction with water delivery services (86.4% for Western Cape and 76.8% for North West). Conversely, the provinces in which interruptions were most frequent were less likely to rate water service delivery as 'good'. Whereas 61% of households in Limpopo and 60% of households in Mpumalanga reported having had interruptions, only 32.4% of households in Limpopo and 40% of households in Mpumalanga rated water service delivery as 'good'.

Access to sanitation

Proper sanitation is a key barrier to disease. Safe sanitation is considered on-site sanitation such as a ventilated improved pit (VIP) toilet, or a flush toilet connected to a sewerage system or a septic tank. Nationally, the percentage of households with access to safe sanitation increased from 62% in 2002 to 80% in 2015.

The highest number of households with access to sanitation are in the Western Cape (93.3%) and Gauteng (91%). The worst performing provinces are Mpumalanga and Limpopo, where only 66% and 54% of households respectively have access to safe sanitation. The Eastern Cape has shown an astonishing improvement in the number of households with access to safe sanitation facilities. Between 2002 and 2015 the province managed to grow sanitation access by 48%. In 2015, 82% of households in the Eastern Cape had access to safe sanitation.

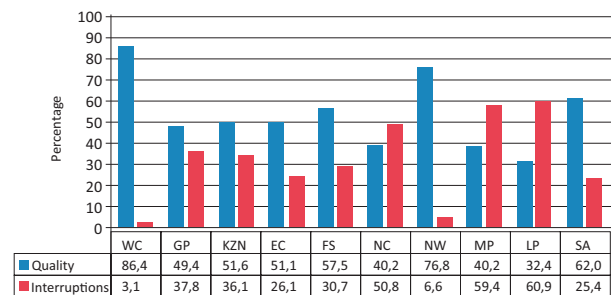
While access to safe sanitation has steadily increased, there has been a concomitant decrease in the number of households making use of the bucket toilet system or having no sanitation at all. Nationally, 4.7% of households used the bucket system or had no toilet. Looking at the figures from the different provinces, the highest number of people without access to a toilet are in the Eastern Cape (7.7%), followed by the Northern Cape (7.4%), North West (6.7%) and Limpopo (6.7%).

The General Household Survey also assessed the quality of the sanitation facilities to which households had access to. Questions revolved around the number of households sharing toilet facilities, breakages in the municipal system, aspects of physical safety, access to water to wash hands, and so on.

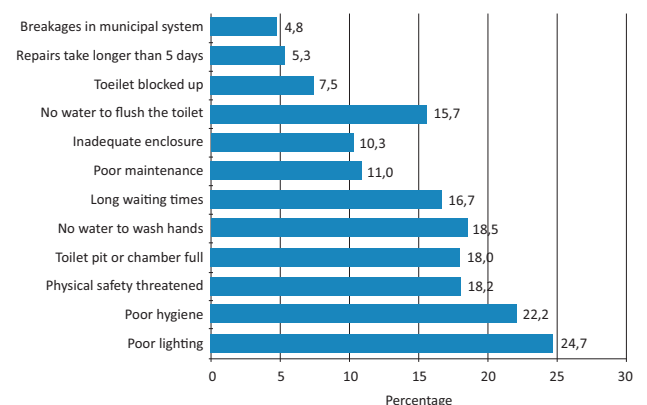
About one third of households surveyed expressed concern regarding poor lighting and inadequate hygiene, while 18% felt that their physical safety were threatened when using the toilet. About a fifth complained that there was no water to wash their hands after they had used the toilet, and another 17% pointed to long waiting times. Only 10% of households complained that the toilets were not properly enclosed. Only 4.8% of households complained that there were breakages in the municipal system and 7.5% of the households had blocked up toilets.

Responding to the results of the survey, the Department of Water and Sanitation (DWS) said it would continue to work with municipalities to improve access to water and sanitation services, and especially to the quality of services households were experiencing. "We are further cognisant of the fact that as this latest survey indicates, 4.4% of households still fetch water from rivers, streams, stagnant water pools and dams, wells and springs...DWS is intent on reducing the numbers of those that are unserved."

Access to dignified sanitation is another primary ideal for the department. "We are aware that access to dignified sanitation lags behind access to other services. Provision of dignified sanitation should and must impact positively on the livelihoods of all South Africans, but especially on women and girl-children."



Percentage of households rating the quality of water services provided by the municipality as good, and those that reported water interruptions, by province, 2015



Problems experienced by households that share sanitation facilities during the six months before the survey

Food and nutrition

Limited food options take their toll on the health of SA's rural poor



Doctoral student, Angela McIntyre, affiliated with the University of Pretoria Institute for Food, Nutrition and Wellbeing and the Centre for the Study of Governance Innovation, highlights the need to address hidden hunger in South Africa amid the drought and rising food prices.

In the past 20 years, researchers have linked the increase of obesity and chronic diseases like diabetes and hypertension in low- and middle-income countries to urbanisation, changing diets and less active lives. The spread of big retail food chains and fast food has also had an impact – increasing the availability of processed, high-energy, nutrient-poor foods and making them more affordable than fresh, healthy food.

Though this is accurate, it does not entirely capture the realities of the rural, agrarian poor people and the nutrition challenges they face. Most South Africans' food energy needs are adequately met and extreme hunger is a thing of the past. This is thanks, in part, to one of the largest cash-based social welfare programmes on the continent.

But the reality is that rural poor people are among the most

disempowered among food citizens. Most poor rural South Africans cannot afford a healthy, balanced diet with adequate fruits, vegetables and legumes. Where these are not locally produced, supermarkets supply them with hefty price tags that are often higher than city prices. As a result, poor people living in rural areas may suffer from malnutrition.

For children, malnutrition comes as chronic under-nutrition. It translates into stunting or growth faltering. This often occurs simultaneously with obesity. For adults, it means a higher risk of obesity.

If the current trajectory continues, the costs of treating obesity-related chronic diseases could be staggering, let alone for a health system that already heaves under the burden of HIV. And the social and economic costs of childhood stunting due

to nutritional deficiencies are even higher, robbing children of quality of life and nations of potential.

Why rural poor face particular problems

Industrialised and highly urbanised developed countries have been leading the charge in the global obesity epidemic, but the world's poorest countries are rapidly catching up. Researchers refer to this as nutrition transition. This is explained as shifts in food consumption, physical activity levels and increasing urbanisation.

But this does not explain why obesity is also on the rise among rural people. It challenges a common argument around obesity: it is caused by unhealthy lifestyle choices, including inactivity and eating junk food.

Clearly the phenomenon of obesity in poor rural communities has little to do with an addiction to drive-through burgers. But it is no less related to food environments.

Food environments are the ways in which food is produced, distributed and consumed. These are determined largely by global trade policies, national food production and distribution patterns, agriculture and nutrition policies and, increasingly, the unfolding crisis of climate change.

And although nutrition transition is linked to changing food preferences, it is also linked to changing rural livelihoods, land and water entitlements, agricultural diversity and urbanisation. The dynamics of these push and pull factors are complex.

The South African case

Livelihoods and food environments – rather than personal choices – often determine the consumption of healthy or unhealthy food. In South Africa, for example, the particular challenge is that most rural people buy, rather than produce, their own food. This is because the country has an underdeveloped smallholder and subsistence-farmer sector and a weak culture of home food production. As a result their choices are severely limited by income, the retail environment and their capacity to produce their own food.

Producing their own food, in turn, is constrained by the high costs of inputs, land and water shortages, and the lack of support for subsistence and small food producers and marketers.

So instead of vibrant local production and markets, rural people rely mainly on processed foods – refined carbohydrates like maize meal, white sugar, mass-produced vegetable oils and, occasionally, processed animal products – bought largely from big retail chains, because these are the cheapest and most prolific.

Food security in rural South Africa is heavily reliant on cash incomes, which, in turn, are boosted considerably by social grants. But, unlike food prices, these do not increase in response to frequent price hikes.

Rural people are often trapped in cycles of chronic food

insecurity. Although they get enough calories, they suffer from hidden hunger. This results in micronutrient deficiencies and obesity due to poor food quality, perpetual anxiety about future food supplies and unstable livelihoods.

There are answers

Malnutrition in rural communities cannot be addressed through manufacturing more food and trucking it to rural areas or sending more food charity. What is needed is a systemic approach that considers the underlying causes of hunger and malnutrition and the whole food system.

Researchers, civil society groups and activists are increasingly highlighting the fact that food systems that primarily generate profits not only fail to deliver adequate nutritious food, but also contribute to environmental damage, biodiversity loss and climate change – and a global obesity epidemic.

South Africa produces enough food for local consumption. It also has the natural resources and technology to do this in more sustainable, nutritious and culturally appropriate ways. The key to this is diversification.

The retail sector is critical when most people rely on food purchased with cash. But like ecosystems, when food systems rely too heavily on one component, it makes for weakness and vulnerability. Relying heavily on purchased food from too few sources is making rural people vulnerable.

One solution may be to improve small-scale farming and household production. With the right support, small-scale, diverse and ecologically sustainable farming need not be a struggle for survival.

“Most poor rural South Africans cannot afford a healthy, balanced diet with adequate fruits, vegetables and legumes.”

But small producers need access to land, water and inputs, vibrant local markets and protection against corporate and charitable dumping. This is but one suggestion. There is much wider scope for innovation in food and agricultural policies.

Addressing current nutrition and health challenges will require improved access to good quality, diverse diets – ending malnutrition is no longer about delivering enough calories to prevent starvation.

This article was first published in The Conversation, Visit: <http://theconversation.com>



Celebrating biodiversity in agriculture

On 22 May, nations all over the world celebrated the International Day for Biological Diversity. The theme for this year was 'Sustaining people and their livelihoods' and the focus fell specifically on the importance of biodiversity in sectors such as agriculture.



The Nguni cattle breed is indigenous to southern Africa and are known for their fertility and resistance to disease.

Formed by combining the words 'biological' and 'diversity', biodiversity refers to the many millions of organisms on Earth and the way they interact with each other. Biodiversity can be used to describe the variety and relationships of animals, plants and microorganisms in different sized habitats – from the African savanna to the great Arctic region.

Think about the food you eat. What kind of foods come to mind? While we don't always realise it, biodiversity is the foundation of agriculture. It has enabled farming systems to evolve ever since agriculture was first developed over 10 000 ago.

Today, agriculture produces an average of 23.7 million tons of food every day, and provides livelihoods for 2.5 billion people. It is the largest source of income and jobs for especially poor, rural households.

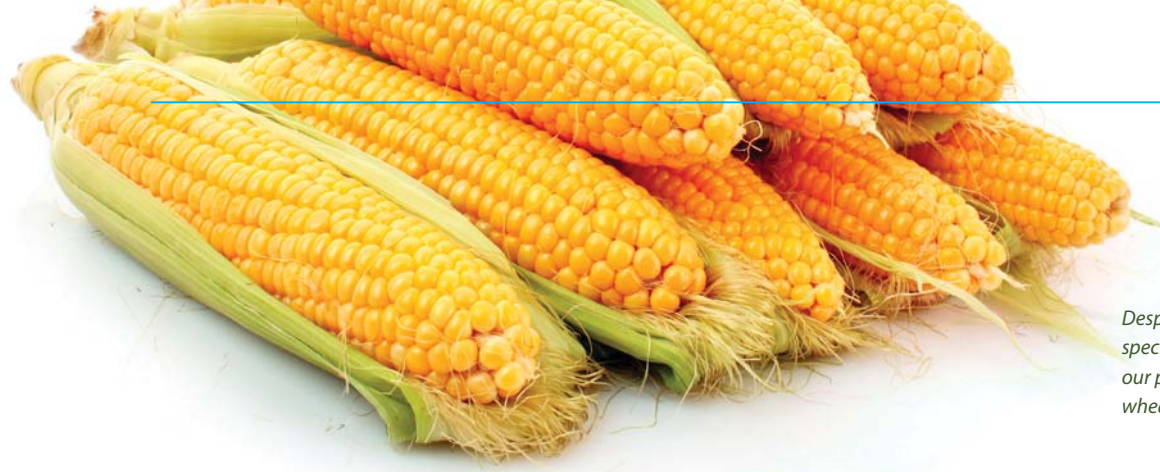
Biodiversity is the origin of all species of crops and domesticated livestock and the variety within them. It is also the foundation of ecosystem services essential to sustain agriculture and human well-being. Biodiversity and agriculture are strongly interrelated because while biodiversity is critical for agriculture, agriculture can also contribute to conservation and sustainable use of biodiversity.

Agricultural biodiversity is the diversity of crops and their wild relatives, trees, animals, microbes and other species that contribute to agricultural production. This diversity exists at the ecosystem, species and genetic level, and is the result of interactions among people and the environment over thousands of years.

Agricultural biodiversity provides humans with food and raw materials for goods – such as cotton for clothing, wood for shelter and fuel, plants and roots for medicines, and materials for biofuels. Agricultural biodiversity also performs ecosystem services such as soil and water conservation, maintenance of soil fertility and biota, and pollination – all of which are essential to human survival.

Genetic diversity of agricultural biodiversity provides species with the ability to adapt to a changing environment and evolve, by increasing their tolerance to frost, high temperature, drought and waterlogging, for example.

However, despite its importance, agricultural biodiversity is threatened. While we know of 7 000 plant species in the world that are edible, over 50% of our plant-derived calories come from only three species: rice, wheat and maize. Our heavy reliance on



Despite there being 7 000 edible plant species known in the world, over 50% of our plant-derived calories come from rice, wheat, maize and potatoes.

a narrow diversity of food crops is putting our future food and nutrition security at risk.

It is estimated that around 940 species of cultivated plants are threatened globally. When a species or the diversity within a species is lost, we also lose genes that could be important for improving crops, promoting their resistance to pests and diseases, or adapting to the effects of climate change. This rapidly diminishing gene pool is worrying for experts. Having a broad range of unique characteristics allows plants and animals to be bred to meet changing conditions. It also gives scientists the raw materials they need to develop more productive and resilient crop varieties and breeds. In those places where hunger is worst, the resource-poor countries of the developing world, farmers may be more likely to need crops that grow well in harsh climates, rather than strains that yield well under good conditions, or animals that are smaller but possess higher resistance to disease. Indeed, for the poorest farmers, the diversity of life may be their protection against starvation.

In South Africa, for example, there is increasing focus on traditional African vegetables, grains and legumes such as Bambara groundnut, cowpea, sorghum, and amaranth to name a few. These plants, which have been cultivated by local

communities for hundreds of years, have proven to require less water than commercial crops, while generally providing more nutrition.

Finally, with plants, animals and their environments left intact, a range of essential services provided by nature are preserved. Livestock, fungi and microorganisms decompose organic matter, transferring nutrients to the soil. Ants and other insects control pest populations. Bees, butterflies, birds and bats pollinate fruit trees. Wetlands filter out pollutants. Forests prevent flooding and reduce erosion. In the ocean, intact ecosystems help keep fish populations stable and healthy, ensuring tomorrow's catch. To feed a growing population, agriculture must provide more food. It will also be essential to increase its resilience by protecting a wide array of life forms with unique traits, such as plants that survive drought or livestock that reproduce in harsh conditions. Sustainable agricultural practices can both feed people and protect the oceans, forests, grasslands and other ecosystems that harbour biological diversity.

Global efforts to conserve plants and animals in gene banks, botanical gardens and zoos are vital. But an equally important task is to maintain biodiversity of farms and in nature, where it can evolve and adapt to changing conditions or competition with other species. As custodians of the world's biodiversity, farmers can develop and maintain local plants and trees and reproduce indigenous animals, ensuring their survival.

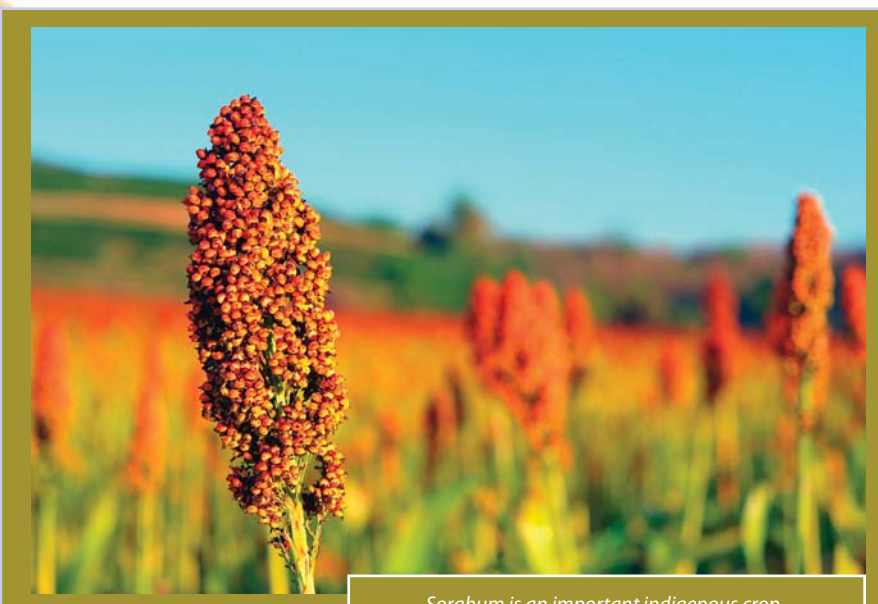
Sources: www.cbd.int/idb/2016 and www.fao.org



Biodiversity is essential in agriculture to:

- Ensure the production of food, fibre, fuel and fodder
- Maintain other ecosystem services
- Allow adaptation to changing conditions – including climate change
- Sustain rural peoples' livelihoods

Source: www.cbd.int



Sorghum is an important indigenous crop.

Successful aquaculture training held at Eastern Cape agri college

The Water Research Commission (WRC), in collaboration with Rhodes University, held a successful workshop on rural freshwater aquaculture at the Tsolo Agricultural and Rural Development Institute, near Umtata in the Eastern Cape. The WRC has funded research into various aquaculture projects and manuals, dealing with issues such as the re-establishment of freshwater aquaculture in South Africa, the revitalisation of state hatcheries and the training of extension officers.

According to WRC Research Manager, Dr Sylvester Mpandeli, aquaculture should not be seen purely as a way of producing food. "There are many forms of aquaculture that produce a marketable commodity that is not necessarily eaten, but sold for

cash. This, in turn, can be used to purchase food." A flourishing example of this is the ornamental fish trade, where fish are produced for sale to the pet trade. Another, often ignored, form of aquaculture is the production of quality seed for sale to other fish farms in the form of fingerlings, explains Dr Mpandeli. "Other than providing protein rich food to rural communities, aquaculture has a job creation potential that responds to the current high unemployment challenge the country faces."

Talks are continuing between the institute and the WRC to explore further grounds for cooperation.



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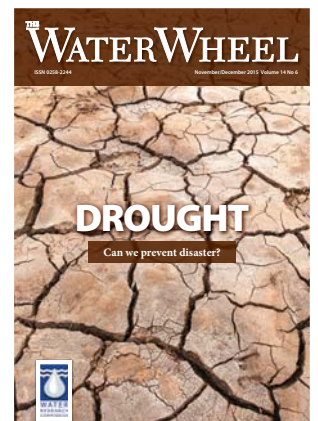
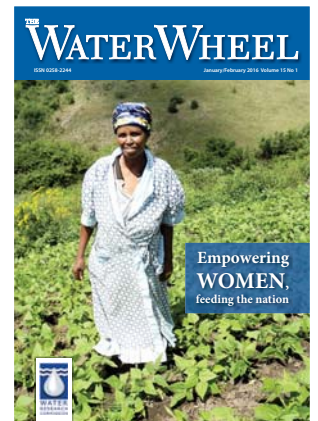
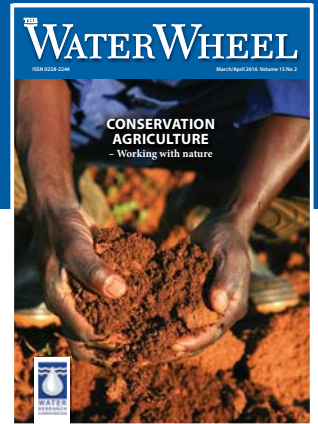
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The Water Research Commission not only endeavours to ensure that its commissioned research remains real and relevant to the country's water scene, but that the knowledge generated from this research contributes positively to uplifting South African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

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

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

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