

THE  
**WATER WHEEL**

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**Nurturing our  
agricultural  
knowledge**



**WATER  
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# THE WATER WHEEL

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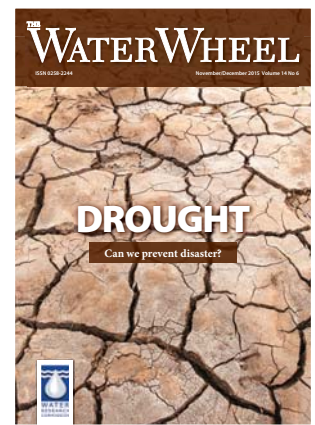
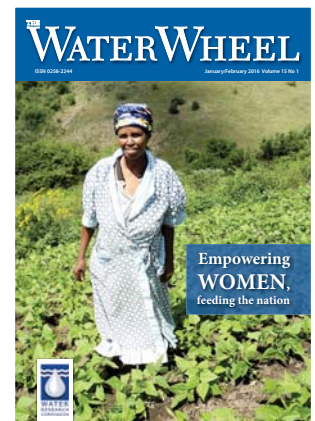
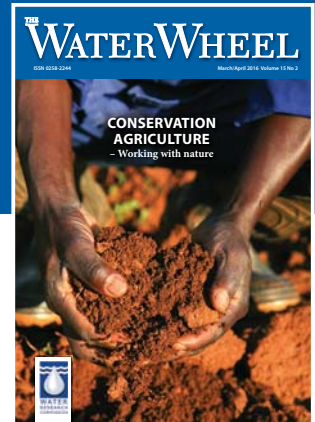
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### The Water Wheel

Tel: +27 (0) 12 330-0340

Fax: +27 (0) 12 331-2565

E-mail: [laniv@wrc.org.za](mailto:laniv@wrc.org.za) / [www.wrc.org.za](http://www.wrc.org.za)

Physical address: Marumati Building, C/o Frederika & 18th Ave, Rietfontein, Pretoria

Postal address: Private Bag X03, Gezina, 0031

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**Editorial offices:**

Water Research Commission, Private Bag X03, Gezina, 0031, Republic of South Africa.

Tel (012) 761 9300. Fax (012) 331-2565.

**WRC Internet address:**

<http://www.wrc.org.za>

**Follow us on Twitter:**

@WaterWheelmag

**Editor:** Lani van Vuuren,

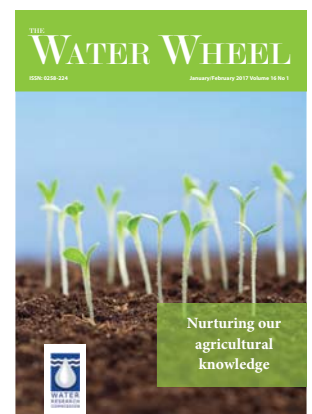
E-mail: [laniv@wrc.org.za](mailto:laniv@wrc.org.za);

**Editorial Secretary:** Dikeledi Molutsi,

E-mail: [dikeledidk@wrc.org.za](mailto:dikeledidk@wrc.org.za);

**Layout:** Anja van der Merwe,

E-mail: [anjavdm@wrc.org.za](mailto:anjavdm@wrc.org.za)



*What makes farmers succeed?  
The three main features in this issue are  
dedicated to Water Research Commission  
research aimed at exploring the success  
pathways of small-scale farmers.*



WRC CEO, Dhesigen Naidoo



## Fluid Thoughts

### Saying goodbye to Fidel



In November 2016 Fidel Castro said goodbye to the world at the age of 90.

Tributes piled in from every quarter, and even traditional enemies from the Cold War era, such as the United States, guardedly admitted that Fidel's influence on the shaping of the globe in the 20<sup>th</sup> century was immense and could not be ignored.

Closer to home, there was a dramatic re-surfacing of a black-white divide in every radio show and social media platform that chose to talk about Fidel. On the one side – the white side – was the familiar eruption of 'rooi gevaar' that I remember so vividly from my childhood years. The stories of communist brutality and oppression that we were being saved from by the benevolent apartheid regime who either failed to assimilate the paradox of their position or that simply thought that the rest of were just ignorant. Why else would we accept their cruel repression if we were anything but.

On the other side came the views of many black South Africans, mostly those with a struggle history, that remembered with a deep fondness the role of Fidel, as he was never Castro, always Fidel, in not only standing up against the dramatic and powerful forces of Imperialism in the sixties, seventies and eighties, that shaped not only this continent, but also the history of this country's tangle with an internal colonialism and the eventual triumph of a non-racial democracy.

We are reminded of the dark days of the Washington-London axis propping up an apartheid government, first to position Mabuto in Zaire and later introduce, arm and support Unita in Angola and Renamo in Mozambique to destabilise the left leaning governments in those two countries. Some have calculated that the Reagan-Thatcher 'constructive engagement' with the Pretoria regime delayed our democracy by more than ten years. And in all that time Fidel led an unrelenting charge for freedom in South Africa, and many other African and Latin American countries.

Perhaps Fidel's parting gift to South Africa is to provide a basis for us to begin a long overdue discussion on our divided experiences of the apartheid years and how this lack of 'toenadering' or converging has led to the divided society that we have today. It is my hope that we can and will use this opportunity.

But, beyond this, we need to take other lessons from Fidel's Cuba and find the right South African formulae that will make them work in our environment. Batista's Cuba was a country of minority elites and an economically disenfranchised majority of very poor people. The parallels with modern day South Africa are uncanny. The game-plan of the soon embargoed Cuban revolution was the development of people through education, an investment in access to people's basic needs, and the development of science. Cuba's Human Development ranking is a tribute to this, despite having a GDP/capita of \$6 051 compared to South Africa's R7 313, it boasts a HDI ranking of 67<sup>th</sup> compared to South Africa's of 116<sup>th</sup>. This is in some part due to a Gini co-efficient which ranks Cuba at 44<sup>th</sup> in the world compared to South Africa's ranking of 118.

The economically embargoed island has been managed through five decades to become one of the most recognised trainers of doctors and engineers in the world. It has over time developed a remarkably enviable track record in many domains, but none more famous that its medical research. This is similar to Nehru and Gandhi's India as they built up a phenomenal human capital capability and technological prowess under its socialist leaning years from independence, and then had the arsenal to take full

advantage of an open economy under Prime Minister Rao in the 1990s to become one of the world's fastest growing economies. This may indeed be the future of Cuba, on a different scale.

*We need to take a lesson from Fidel's Cuba and find the right South African formulae that will make them work in our environment.*

As South Africa grapples with the throes of the challenge of finding sufficient water security to both see to the current needs of its people in the wake of climate change and extreme weather events, while all the time trying with use innovation, creativity and new knowledge to free up vital water to fuel the engine of badly needed economic growth, we can take another lesson from our Caribbean friend. I think that Cuba's biggest lesson, and Fidel's most important legacy, is that you will never have enough to completely and immediately fulfil all your goals; but, no matter how little you have, you will always have enough to start that journey.



## Water Diary

### **Odour control**

**February 14-16**

The International Water Association (IWA) Symposium on Tastes, Odours, and Algal Toxins in Water: Occurrence and Control, will be held at the University of New South Wales, Australia. Visit: [www.iwatando2017.org](http://www.iwatando2017.org)

### **Faecal sludge management**

**February 19-22**

The Fourth International Faecal Sludge Management Conference (FSM4) will be held in Chennai, India. FSM4 aims to bring together professionals working in the sector, including utilities, service providers, cities, governments, academics, scientists, consultants, donors and industries to support the global initiative of disseminating sustainable solutions for faecal sludge management. Visit: [www.fsm4.susana.org](http://www.fsm4.susana.org)

### **Water storage and hydropower**

**March 14-16**

The International Conference on Water Storage and Hydropower Africa 2017 will be held in Marrakech, Morocco. The event is supported by the International Committee on Large Dams. Email: [africa2017@hydropower-dams.com](mailto:africa2017@hydropower-dams.com) for more information.

### **Large rivers**

**April 18-21**

The Third International Conference on the Status and Future of the World's Large Rivers will be held in New Delhi, India. Topics to be covered include hydrology, hydraulics and water quality; sediment transport and river morphology; ecology and restoration; and integrated river management. Visit: <http://worldslargerivers.bku.ac.at>

### **Water history**

**June 15-17**

The conference of the International Water History Association will be held in Grand Rapids, Michigan, USA. The conference is co-hosted by the Western Michigan University. Visit: [www.iwha.net](http://www.iwha.net)

### **Hydrology**

**July 10-14**

The 2017 scientific assembly meeting of the International Association of Hydrological Sciences (IAHS) will be held in Port Elizabeth. The theme of the meeting is 'water and development: scientific challenges in addressing societal issues'. This is the first time the IAHS scientific assembly meeting will be held in sub-Saharan Africa. Abstracts can be

submitted until 14 February. Enquiries:

Email Prof Graham Jewitt at Email: [JewittG@ukzn.ac.za](mailto:JewittG@ukzn.ac.za) or Visit: <http://cwrr.ukzn.ac.za/iahs/call-for-papers/iahs-2017-in-south-africa---invitation>.

### **Groundwater**

**October 14-18**

The Groundwater Division of the Geological Society of South Africa will be hosting its Biennial Conference at Spier Hotel, outside Stellenbosch with the theme 'Change, challenge, opportunity'. Contact: Deidre Cloete; Email: [deidre@iafrica.com](mailto:deidre@iafrica.com); Visit: [www.gwd.org.za](http://www.gwd.org.za)

### **Municipal engineers**

**October 25-27**

The Institute of Municipal Engineering of southern Africa (IMESA) will hold its annual conference at Emperors Palace, Gauteng. The theme for this year's event is 'Sustainable engineering. Back to basics for the future'. Visit: <http://www.imesa.org.za/> for more information.



## R212-m to support farmers in drought-stricken provinces



The Department of Agriculture, Forestry and Fisheries has allocated R212 million to assist provinces that have been severely affected by the drought.

The money is to be used for animal feed in seven provinces including the Free State, KwaZulu-Natal, Limpopo, Mpumalanga,

North West, Northern Cape and Eastern Cape. These provinces have declared a provincial state of drought disaster, as South Africa battles the worst drought since 1992.

A total of R29 million has been allocated to the Eastern Cape, Free State R31 million, KwaZulu-Natal R23 million, Limpopo R28 million, Mpumalanga R26 million, Northern Cape R25 million, North West R38 million and the Western Cape allocation is R12 million.

“The Western Cape has declared a local state of disaster in three municipalities - Central Karoo, Eden and the West Coast. Gauteng is the only province that has not yet declared a state of drought disaster,” the department said in statement late last year.

During the 2015/16 financial year, the national Department of Agriculture allocated R263 million towards drought relief through reprioritising the Comprehensive Agricultural

Support Programme (CASP). Provincial Departments of Agriculture made R198 million available through their equitable share funding.

“These funds were utilised to assist affected farmers with animal feed and water reticulation for livestock. For the 2016/17 financial year, the department further requested for drought relief assistance from National Treasury through the National Disaster Management Centre,” the department said.

While some parts of the country have experiencing some excessive rain recently, the department noted that the country in its entirety is receiving below average rainfall compared to previous seasons due to the El Niño.

Most rivers are not flowing normally and dam levels are at their lowest in a decade.

*Source: SAnews.gov.za*

## Pour flush/Low flush toilet scoops SAB Foundation Social Innovation Seed Grant Award

On 27 October 2016 the WRC's pour flush/low flush toilet scooped a Social Innovation Seed Grant Award from the South African Breweries (SAB) Foundation.

WRC Research Manager, Dr Sudhir Pillay, received the award on behalf of the organisation. The WRC was one of 23 finalists across the health, disability, education, energy, water and sanitation, and livelihoods and sustainable agriculture sectors.

The pour flush toilet aims to bridge the gap between basic sanitation (VIP toilets) and full-flush sanitation while improving the safety and dignity of recipient communities. The system has a similar look and feel to a full flush toilet but uses significantly less water.

The Ndakana village, in Amathole District Municipality, in the Eastern Cape is the latest community to benefit from the installation of the pour flush toilet, a

project being rolled out by the WRC in collaboration with the Department of Science & Technology and the Bill and Melinda Gates Foundation.

The low flush toilet addressed the aspirations of many South Africans for flush toilet, while overcoming the logistical challenges involved with standard sewerage and working within the limits of the country's water resources.

## 'Soil crusting' Significant challenge for SA – ARC

The Agricultural Research Council (ARC) celebrated World Soil Day on 5 December. On this day the importance of soil as a critical component of the natural system and as a vital contributor to human well-being is celebrated.

The ARC focused its event – which featured celebrated soil scientist Prof Giel Laker – on soil crusting. Soil crusting, that is surface sealing of soil, is a widespread and very serious problem throughout South Africa. This is due to the fact that large parts of the country are covered by soils that are inherently susceptible to crust formation.

It is particularly severe where the surface of vulnerable soils is left bare due to injudicious farming practices. It is found under all kinds of farming. In extensive rangelands, under both livestock farming and game parks or reserves, it is caused by

overgrazing.

Under dryland cropping, the worst situations occur where non-arable soils are cultivated and then abandoned. Soil crusting is also a serious problem under overhead sprinkler irrigation. This phenomenon in addition affects high value crops, such as fruit orchards, where the soil surface under the canopy in the row is kept bare by use of herbicides.

Soil crusting has several serious consequences. It causes poor water infiltration into soils and thus excessive runoff. The increased runoff leads to increased soil erosion and also to floods, even under normal rainfall conditions. Due to the poor water infiltration, little water enters the soil and causes drought conditions to prevail even under adequate rain.

Poor water infiltration under irrigation leads to poor irrigation water use efficiency. A dense crust also leads to poor soil aeration, and thus poor germination, and causes a high mechanical resistance against seedling emergence. This leads to a poor crop stand, especially of small-seeded crops such as wheat.

Much research has been done in South Africa on the mitigation by soil crusting and amelioration of crusted soils. In rangelands, a dense grass cover should be maintained by avoiding overgrazing, especially of vulnerable areas. This is a large and a difficult challenge in game parks. Cultivation of mulch is essential. In irrigated areas under high value crops, application of organic soil conditioners or mulching are both very effective.

*Source: ARC*

## National water RDI Roadmap hits the highway with national workshops



In order to overcome the challenge of water-related innovation and associated skills needs in the South African water sector, the Water Research, Development and Innovation (RDI) Roadmap was conceptualised and co-created by the Department of Science and Technology

and the Water Research Commission (WRC).

The Roadmap provides a structured framework to focus the contribution of national policy, strategy and planning in water resources management in

South Africa. It lays out seven innovation investment clusters which over a ten-year period intend to facilitate a more competitive and effective innovation position for the South African water sector and ultimately help to secure water for future needs.

Late last year the WRC rolled out a national roadshow, holding workshops in four centres, Cape Town, East London, Bloemfontein and Durban, in an effort to introduce a finalised plan to all interested stakeholders and allow them to engage with the instruments that have been put in place to support the implementation of the Roadmap.

Commented Dr Valerie Naidoo, WRC Executive Manager responsible for Business Development: "In all the planned roadshows, the morning sessions served as a short introductory overview of the roadmap, while in the afternoon stakeholders had the opportunity to engage with the Roadmap team on a one-on-one basis."



## Global

### Year 2016 set to be named 'hottest' year yet



It is very likely that 2016 will be the hottest year on record, with global temperatures even higher than the record-breaking temperatures in 2015.

Preliminary data (released in November) showed that 2016's global temperatures

are approximately 1.6°C above pre-industrial levels, according to an assessment by the World Meteorological Association (WMO).

Global temperatures for January to September have been about 0.88°C above the average (14°C) for the 1961-1990 reference period, which is used by WMO as a baseline. Temperatures spiked in the early months of the year because of the powerful El Niño event of 2015-16. Preliminary data for October indicated that they are at a sufficiently high level for 2016 to remain on track for the title of 'hottest year on record'. This would mean that 16 of the 17 hottest years on record have been this century (1998 was the other one).

Long-term climate change indicators are also record breaking. Concentrations of major greenhouse gases in the atmosphere continue to increase to new records. Arctic sea ice remained at very low levels, especially during early

2016 and the October re-freezing period and there was significant and very early melting of the Greenland ice sheet.

Ocean heat was boosted by the El Niño event, contributing to coral reef bleaching, and above-average sea-level rise.

The deadliest event in 2016 was Hurricane Matthew, which was Haiti's worst humanitarian emergency since the 2010 earthquake. Throughout the year, extreme weather led to considerable socio-economic losses in all regions of the world.

"Another year. Another record. The high temperatures we saw in 2015 are set to be beaten in 2016," said WMO Secretary-General Petteri Taalas. "The extra heat from the powerful El Niño event has disappeared. The heat from global warming will continue."

Source: WMO

### Global report places spotlight on water quality

The quality of surface water has noticeably improved in recent decades in many parts of the developed world, but is being challenged as economic growth, intensification of land use often combined with demographic or climate change lead to widespread and severe degradation.

The need to reverse this development is reflected in the 2030 Agenda for Sustainable Development, both as a dedicated goal on water and as an integral element of the objectives in other sectors.

The report, *A Snapshot of the World's Water*

*Quality – Towards a global assessment summarises*, key findings of the pre-study for a World Water Quality Assessment. This includes the fact that water pollution has worsened since the 1990s in many rivers in Latin America, Africa and Asia; the majority of rivers are still in good condition, and there are great opportunities for short-cutting further pollution and restoring the rivers that are polluted; monitoring and assessment are essential for understanding the intensity and scope of the global water quality challenge, yet data coverage is inadequate.

The methodology developed offers a baseline to measure progress, a framework for global assessment and a pathway towards sustainable solutions that will deliver on that agenda. With the support from UN Water and the many contributing authors, this report will help bridge the gap between water quality, the inclusive green economy and the interlinked issues of sustainable development.

To download the report, Visit: [www.wwqa-documentation.info](http://www.wwqa-documentation.info)



## Researchers produce world map of farming households

Smallholder and family farms are crucial to feeding the planet, and successful policies aimed at alleviating poverty, boosting food security and protecting biodiversity and natural resources depend on the inclusion and participation of small farmers.

However, despite the recent spotlight on small farms and increasing consensus on their importance, detailed information on location and size of smallholder farms is virtually absent. Small farms exist in some of the planet's most diverse landscapes and are home to many of the planet's most vulnerable people, and yet we have very little information about them.

A recently published study by researchers at the University of Minnesota Institute on the Environment attempted to fill this crucial knowledge gap using household

census data made available by the Minnesota Population Centre to identify and map smallholder farms in developing countries. The study was published in the journal, *Environmental Research Letters*.

"This map is a first step toward a better understanding of where and how smallholder farming can be sustainable for both landscapes and livelihoods," said Leah Samberg, lead author of the study. Information about the number, location and distribution of small farms can be used to guide investments and target policies for agricultural development, food security and sustainable land use, adds study co-author, Paul West.

In addition to producing the map, the study identified more than 900 places in 83 countries in Asia, sub-Saharan Africa and Latin America where there are fewer

than 5 ha of agricultural land per farming household. These places are likely to be home to a high concentration of small farms and are farmed by more than 380 million households. These smallholder systems produce more than half of the planet's food calories.

"This study is only a first effort at utilising these rich and complex data sets," noted Samberg. "We envision numerous future applications of this farm size product in combination with other variables related to food security, natural resource use and human well-being that will further increase our understanding of the dynamics of small farms and the livelihoods of those who depend on them."

*Source: University of Minnesota*

## Mainstreaming 'nature' can help conserve ecosystems

Time is running out to stop the global decline in biodiversity and protect ecosystems that are essential for the livelihoods and well-being of billions of people, the United Nations Convention on Biological Diversity warned before the 13th meeting of the Conference of the Parties to Convention on Biological Diversity (CBD), known as 'COP13'.

Protecting biodiversity is crucial for human well-being and economic development. For example, global benefits from coral reefs including tourism, fisheries and coastal protection are estimated at some US\$30 billion per year, insect pollination of over 40 commercial crops in the United States alone at US\$30 billion per year, and the international trade of medicinal plants is estimated to be worth around US\$60 billion per year.

Biodiversity loss caused by agriculture, infrastructure expansion and climate change will greatly affect these sectors. For instance, it is estimated that 40% of land currently used for extensive agriculture will be lost by 2050. However, global agricultural production will need to increase by 50% to feed the world

population by 2030, making sustainable agriculture a pressing issue.

"If we are going to save biodiversity, we need to work with these sectors that depend on biodiversity and whose activities have a considerable impact on the variety of life on our planet," said Dr Bráulio Ferreira de Souza Dias, Executive Secretary of the Convention. "Agriculture, forestry, fisheries and tourism are important sectors whose activities need to take biodiversity conservation and sustainable use into account in a coherent manner."

Since 2010, Parties to the CBD have been working to achieve 20 biodiversity goals known as the Aichi Targets, named after the Japanese prefecture in which they were adopted. However, the CBD has warned that around two-thirds of these targets are not on track to being met by their 2020 deadline.

"Governments have made ambitious commitments to achievement of the Aichi Biodiversity Targets, but these declarations need to be matched with actions at the national level," Erik Solheim, Chief of UN

Environment said. "If countries do not ensure that national targets are set and achieved, their ambition will only remain on paper."

The Aichi Targets address issues ranging from the loss of natural habitats, sustainable agriculture and declining fish stocks, to access and sharing of the benefits from the use of genetic resources, indigenous knowledge and awareness of the values of biodiversity.

Achieving the Aichi Targets goes hand in hand with achieving the Sustainable Development Goals (SDGs), the CBD has stressed. While the protection of biodiversity is specifically mentioned in Goal 15 of the SDGs, biodiversity affects other goals as it is a source of economic growth, provides livelihoods for vulnerable populations, and can help eradicate poverty and hunger. Its protection is also crucial to climate change, and will help countries limit the global average temperature increase as specified in the Paris Agreement, which entered into force last month.



## New WRC reports



### *Development and testing of an optimisation model at selected Eskom sites for an integrated water solution*

This is a consolidated account of both Phase 1 and Phase 2 of the project. Phase 1 is focused on integrated water and membrane network systems, whilst Phase 2 is dedicated to cooling water system design that is characterised by multiple

cooling towers. A cooling water system, in the context of this investigation, refers to a cooling tower with its associated set of heat exchangers. In Phase 1, the developed model was validated using Eskom Kriel Power Station. The choice of this 110 Ml/day site was informed by the availability of data and willingness of personnel to give guidance on testing and implementation of results. Preliminary results have shown potential savings of more than 12% in freshwater use. This facility operates on a zero liquid effluent discharge philosophy. Consequently, no mention is made of wastewater savings.

**Report No. TT 672/16**

### *The current rain-fed and irrigated production of food crops and its potential to meet the year-round nutritional requirements of rural poor people in North West, Limpopo, Kwazulu-Natal and the Eastern Cape*

While there is not much evidence of widespread starvation and extreme undernutrition in South Africa, national surveys provide evidence of multiple forms of deprivation related to the experience of hunger, widespread manifestation of hidden hunger or micronutrient deficiencies and increasing rates of overweight and obesity. Moreover, the co-existence of adult (especially female) overweight and obesity with hidden hunger and child malnutrition raises serious concerns over household food security. A previous WRC study revealed numerous knowledge gaps with regard to smallholder production and food security in South Africa. This project set out to address this significant and longstanding gap in knowledge and to propose a set of options for strengthening rain-fed and irrigated crop production in the rural areas investigated to identify the research focus areas related to efficient water use that could directly overcome dietary inadequacies and lead to better nutrition of rural household members. This unique study drew on a trans-disciplinary research approach to investigate the consumption and production patterns of rural households in communities in four selected sites in the poorest local municipalities in South Africa. This report presents the findings of this study.

**Report No. 2172/1/16**

### *Exploring the value of integrating green innovations in business*

South Africa faces significant challenges related to water scarcity and poor quality in most of its water-supply systems. The growing demand for water, coupled with the deteriorating state of water infrastructure, due to lack of adequate investments, poses significant risks to water users. The resultant risks for business, broadly speaking, can be classified as reputational, physical, regulatory, financial and governance risks. The experience of these risks however varies according to sector. There is increasing recognition by businesses to reduce their water risks through interventions that help to green their operations and value chains in order to respond to the challenges they face. A strategic approach to managing water risk exposure also helps businesses to identify new opportunities and build long-term competitiveness. Due to the fact that water poses a shared risk to business, the public sector and the general public, there is an opportunity to explore measures that promote action by business to create shared value. Green innovations provide an excellent opportunity to create shared value in the context of water management through promoting interventions that result in improved business performance and the broader landscape and socio-economic outcomes. The purpose of this study was therefore to begin to explore the opportunities through which companies could create shared value, by effectively understanding their relationship with water and in turn invest in interventions that add value both to the business and to their broader stakeholders. It is envisioned that this report will be used by corporate organisations as a guide in assessing the water risks in their value chains and to consider possible interventions. We also envision the report being used, although to a lesser extent, by government to understand the context of water management in business, which in turn can inform policy.

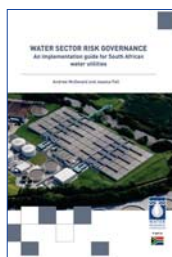
**Report No. 2349/1/16**

### *The VitaSOFT Process: A sustainable, long-term treatment option for mining impacted water*

The VitaSOFT process was developed in response to further development requirements that were identified during the development and full-scale demonstration of the Rhodes BioSURE Process, a biological sulphate reducing process for the treatment of mine impacted water with a high sulphate concentration. One of the disadvantages of the BioSURE Process was its reliance on primary sewage sludge (PSS), which may not always be available, as well as on a continuous supply of iron hydroxide, and the associated disposal requirements for large amounts of iron sulphide sludge. This study addressed these shortcomings and developed a more robust process with broader and more flexible application potential: VitaSOFT. Maize silage was identified as an alternative carbon source, with

advantages over PSS such as long shelf life, a higher percentage biodegradability, and lower nitrogen content. The validity of the new process was conclusively demonstrated. It differs significantly from the original patents by Rose *et al.*, and the BioSURE process as applied at the Ancor site for Grootvlei mine, and a new patent was filed in July 2014, leading to a patent application in July 2015, as well as a full patent application in Argentina. Because the newly developed process differs sufficiently from the initial patents and original BioSURE Process, the decision was taken to change the name of the process to VitaSOFT, as acronym that refers to the four integrated biological processes.

#### Report No. 2232/1/16

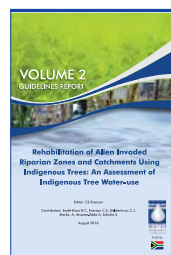


#### *Water sector risk governance: An implementation guide for South African water utilities*

Water resources remain one of the most critical issues for economic growth, the integrity of natural ecosystems and human societies that depend on them. Therefore, the implementation of sound risk management and governance practices is critical to finding meaningful solutions

that contribute to sustainable water management. A paradigm shift in water sector risk management and governance is also required in order to secure the efficient provision of water services in South Africa. Moreover, a change in the water sector governance structures is required to improve accountability and foster a shared responsibility and ownership of risks. An assessment of the risk maturity of water institutions in South Africa has shown that the overall average maturity varied from 2.4 (initial) to 3.9 (managed) on a scale of 5. The results obtained are encouraging as they suggest that some organisations that are already practicing reasonably good risk governance. The Water Boards and the metropolitan municipalities were observed to have a higher maturity level compared to the small municipalities and municipal entities. The journey to risk governance excellence requires strong leadership; a clear vision; a policy, framework and implementation plan; commitment and resources to implement the plan; good governance structures; open and transparent reporting mechanisms and regular engagement with all stakeholders. This implementation guideline serves as a primer to provide guidance in the planning, implementing and improvement of risk governance activities, irrespective of the utilities' size, legal entity or experience. It focuses on the practical steps that can be taken to achieve best practice and the main competencies required.

**Report No. TT 669/16** (The other reports in the series are *Risk Governance in the South African Water Services Sector: Business Value Creation & Best Practice* (Report No. TT 667/16), and *Water Sector Risk Governance: A compendium of South African and international case studies* (Report No. TT 668/16)



#### *Rehabilitation of alien invaded riparian zone and catchments using indigenous trees: An assessment of indigenous tree water-use*

There are many different views on how invasive alien plant (IAP) stands should be managed, but the general perception is that IAPs impact negatively on biodiversity and should be cleared. In recent years there were several studies and papers

that indicated the opposite trend in terms of natural forest species, i.e. that planted and naturalising stands of introduced tree species can facilitate the regeneration and establishment of indigenous tree species on a disturbed site. This would therefore require a different approach to the rehabilitation of areas of IAPs towards natural forest. This WRC project had two main components: a hydrological component to compare the water use of indigenous tree species versus introduced tree species; and an ecological component to determine how natural forest species become established within invader plant stands. The general concept of the ecological study was that natural forest species have the potential to regenerate within IAP stands. This challenged the perception that invasive plants nullify the capacity of native species to regenerate in IAP vegetation systems. The aim of the study was to understand the dynamics of the spread of native regeneration within IAP stands and how adjacent natural forest influences such regeneration. Several hypotheses on the regeneration processes were tested to provide a sound scientific rationale into the ecology of indigenous tree species establishing in IAP stands, particularly the development and expansion of clusters of native forest species, and the influence of distance to native seed sources. The purpose of this report is to give a brief overview of the results from the different ecological and hydrological studies within this project, as a basis for improving the forest rehabilitation guidelines for practical conversion of IAP stands towards recovery of mixed indigenous forest.

#### Report No. TT 677/16

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# Capacity building

## Training the trainers – Guiding extension advisors in irrigation

*A recently published study by the Water Research Commission (WRC) has sought to improve knowledge dissemination on irrigation management to the country's extension advisors.*

*Article compiled by Lani van Vuuren.*



South Africa faces particular challenges regarding water supply. Rising temperatures and changing rainfall patterns will have further consequences for food production and water supply. At the same time, the National Development Plan 2030 proposes the advancement and expansion of agricultural development through effective land reform and growth in irrigated agriculture. This goal, however, requires skilled and well trained agricultural advisors to support smallholder farmers with decision-making on opportunities open to them.

For many farmers, but especially smallholder farmers, extension advisors play a pivotal role in building capacity through programmed learning and access to information. The WRC identified the need for training of extension advisors, in particularly irrigation management, as this would give

smallholder farmers a better chance of being successfully integrated into the food value chain.

### **Motivation for WRC project**

In South Africa, extension services play an important role in the investment of human and social capital required for sustainable agriculture development. The policy environment for the agricultural sector in South Africa is dominated by three important policy issues: land reform, black economic empowerment and the strategic vision for agriculture. Agricultural education and training has an indispensable role to play in all of these strategic policy issues.

Despite playing such a critical role in especially smallholder agriculture, studies have shown that the extension link has

deteriorated in recent years and become less effective. A previous WRC project illustrated that many educational programmes and curricula offered by tertiary education and training organisations in South Africa are inappropriate and not aligned to the skills and knowledge required by extension advisors to do their work properly.

In many cases this results in a lack of confidence and self-esteem among extension advisors, decline in credibility and therefore withdrawal from the community which they must serve. An urgent need was therefore identified to restore the self-esteem of these individuals and to improve the service delivery of the extension profession.

A first step in rectifying the situation was to define the 'knowledge profile' for training of extension advisors, or the basic knowledge required to advise farmers effectively on irrigation management. This conceptual knowledge profile of the irrigation extensionist does not imply that extensionists should become subject matter experts in each of these identified technical learning areas, but rather that adequate technical knowledge and competence in each of these learning areas is a prerequisite for credible extension service delivery to irrigation farmers.

Already in 2006 the WRC, through a project led by the University of Pretoria, developed learning material (93 modules) for the eight learning areas identified to form the knowledge profile of the extension advisor. This training material includes the main elements required to inform irrigation water management on farm level and have been divided into technical and extension related modules. The aim of the learning material is to support tertiary education organisations, commonly demarcated as further and high education.

This latest project involved disseminating the research output to agricultural colleges; universities of technology; AgriSETA accredited training colleges; FET colleges; commodity organisations involved in irrigated agriculture development; provincial Departments of Agriculture; and international irrigator advisors and professionals.

The report emanating from the project reflects activities and discussions held with various stakeholders involved in agriculture education and training to raise awareness of the training material, but also to encourage and catalyse the possible inclusion into existing curricula and use in short courses for practical training of irrigation farmers at irrigation scheme level.

The discussions with stakeholders have resulted in a number of key messages, opportunities and challenges for shifting the discourse within the educational and training sphere to include irrigation water management learning material in existing curricula offered at agricultural colleges and university of technology.

The aim of the WRC project was to make key actors within the various education and training organisations aware of the learning material and to disseminate the knowledge on the training and learner guides developed by the WRC for extension advisors in irrigation water management, and to identify possible constraints in the uptake of the research knowledge.

*“Capacity building is not a once-off event but must rather be seen as a ladder where information access, facilitation and empowerment, technological development, mentorship role of consultation/extension advisors and programmed learning and important pillars for increasing of capacity.”*

#### **Main messages and recommendations**

Extension is a process of capacity building through engagement of individuals, groups and communities so that farmers are more able to deal with various issues affecting them and opportunities open to them. Extension therefore comprises several activities that may provide: a framework for learning, a specific learning event; a process for developing or modifying specific management practices or technologies; individual mentoring and an on-going access to needed knowledge and information.

Capacity building is not a once-off event but must rather be seen as a ladder where information access, facilitation and empowerment, technological development, mentorship role of consultation/extension advisors and programmed learning and important pillars for increasing of capacity.

The reflections and insight of a strong set of knowledgeable individuals involved in training and extension provide a nuanced image of challenges and shortcomings that are critical to address training and education in irrigation water management. It helped to better understand the underlying challenges at training organisations for the uptake of the learning material.

In summary, there are a number of proposals emanating from the discussions to move forward:

**Quality of training in irrigation water management:** A positive interest and need exists with all stakeholders to upscale the quality of training to extension advisors, farmers and academic staff/lecturers responsible for training through mainly the offering of accredited short courses. These courses can be offered through private training organisations, universities or agricultural colleges. An important condition will be that, apart from theory being offered, attention should also be given to hands-on skills during these courses. The training product should therefore be designed to address specific competency needs of clients.

**Policy enabling environment:** The necessary conducive strategies and policies already exist for the role that extension advisors should play in enhancing sustainable irrigation agricultural development, such as Farmer Support Programmes that are implemented in all the provincial Departments of Agriculture. However, the lack of necessary political will to implement these strategies in a way where extension advisors are released to address the real needs of farmers and do what is required of extension, undermine smallholder farmer advancement.

## Topics covered by the extension training guides on irrigation water management:

**Soil-plant-atmosphere-continuum:** The soil-plant-atmosphere relationship recognises that all components of the irrigation field should be taken collectively into account when decisions are made regarding irrigation water management. This section serves as an introduction to concepts such as dynamic field balance of water and energy that is required for the flow of water and helps the learner understand the whole picture.

**Assessing of soil resources:** The objective of this technical guide in soil science is to provide learners with a comprehensive understanding of the soil factors required for land suitability evaluation and land use planning for irrigated agriculture. Specific attention is given to soil requirements (ideal conditions) and tolerances of crops grown under irrigation.

**Agro-climatology:** This learning material consists of ten modules. The aim is to provide learners with a general overview of the agro-climatic factors that need to be taken into consideration for effective irrigation management. This will enable them to communicate effectively with subject matter specialists and farmers in this regard.

**Irrigation water management:** The aim of this learning material is to acquaint learners with a comprehensive understanding of irrigation water management principles, introduce them to various irrigation systems that can be selected, an understanding of the layout and operation of an irrigation system and how to set benchmarks for efficient irrigation water management on the farm.

**Irrigation engineering:** In this guide learners are provided with an overview of irrigation engineering aspects required for effective management such as evaluation and maintenance of irrigation systems. The resultant knowledge and skills will enable the extension officer to communicate effectively with specialists such as irrigation engineers and to troubleshoot on the farm.

**Irrigation legislative context:** This learning material aims to provide the basic knowledge and understanding required

to apprehend the legal environment of an irrigation farmer. Four modules relating to the agricultural policy of South Africa, including the National Water Act, National Water Resource Strategy and Irrigation Strategy, are included.

**Irrigation economics:** This learning material aims to provide a basic understanding of farm management with the various tools that can assist the farmer to achieve his objectives. These tools and methods are divided into six sections, which include production and resource planning, financial management, marketing, human resource management and risk management. All of these sections are then incorporated into the business plan which forms the roadmap for the farm.

**Irrigated crop and fodder production:** This learning material provides an overview of sustainable cropping systems, basic understanding of the water uptake by plants, vegetative and reproductive growth of plants, followed by a comprehensive overview of production practices with specific emphasis on the crop irrigation requirements of various crop types.

**Agricultural extension:** This material addresses the identified skills and competencies as identified for agricultural extension. The 11 modules in this section covers various extension-related aspects, such as communication for rural innovation, extension approaches for agricultural development, leadership and facilitation, group mobilising, holistic farm planning and land evaluation skills.

The guides, *Training material for extension advisors in irrigation water management Volume 1 (Main Report)* (WRC Report No. TT 539/12); and *Training material for extension advisors in irrigation water management Volume 2 (Technical learner guides)* (WRC Report No. TT 540/1/12 to TT 540/8/12); *Training material for extension advisor in irrigation water management Volume 3* (WRC Report No. TT 541/12). To order any of these reports, contact Publications at Tel: (012) 761 9300; Email: [orders@wrc.org.za](mailto:orders@wrc.org.za) or Visit: [www.wrc.org.za](http://www.wrc.org.za) to download free copies.

## Strengthening agricultural colleges organisational capacity

An urgent need exists for reviewing of content on current curricula offered at Agricultural Colleges and Universities of Technology to align with industry needs. Instead of developing new curricula at colleges and universities of technology, the general preference by participants were that updating of existing curricula with information from the learning material will be the best option in the short term.

At some agricultural colleges serious staff shortages necessitate

the employment of young, inexperienced staff, who require additional mentoring and support. This learning material can be of great support to help these young scientists and lecturers with the updating and revision of existing curricula. Overall, much agricultural education and training focuses on primary production rather than on farming as a business – a crucial need for general economic business skills which are clearly addressed in the learning material content.

Very positive findings from the discussions were the general attitude and understanding expressed by participants that

current curricula offered at many colleges and universities of technology are outdated and should be reviewed. The general opinion expressed in the majority of discussion forums and meetings held was that the WRC should play a more important intervening or brokering role in addressing the shortcomings and misalignment of formal education by agricultural colleges and universities.

#### Explore possibilities of establishment of irrigation water school or Centre for Irrigation Water Management

Participants suggested exploring the establishment of an irrigation water school or Centre for Irrigation Water Management. The private sector can help with the funding of such a project, and also be involved in the training and research envisaged for such a centre.

#### Policies and implementation of decisions that support the proper functioning of agricultural education and training

Although the necessary policies and strategies with regard to the repositioning of agricultural education and training have been accepted, no concrete actions to implement these decisions have been taken yet. Unless the current position of agricultural education and training is not clarified soon, the degradation of infrastructure (including irrigation infrastructure) and demoralising of lecturing staff will continue.

Clear and distinctive decisions and implementation of an action plan are required to enable agricultural education and training centres to play its role in providing training and short courses to the agricultural sector.

#### Professional registration of extension advisors

Professional registration of extension advisors open doors for the offering of credit-bearing courses and training events as part of the continuous professional development required to maintain registration. This will help foster ongoing involvement in learning as well as support the national institutional arrangement for recognition an accreditation of learning.

#### Extension Suite On-line

Extension Suite On-line is an Internet-based application developed by Manstrat Agricultural Intelligence Solutions and provides an important link and information transfer mechanism between agricultural research and extension services.

The system facilitates and enhances the transfer of information between these parties by collecting, collating, interpreting and transforming scientific agricultural data into useful and user-friendly formats for use by extension practitioners and farmers. The possibility of including some of the material as part of this service rendered to extension practitioners were discussed with the developer.

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To obtain the report, *Knowledge brokering and dissemination of irrigation management guidelines for training of extension advisors (WRC Report No. KV 356/16)*, contact Publications at Tel: (012) 761 9300; Email: [orders@wrc.org.za](mailto:orders@wrc.org.za) or Visit: [www.wrc.org.za](http://www.wrc.org.za) to download a free copy.



# Smallholder irrigation

## Recipe for success – exploring the tools farmers need to succeed

*Smallholder irrigation farmers require more than infrastructure investment and training to make them succeed, as a Water Research Commission (WRC) study has discovered.*

*Article by Sue Matthews.*



Over the past 25 years, the WRC has funded an extensive body of research on smallholder irrigation schemes. A review of knowledge generated through this research was undertaken by Wim van Averbek and colleagues in 2010, and published in *Water SA* in January 2011. At that stage, only 206 of South Africa's 302 schemes were operational, and most were running at a fraction of their capacity. The problem was related to the fact that the schemes were located mainly in the former homelands, and many collapsed or went into decline when the parastatals responsible for them were closed post-1994 and their management transferred to the farmers.

Government has made efforts to revitalise the schemes, but the interventions typically focus on infrastructural improvements rather than management and socio-economic issues. Two such schemes – both situated on the floodplains of the Pongola River – serve as study sites for a WRC-funded research project currently being conducted under the leadership of Prof Edilegnaw Wale Zegeye of the University of KwaZulu-Natal's School of Agricultural, Earth and Environmental Sciences.

The Ndumo B scheme is located in the northernmost reaches of the province, close to South Africa's border with Mozambique, while the much larger Makhathini scheme lies just downstream of the Jozini Dam. In essence, the research is exploring opportunities and constraints presented by the schemes in facilitating sustainable rural livelihoods and entrepreneurial development, but a novel aspect is the focus on farmers' psychological capital – their hope, optimism, resilience and self-efficacy.

"It is common knowledge that farmers working in the same community – with similar resource endowment and faced with similar institutional and infrastructural constraints – are adopting different strategies, responding differently to incentives, calling for different interventions and achieving different livelihood outcomes," note the project team. "While some take advantage of opportunities when they arise, others do not. While some wait and expect the government to do everything for them, others make their own effort and decide on their destiny, act and mobilise available resources. While some are confident





*This Makhatini community gardener cultivates tomatoes, cabbage and spinach on his 0.1 ha plot.*

in farming as a means of supporting household livelihoods, the others are not. While some give up easily when faced with challenges, the others do not.”

*“The attitudes of young people towards farming needs to be changed and the policy of the government should deliberately create conditions that encourage young people to be involved in farming, not only as workers but also as owners of farming businesses.”*

The project team aimed to explain these differences using the ‘PsyCap’ concept. They gathered data during three week-long field visits to each of the schemes in 2015, using trained enumerators, guided focus group discussions and structured questionnaires, which focused mainly on sources of livelihoods, asset or capital endowment, water availability and irrigation, cropping patterns, agricultural production and marketing.

Agricultural producers in and around the two schemes could be roughly differentiated into five different types: scheme irrigators, independent irrigators, home gardeners, community gardeners and non-irrigators. This partly explains why irrigated crop production was found to be only the second most important source of income for the farmers sampled, with temporary employment, livestock, remittance, arts and craft, rain-fed crops and permanent employment being lower in order of importance. For home and community gardeners, farming is mainly a source of food, rather than income.

What is somewhat surprising, though, is that the primary source of income in the rural areas was welfare grants, such as child

support, old age, disability and foster grants. The project team note that these grants have likely contributed to the farmers’ entrenched mindset that they are entitled to government support, as well as their low psychological capital to ‘make things happen’ using the resources and assets they do have. Furthermore, farming is considered an unattractive economic activity by the youth, who consider it an old-fashioned and dirty occupation that does not bring quick money.

In their progress report, the project team suggest various ways of addressing this. For example, the provincial Department of Agriculture and Environmental Affairs (DAEA) could arrange field visits and mentorship programmes for smallholder farmers, aimed at boosting their confidence and hope in agriculture when they see how more experienced, entrepreneurial or successful farmers operate.

“The attitudes of young people towards farming needs to be changed and the policy of the government should deliberately create conditions that encourage young people to be involved in farming, not only as workers but also as owners of farming businesses,” they write. “The long-term focus should be on developing entrepreneurial spirit from young ages. If established smallholders can run their farming profitably, the perception will change over time.”

Mentorship programmes and additional training could also help to address some of the more practical issues that act as barriers to success. Although the majority of farmers have received some sort of agricultural training from DAEA and/or various non-governmental organisations and suppliers, there is a clear need for training in financial management and business operation.

“Most of the farmers do not know whether they are making a profit from their produce as they don’t distinguish farm operations from family operations, and do not always keep records of their yield, input costs, household consumption and marketable surplus,” note the project team.



Community gardeners in Makhatini are sourcing water from the river located a kilometre away. The water is stored using buckets.

*“The various research projects on the theme of entrepreneurial development being funded by the WRC emphasise the importance of establishing small business in agriculture.”*

Even the training that the farmers have received is often not put into practice because of limited resources, irrelevance to their situations and lack of finance to buy equipment or materials. Unlike large commercial farmers, smallholder farmers typically do not have access to credit and cannot take advantage of economies of scale in marketing, transportation and acquiring services such as tractor hire. Collective action organisations in the form of cooperatives and farmer groups can play a valuable role in reducing costs and increasing bargaining power, but many farmers are averse to them because of previous bad experiences. Some view cooperatives as a tool being used by government to control them, while others cite issues of mistrust, accountability and the ‘free riding’ syndrome as major problems. Corruption and nepotism displayed by the leadership, as well as different visions among members, were additional problems mentioned by the farmers surveyed.

Relations between farmers and buyers are also poor, with low levels of trust. Farmers often fail to consistently meet their market obligations in terms of quantity and quality of produce, although this may be through no fault of their own. The irrigation systems are often faulty or non-functional – hindering production – while pest outbreaks are common. Most farmers cannot afford to buy pesticides, nor the fertilisers that would encourage bumper crops.

Market access is also affected by such ‘real-world’ problems as the poor condition of roads. All of these factors mean that farmers mostly sell their produce at low prices to local hawkers, instead of targeting high-value markets further afield. Consequently, farmers barely recoup their costs, particularly at the Ndumo B scheme, where the monthly electricity bill for pumping irrigation water amounts to R700-900/ha/month for each farmer. The Makhatini farmers benefit from a government subsidy, and only pay about R2 700/ha/year.



*The research project is exploring opportunities and constraints presented by smallholder irrigation schemes in facilitating sustainable rural livelihoods and entrepreneurial development.*

Currently, the two schemes cannot accommodate any more farmers, with the only options being leasing, borrowing and renting. However, because such arrangements are generally informal, the farmers have no security of tenure.

“Land owners can always claim their land at any time, making capital investments like improving drainage or applying organic manure on the land irrational,” write the project team. “One of the inherent challenges in this regard is the ‘unquestionable’ and absolute power of traditional leaders on land. There is a perception by the small producers in the rural areas that any time the traditional leader can take away the land, or change the tenure arrangement.”

Clearly, government intervention is required to address rights issues relating to land and water, but the private sector can assist smallholder farmers through, for example, local procurement of their products, offering input and credit schemes, and rewarding excellence in sustainable farming. There are even opportunities for ‘techies’ to get involved. The project team note that almost all the farmers have cellphones, so an app developer could make a valuable contribution by creating an online directory, where farmers could access market prices, agricultural services and extension advice.

Since completing this phase of the research, the project team has focused on determining the aspirations and goals of farmers to expand irrigation crop production from homestead gardens to irrigation plots, and/or from one to multiple irrigation plots on the two irrigation schemes. They are also formulating appropriate development paths for establishing sustainable farming businesses with crop enterprises, in order to increase food security, profitability and employment opportunities.

The various research projects on the theme of entrepreneurial development being funded by the WRC emphasise the importance of establishing small business in agriculture, notes WRC Executive Manager, Water Utilisation in Agriculture, Dr Gerhard Backeberg. “These small business opportunities must be identified along the whole food value-adding chain, from ‘farmer, field, to consumer form’. The challenge is to fully exploit the potential for employment generation and poverty reduction in both rural and urban areas.”

# Irrigation

## Irrigation farming: a lifeline for budding 'agripreneurs'



*In South Africa, unemployment and poverty are closely associated. Rural areas are nodes of both unemployment and chronic poverty. A study conducted in two districts of Limpopo Province indicates that irrigation farming is strongly associated with significantly better livelihoods. Irrigators were revealed to be clearly better off in terms of food availability and household income than other groups. While caution is needed in celebrating causal linkages, the strong association provides a robust case for irrigation as a core rural development strategy, as set out in the National Development Plan (NDP) of 2011.*

*Article by Kim Trollip.*

Rural poverty is the most severe, with rural people more than twice as likely to be poor; and the severity of rural poverty is nearly three times that of urban dwellers. Women and youth suffer the most. The challenges in tackling poverty are compounded by high unemployment, most visibly reflected in youth unemployment, which in 2015 was estimated at 45.3%. This is a crisis indeed.

In rural areas, agriculture makes an important contribution to food security at a household level, particularly for the poorest households. Agriculture is also seen as one of the key strategic opportunities for employment and rural development, but smallholder farmers face formidable challenges.

The general aim of the study, funded by the Water Research Commission, was 'to review and evaluate appropriate development paths for expansion from homestead food gardening to smallholder irrigation farming, increased water use productivity of crop production and improved livelihoods on selected smallholder irrigation schemes in South Africa.'

Enhancement of entrepreneurship is seen as key to growth in a free-market economic system including in the agricultural sector. The study findings show that irrigation is strongly associated with improved livelihood outcomes and a strengthened human, physical and financial capital base. The incomes of irrigator households were significantly higher, with all irrigator households above the upper-bound poverty line, while home gardeners were on or below this line. Irrigator households were also more food secure with greater food diversity. Entrepreneurial farmers with varied characteristics, but sharing a business outlook, were identified in similar numbers to classical peasant-farming categories, with true capitalist farmers a rarity.

The research effort in this study pivoted on three dominant themes: irrigated agriculture, rural livelihoods and entrepreneurship. The project identified three main populations of irrigators that were the focus of the study. The first population was home-food gardeners comprising individuals engaged in agricultural production within their homestead. The second population comprised farmers active on smallholder irrigation

schemes, where a scheme is defined as the hydraulic system which is shared by a group of farmers. The third population comprised independent irrigators who are solely responsible for their own irrigation system and typically pump from adjacent rivers or boreholes.

The research was conducted using a multiple-case study approach, conducted at two research sites aiming for symmetrical analysis, covering the three populations. Thulamela Local Municipality, located in Vhembe District, was the first site and Greater Tzaneen Local Municipality, located in Mopani District, was the second. Both are located in Limpopo Province.

The key proposition in the project was that increased local, regional and national benefits from smallholder irrigated crop production will be driven by entrepreneurs who identify opportunities, develop strategies to exploit these and turn these into viable and profitable irrigated crop production (and perhaps processing) enterprises.

Comparison of the livelihoods of three groups provided compelling evidence that irrigated smallholder agriculture and improved livelihoods were closely associated. Smallholder irrigation is considered to be a successful poverty alleviation tool when it paved the way for increased consumption, asset accumulation, nutritional improvements and reduced persistent poverty among users. Over time these gains lead to institutional feedbacks that support sustained economic development and the evidence collected at the two study sites indicates that most if not all these criteria had been met.

The study found that people arrive at irrigation farming via many experiential routes; from starting points as diverse as desperation and hunger, to planned early retirement with savings and a business outlook. It was found that regardless of their historical experiences (pathway), it was the physical location of farming – in the home garden, on a scheme, or as an independent irrigator – that defined the current farming challenges that they faced. This was because the institutional uncertainties were a dominant challenge limiting their growth and land and water issues were quite different in the different physical locations. This is said noting that wider agricultural production challenges such as finance, knowledge and marketing were shared by all groups.

“Another important finding was more a confirmation of our own and other published work,” explains project leader Jonathan Dennison of Umhlaba Consulting Group, “Smallholder irrigators are not homogenous and different types of smallholder farmers need different kinds of support interventions to meet their priority needs. Modelling responses for smallholders only on successful approaches from the large-scale highly commercialised agricultural sector will serve some, but not most smallholder farmers. A suite of interventions which can be tailored to be responsive to smallholder diversity is essential if the opportunities for smallholder agricultural entrepreneurial development are to be more fully exploited.”

### Key messages for policy-makers

Obstacles to successful farming are severe and dominated by institutional disincentives in the acquisition of secure land and in obtaining secure water supply. The wholly inadequate



*The study findings show that irrigation is strongly associated with improved livelihood outcomes and a strengthened human, physical and financial capital base.*

communal land-tenure arrangements, combined with high risks related to inadequate irrigation water supply turn development pathways into somewhat treacherous endeavours. Relocation of promising farmers onto well-established (previously white-owned) schemes, fundamental reforms in communal land-tenure systems on smallholder schemes, investment in water management institutions, marketing support, and water management interventions are all strategies that would have to be pursued in parallel to achieve results. Irrigation can, it seems, provide the much sought after development outcomes, but this requires a new political will to re-set the development direction, drive profitability initiatives and re-institutionalise the smallholder irrigation sector from a land and water perspective.

“We found that smallholder irrigators are heavily constrained by a reality of institutional ‘chaos’ on the ground due to widespread uncertainties in regard to land-leasing arrangements and water-use rights, says Dennison. “Land-tenure arrangements are quasi-legal in most situations and practices on the ground show diverse interpretation of the law, with high transaction and financial costs for farmers. While smallholder irrigators face serious hurdles in regard to production knowledge, financing and marketing in particular, bringing institutional order to tenure, both land and water, would greatly reduce farming risks and increase smallholders’ resilience to other livelihoods shocks.

“If decision-makers want to achieve ‘bang-for-buck’, local-level institutional and organisational interventions should be pursued as a priority. The methods to address these institutional issues are well-established and the costs are relatively small compared with

capital investment in bulk-water supply and in-field irrigation infrastructure. A triple thrust in organisational development comprising secondary cooperatives with an emphasis on knowledge and market linkages, water management organisations (WUAs) with support for registrations/licensing, and skilled support interventions in local land-leasing, would initiate a significant reduction in risk exposure and our evidence shows this would trigger a quantum leap in local investment and profitability. Entrepreneurs, particularly those on the margins in this high risk agricultural production context, will respond to the increased certainty. In the present, seriously-constrained fiscal context, these relatively-low-cost facilitative interventions will lead to marked growth for existing irrigators who are currently surviving and remain active despite the odds which are stacked against them."

In summary, Dennison's message to policy-makers is, "We know what to do and how to do it – just do it!"

#### Strategies to overcome the many identified challenges:

- Land tenure interventions
- Market and knowledge interventions
- Water infrastructure investment
- Water regulations and irrigation management

#### The so-called 'good life' can be enjoyed in rural areas too

Smallholder farming in South Africa was historically geared for food provisioning, which is fundamentally different from farming as a business. The typical 1.5 ha scheme plot size is evidence of this, resulting from the early apartheid Tomlinson Commission

recommendations for maize self-sufficiency of a typical 'Bantu' family. It is understandable that the image of old or so-called 'uneducated' people farming maize and pumpkins does not resonate with trendy western-dominated ideals of the youth, but there is a change in perceptions that comes from the reality of the ever failing 'urban dream'.

Some of the successful younger agri-business entrepreneurs, or 'agripreneurs', who were documented in the study had tried their hand in cities and returned disillusioned and desperate, and took up farming, because there was nothing else left to try. Their vision of agriculture is now very different from that of a parochial agrarian existence. It is one where irrigation means business and production; where crops are planted with money and markets in mind; and where farming is seen as the means to achieve success – in their eyes and in the eyes of others. It is the view of the research team that the reality is one where perceptions of irrigated farming are in transition. While some of course stick to an aged view of agriculture, the new entrepreneurs are fully aware that agriculture is a way out of poverty and a pathway to a better life. But these post-millennial young farmers need more than market forces to get established. Much like the successful mid-century approaches to settle and establish unemployed workers and soldiers, a medium term view and state support is unavoidable.

Agricultural transformation demands a ten-year plan as a minimum. If nothing else, the youth have time on their hands, smartphones at their ears and their eyes on possibilities – pathways to a better life. The challenge is not to change perceptions, but to support those already keen and that will change the wider perspective of irrigation farming: from a dominant picture of gumboots-and-mud to one about making money.



*New entrepreneurs are fully aware that agriculture is a way out of poverty and a pathway to a better life.*

# Water-energy nexus

## Measuring integration – towards a water-energy-food nexus index

*How do you measure whether a country is advancing towards integrating water, energy and food production? Gareth Simpson and Marit Berchner propose a new water-energy-food nexus index.*

Water, energy and food are three of the key pillars upon which humanity exists and develops. But these pillars are not independent, as illustrated in Figure 1. Rather, a multitude of connections and trade-offs exist between them. For instance, water is utilised in agricultural irrigation and food processing. Water is also essential for energy generation, be it directly in the case of hydropower or indirectly in coal mining. Energy is utilised in the pumping of water and for the mechanisation of various agricultural activities. The nexus approach to sector management seeks to understand the linkages, dependencies, and trade-offs associated with the core elements within the particular nexus.

The regulatory custodians of water, energy and agriculture, often reside in separate departments. With a lack of coordination between them, these departments can (and do) promote conflicting programmes that inadvertently threaten the security associated with an adjacent sector. One of the reasons for this lack of coordination is that a general understanding of the nexus dynamics is limited. While research on the nexus has mainly focused on a qualitative examination of the linkages and dependencies between the sectors in the nexus, what is lacking to date is a quantitative indicator or index assessing the performance of the sectors in relation to each other. A number of indicators currently exist for each of the three individual resources within this Water-Energy-Food (WEF) nexus. Many of these sector-specific indicators are reported upon by the World Bank and United Nations. These indicators, however, describe isolated pieces of information, and thereby neglect the interconnections between sectors.

It is therefore proposed that a composite indicator, or index, be developed to report on the WEF nexus. This index should ideally be based upon quantitative data, and must ultimately be represented by a single numeric indicator, whereby different cities, regions or countries can be compared and evaluated. The WEF nexus index for, e.g. a country, could then be calculated on an annual basis in order to assess progress in sustainable development, as it relates to these three vital sectors. Similarly, mitigation scenarios could be tested in order to establish achievable and measurable goals to improve the WEF nexus index over time.

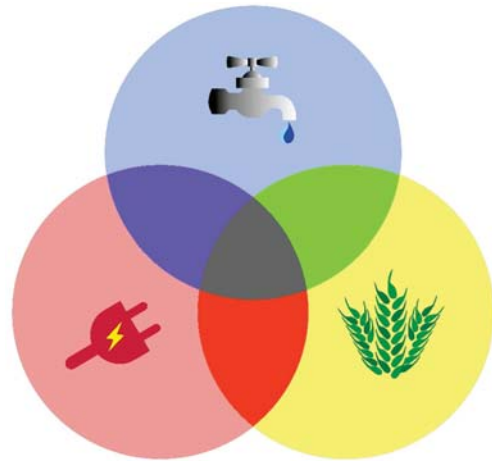


Figure 1: A schematic representation of the Water-Energy-Food nexus.

It is proposed that the WEF nexus index be calculated using two key existing indicators from each sector: one representing a country's sustainability level in terms of that sector; and a second one representing that nation's population's vulnerability in terms of that resource in the WEF nexus. These components are intimately connected, since a country's sustainability has a major impact on its population's vulnerability.

The three 'human vulnerability' indicators are the key targets for their respective United Nations Sustainability Development Goals (SDGs):

SDG 2 (Zero hunger),  
SDG 6 (Clean water and sanitation for all), and  
SDG 7 (Affordable and clean energy).

The six parameters which constitute the WEF nexus index for the case of South Africa are presented in a radar chart, termed the WEF nexus hexagon, in Figure 2. This is a visual representation of the numeric WEF nexus index. The WEF nexus index for South Africa is 0.728. This ratio is the average of the six indicators presented in Table 1. For comparison purposes, Germany's WEF nexus index is 0.877. Based on the presentation of data in this

figure, South Africa is relatively self-sufficient in terms of cereal production, the prevalence of undernourishment is relatively low, and a large proportion of the population has access to improved drinking water sources and electricity.

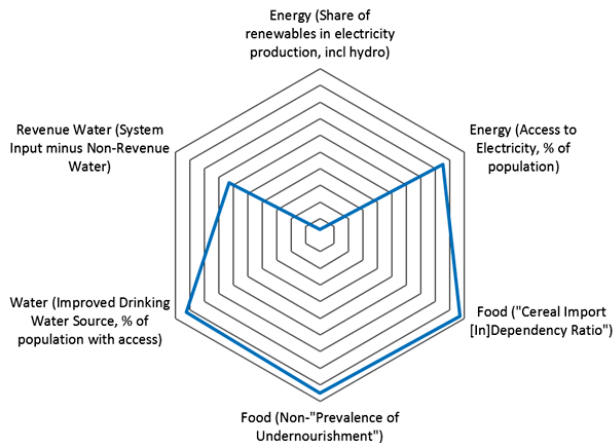


Figure 2: The WEF nexus hexagon for South Africa

Regionally, South Africa is one of the most advanced countries in terms of achieving the targets set in the three relevant SDGs. Ongoing developments such as population growth, urbanisation and changing dietary patterns however result in the goals never being achieved absolutely, but rather that they are dynamic and in need of continuous monitoring. The proposed WEF nexus index can support the monitoring process and draw attention to strengths and weaknesses associated with the sectors in focus, and the policies that are being implemented.

For instance, although the proportion of non-revenue water, which is the sum of unbilled authorised water, commercial losses and real or physical losses, in South Africa (36.8%) is very similar to the world average (36.6%), this still represents a staggering volume of water. The goal of reducing the proportion of non-revenue water must remain a key national goal.

The sector that lowers the WEF nexus index for South Africa most significantly is the energy sector, which is due to this sector being dominated by coal. South Africa is the seventh largest producer of coal in the world. The Council for Geoscience estimates that South Africa has a run-of-coal reserve of about 66.7 billion tons. Eskom, the national utility, purchases approximately half of the locally produced coal, and about 90% of this country's electricity is generated by means of coal-fired power stations. Only a little more than 3% of South Africa's electricity is generated by means of renewable sources.

When considering the influence of coal in South Africa, its impact upon agriculture and water is significant. The Bureau for Food and Agriculture Policy explains that, "At the current rate of coal mining in Mpumalanga, it was calculated that approximately 12% of South Africa's total high potential arable land will be transformed, while a further 13.6% are under prospecting by the mines in Mpumalanga." These statistics indicate that current and future mining enterprises could soon have a negative impact upon agricultural production, as well as

long-term implications for food prices.

It is estimated that there are about 5 000 endorheic wetland pans in the Mpumalanga Province alone. This is the second smallest province in South Africa. The change in land use due to mining represents a loss of cultivated land for food production, and will have a negative impact on water quality and biodiversity in the wetland system. Once an opencast mine is rehabilitated, its pre-mining land capability will never be restored. Similarly, some of the hydrological drivers of the wetland ecology will be irreparably removed. Yet in a country such as South Africa, where there is such a large dependence on coal, to stop developments such as this mine would be tantamount to switching the lights off on a national level. Further, the coal industry in South Africa employs about 90 000 people. There is thus a dilemma between business as usual and sustainable development.

Similar to the loss of high potential arable land, biodiversity and wetland systems, the hundreds of operating and derelict, ownerless mines in the country result in water pollution because of acid mine drainage. Water bodies such as the Olifants River have been significantly impacted in terms of quality (and quantity) by extensive coal mining within its catchment area. These factors, combined with the high proportion of non-revenue water, and South Africa being a water scarce country, yield a potential crisis within the WEF nexus.

The WEF nexus hexagon, together with the aforesaid impact of coal mining on the WEF Nexus, shows that in addition to seeking to reduce the level of unaccounted-for water in the country, a key focus must be to develop clean energy technologies, and in particular renewable energy. South Africa is endowed with massive potential in terms of solar and wind power generation. The South African Department of Energy's Integrated Resource Plan, released in November 2016, recognises this, with the base case allocating 55 000 MW for new renewable energy to be delivered between 2020 and 2050. This comprises of 37 400 MW of wind and 17 600 MW of solar photovoltaic power generation.

There are, however, some concerns regarding the constraints that are specified regarding the annual delivery of renewable energy.

The WEF nexus index, together with its visual presentation as the WEF nexus hexagon, can serve as a tool to illustrate how sustainable development is advancing in the water, energy and food sectors, particularly when their linkages are taken into account. The WEF nexus index, being a quantitative ratio, enables comparisons across different geographic entities or within one geographic region over a period of time.

Especially if supplemented with qualitative information, this index can assist researchers, regulators, consultants and NGOs in identifying strengths, weaknesses, opportunities and threats within the interdependent sectors. This can lead to the development of policy recommendations which take into account the interconnections between sectors, and which encourage dynamic progress towards the achievement of the SDGs.

# Opinion

## South Africa's drought preparedness – Too little too late?



*South Africa experiences drought on a regular basis, often associated with significant negative impacts on society and the economy. Despite improvements in forecast technologies, there is a tendency to implement remedial interventions when droughts occur, rather than implementing proactive and preventative strategies. This has also been the case with the 2015/16 drought, writes Richard Meissner and Inga Jacobs-Mata.*

The current country-wide drought in South Africa, which is likely to continue into 2017, has raised important questions regarding the country's drought preparedness. There is a general sense that the government, in particular, was not well prepared to respond to the current drought.

This criticism is compounded by the fact that South Africa is prone to cyclical droughts at regular intervals; since 1980, the country has experienced four droughts. These droughts varied in severity, but all had a negative impact on the agricultural sector, the country's ability to generate electricity and the broader economy.

The current drought is the worst in 35 years. Although one can define drought scientifically (meteorological droughts occur when rainfall is 75% below normal over a one-year period or longer), this does not mean that a drought is a weather-related

phenomenon only, it also has a social dimension.

### **Forecasting and responding to drought**

The strongest El Niño since 1997 has generated the current drought and, as a result, eight of South Africa's nine provinces have been declared disaster areas. Ian Khama, President of Botswana and current Chair of the Southern African Development Community (SADC), declared a regional disaster in July 2016. Southern African countries have appeared for US\$2.7 billion in drought aid, reflecting the extent of the drought's socio-economic ramifications.

South Africa has put in place a number of coping strategies and policies to respond to periods of drought. This includes the promulgation of the Disaster Management Act No. 57 of 2002 and the National Disaster Risk Management Framework of 2005. Yet, despite the development of these policies, the focus of



the South African government still seems to be largely centred around remedial action rather than on preventative mechanisms. Operationally, the country's bulk water-supply system and interconnected water networks play a pivotal role in South Africa's drought response strategy. The Department of Water and Sanitation (DWS) manages the country's system of dams, water pipelines, and irrigation schemes through operating rules, both under normal conditions and during droughts. When a drought occurs, the department prioritises water supply according to different water-use sectors' requirements to ensure sustainability of the resource.

Water-use priority is given to basic human needs and the water requirements of strategic users, such as power stations and major industries. Urban water users are curtailed less than the agriculture sector. Each specific system will therefore have different levels of curtailment, according to the profile of water users reliant on the system. The computer-generated models determining these operating rules need regular updating in response to improved understanding of the system's water resources and the country's water requirements.

Additionally, the department's water conservation and demand management programmes constantly engage with municipalities to address the issues of non-revenue water loss (such as water leaks) that can waste up to 40% of the bulk water supply in large municipalities.

Implementation of water conservation and water demand management (WC/WDM) strategies is critically important if South Africa is to overcome the effects of droughts at the municipal level. Despite the fact that WC/WDM is a critical element in all strategies to balance water supply and demand, many municipalities have not fully adopted the water conservation ethos. Indeed, some municipalities are not aware of their exact water use and/or water losses due to a lack of monitoring information on water use and backlogs in water infrastructure maintenance.

At the household level, South Africans use more water than many other developed and developing countries. Water is often wasted, even during times of drought. About 40% of urban household water is used for watering gardens. An effective drought policy needs to address individual water-use habits on a continuous basis, rather than focusing predominantly on the introduction of water restrictions in various water-use sectors when a drought occurs.

At the national level there is still a gap between scientists' ability to model the incidence of drought and the incorporation of this information into government and sectoral responses. Both the government and the agricultural sector were aware of forecasts, in 2015, of significantly below-normal rainfall and were not completely unprepared.

What was unexpected was that this El Niño would be the strongest since 1997 and that the below-normal rainfall it would cause would be the lowest in more than 90 years. The below-normal rainfall (meteorological drought) led ultimately to a

hydrological drought, where the lowest reservoir levels were observed in a decade and the deficiency in soil moisture posed a significant threat to livelihoods and food security.

There is a growing realisation that South Africa requires a long-term, national drought policy and strategy to mitigate the risk of future occurrences of drought. Embedded within this is the need for regular science-based mechanisms and monitoring that will deliver timely information to decision-makers and so strengthen risk management measures and preparedness plans.

#### South Africa's drought preparedness

The South African Weather Service (SAWS) issues drought warnings, while the Applied Centre for Climate and Earth Systems Science and institutions such as the CSIR are also capable of giving ample warning of probable droughts. The CSIR's Dr Francois Engelbrecht indicated in October 2015 that South African "farmers are used to a high degree of climate variability. It is not the first time they have faced El Niño." Engelbrecht observed that the commercial farming sector is quite sophisticated in gathering information on weather patterns. However, farmers who have been experiencing dry spells for three consecutive years are vulnerable to a major El Niño-induced drought. This places added pressure on commercial farming operations, and even more for subsistence farming.

To address the issue of drought preparedness it is necessary to implement collaborative governance spanning the government, major water-use sectors and the broader citizenry. A number of tactics can be employed, one of which is adequate drought monitoring. The DWS has a number of drought plans in place that are operationalised through the mobilisation of various teams. Water resource development teams that site and drill boreholes for short- to medium-term needs are a case in point.

The department's Drought Management Unit monitors drought and floods before, during and after such events occur. However, this unit operates largely in a reactive manner, providing remedial actions as opposed to implementing a proactive, long-term strategy. Long-term strategies include the assessment of the use of groundwater resources, where it is sustainable, to augment water supply.

*"There is a growing realisation that South Africa requires a long-term, national drought policy and strategy to mitigate the risk of future occurrences of drought."*

Water conservation and awareness projects should also be expanded. On the supply side, the refurbishment, operation and maintenance of bulk water supply systems and water distribution systems need to be improved. It is also important to



*Wastage of water remains an issue in most municipalities, despite the country's semi-arid nature.*

improve weather forecasting and confidence levels in predicting extreme events. Investments in research and technology developments are essential in this regard.

Cooperation between various science and technology organisations such as SAWS, CSIR, the Water Research Commission and universities is needed to enhance the efficiency of climate protection tools and climate model scenarios.

A major challenge for South Africa's meteorological data gathering system is the theft and vandalism of weather monitoring stations. This undermines the country's weather monitoring system, making it more difficult to gather essential data for forecasting purposes. Rainfall data and streamflow gauges are important elements of meteorological infrastructure to gather data and operate an effective flood and drought early warning system.

There is also a shrinking budget to replace, and/or maintain damaged monitoring stations. On top of this, rainfall data, necessary for streamflow assessments, is no longer freely available, but needs to be purchased from SAWS and the

Agricultural Research Council, placing a burden on forecasting budgets and hindering climate change research.

One way of addressing the problem of a weakening monitoring system is to engage citizens and gather data from private individuals who keep rainfall records. In 2014, the WRC launched such an initiative and received a significant response. This culminated in a hydrology data service centre from citizens and other private data collectors, developed in collaboration with the Department of Science & Technology, USAID, the US Army Corps of Engineers and the US Bureau of Reclamation.

The challenge with data generated through such processes is that it needs to be vetted and verified, which in turn requires a greater allocation of human resources as well as computing power. However, with the appropriate support such programmes hold great promise for enhanced drought preparedness in South Africa and the broader region. Since drought is a regional phenomenon, citizens across the southern African region should be included in such initiatives.

For such programmes to be effective, however, the service centre needs the necessary resources to process and effectively disseminate the data.

### Conclusion

The current, country-wide drought is not a once-off event, and preparedness for such natural disasters, which are usually followed by La Niña-related flooding across southern Africa, is essential. South Africa has been ravaged by drought before, and this natural phenomenon will happen again. It is not a matter of 'if' but 'when' and broadening monitoring capability, including through citizen participation, can contribute to improved preparedness.

In this regard, the DWS should enlarge the scope of the Drought Management Unit to include the effective forecasting of other natural disasters, such as flooding, as well. This unit could also engage the citizenry more proactively, rather than focusing on the scientific and policy community. In this way, the governing capacity of the department could increase immensely, contributing to enhanced drought preparedness at the national level.

This article forms part of the project, Climate Change Adaptation Readiness: Lessons from the 2015/16 El Niño for Climate Readiness in Southern Africa, funded by the Embassy of the Federal Republic of Germany in Pretoria. First published by the South African Institute of International Affairs ([www.saiia.org.za](http://www.saiia.org.za)).

# Ecological infrastructure

## Protecting the environment for development – Linking ecosystem function and development outcomes

*'Ecological infrastructure' is a term that is increasingly being bandied about, however, few people understand how important taking care of our natural resources are to our own development and well-being as communities. Article submitted by CSIR.*

Olivia wakes up to a sunny day and after a quick shower, she enjoys a hearty bowl of cereal and milk. On her way to school she passes the factory where her father converts wood to paper. She enjoys the scenic route along the stream, thankful that the previous night's heavy rain didn't flood the fertile valley below. Instead, it filled the dam that supplies the community and the nearby mine, which provides jobs for many people in the surrounding area. The reliable supply of water and electricity at her school enables learners to focus on the academic programme.

This story reflects 12 water-related goods and services. This article will explain the relationship between functional water-related ecosystems and the goods and services that they provide in support of social and economic development, after considering the national picture.

According to the South African National Biodiversity Institute (SANBI), South Africa's ecosystem diversity is a kind of infrastructure which, just like roads and railway lines, is critical to the wellbeing of the economy, communities and individual people. The National Development Plan calls for the sustainable management of our natural endowments.

One of the principles of spatial planning is spatial sustainability, which requires sustainable patterns of consumption and production, and ways of living that do not damage the natural environment. The second edition of National Water Resource Strategy sets out to ensure that South Africa's aquatic ecosystems are protected effectively at different levels in accordance with the classification system, and that decisions concerning levels of protection take transparent and just account of environmental, social and economic well-being.

The above policies are progressive and aspirational, but the current reality presents some key challenges. The South African national reliable water yield with our current infrastructure is 15 billion m<sup>3</sup>/annum. However, the current registered water use is 17.3 billion m<sup>3</sup>/annum. Given that the maximum possible reliable yield is 19 billion m<sup>3</sup>/annum (if all possible infrastructure

is put in place to capture and store water), it is clear that we should focus on more efficient water use.

Our rivers and wetlands are also under pressure, with 48% of wetlands critically endangered and only one third of our big rivers being in a good ecological condition. Furthermore, more than 40% of lowland river ecosystems and more than 30% of our lower foothill rivers ecosystems are critically endangered. This decline in the state of water resources has consequences for the health of related ecosystems and for people and economic activities that depend on the goods and services that these ecosystems provide.

*"This decline in the state of water resources has consequences for the health of related ecosystems and for people and economic activities that depend on the goods and services that these ecosystems provide."*

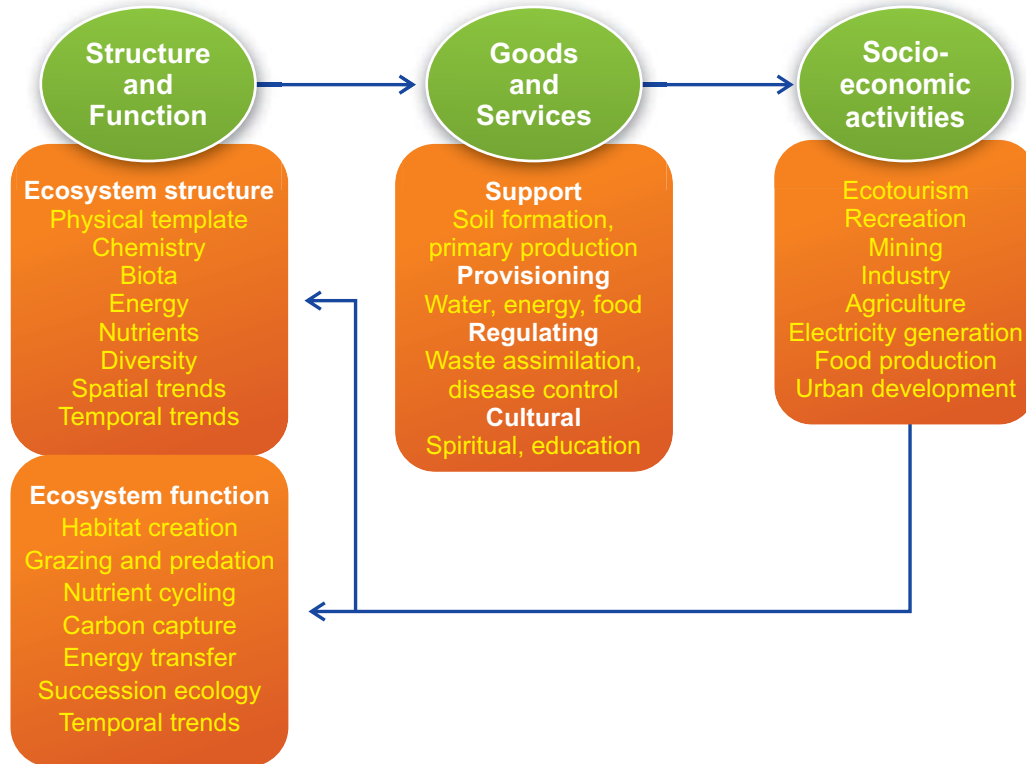
It is essential to look at water quantity, water quality and biodiversity, but it is also important to balance the protection of our water-related ecosystems while providing the best opportunities for social and economic development. To enable this, we need a more in-depth understanding of the structure and function of these systems, the associated goods and services, and effective measures to ensure that the goods and services are also available to future generations. In short, this requires "development with nature" and "protection for development".

The structure of water-related ecosystems refers to the linkages between physical, chemical and biological components. The functional aspects of these linkages are of critical importance to the provision of goods and services. We need to understand for specific systems, how dynamic processes alter geomorphology,

# Ecological infrastructure

how energy and nutrients are converted to biomass, how communities utilise this biomass to grow and proliferate, and how resilient these systems are to change.

The seasonal patterns, long-term cycles and directional change, due to global change, affect the intrinsic structure and function, but importantly also the goods and services that these ecosystems can provide. For instance, the systems' resilience to change serves to assimilated waste products, but once this capacity is exceeded, the ecosystem will change to a new state, with different structure and function and thus altering the goods and services that these systems can provide. This could mean that some of the goods and services that people rely on are no longer available.



Goods and services are classically understood to include: maintenance of the ecosystem; provisioning services; regulatory services; and cultural services. These services depend on the structure and function of the system, which, like industries, power lines and roads, provide the ecological infrastructure for the delivery of social and economic value.

Let's look at some examples of ecological infrastructure and the associated benefits.

Landscapes are physically altered through mining activities (open cast or subsurface), which also affect the settlement and expansion of communities and the establishment of support services. Functioning water-related ecosystems can provide a secure supply of water for mining activities and ecological infrastructure, such as rivers and wetlands, assimilate the waste from the mining activities, associated urban areas and support services.

The provision of water and assimilation of waste is currently treated as fixed services, whereas the ecosystem structure and functions that support these services are in fact highly dynamic

in space and time. If longitudinal connections and seasonal cycles are brought into the equation, we could increase the supply of water and assimilation of waste when and where the ecological infrastructure can sustainably provide such services, whereas the demand for these services can be managed more tightly when and where the capacity of the underlying systems and processes are reduced.

Similarly, other goods and services can be utilised more effectively if the underlying processes are understood better. This will for instance reduce the reputational risk for companies where ecosystems respond in unexpected ways to physical or chemical stressors. Water-related landscapes that have previously been altered by mining activities can still provide goods and services, and although the portfolio of socio-economic activities that can be supported by the altered system would be different to the pristine landscape, it can be valuable in providing post-mining social and economic development opportunities.

These opportunities can include ecotourism and high-value housing in rehabilitated areas, water provision and waste assimilation for alternative economic activities, agricultural

activities in line with the residual risk and opportunities, and supporting biodiversity in specific areas. Thinking of the ecosystems' structure and function as "ecological infrastructure", we also have the opportunity to "engineer" these environments to maximise the environmental and socio-economic benefits. Examples include the protection of blue swallow nesting sites in grasslands and wetland areas (both a conservation and ecotourism benefit), construction and/or enhancement of wetlands (improving biodiversity, waste assimilation, ecotourism and property value) and improved pastures for livestock and wildlife.

*The structure and function of water-related ecosystems are of particular importance during drought (and flood) conditions.*

Urbanisation is happening at a pace that often puts the provision of basic services under pressure. Urbanites also put a premium on an environment that supports a good quality of life. Given this context, urban waterscapes are a neglected resource. Although it is deemed a source of water and a conduit for waste, these systems are not generally managed to enhance their structure and function and consequently provide a broad range of goods and services.

With riparian spaces being confined in urban contexts, we need to understand the dynamic successive processes that create and maintain riparian zones that not only provide excellent opportunities for recreation and increase property values, but also serve as buffer for floods, increase the capacity for waste assimilation and support biodiversity. Again, when we view urban waterscapes as ecological infrastructure that should be integral to the development of urban infrastructure, we can identify the underlying structure and function to enhance intrinsic value and socio-economic benefits.

Whereas developers tend to stay away from urban waterscapes that have been turned into waste conduits, the opposite is true for waterscapes that are managed to provide a variety of services. Businesses and residential areas alike will benefit from secure water provision, sustainable waste assimilation, increased opportunities for recreation and aesthetic appreciation. Such conditions will improve property values, improve quality of life, create jobs and improve the overall attractiveness of a metropolitan or municipal area for investment.

The structure and function of water-related ecosystems are of particular importance during drought (and flood) conditions. The resilience of a system to respond to stresses and return to the original state after such stresses, depends on robust structural and functional elements. In this instance, we need to understand the goods and services that are available under stressed conditions, without pushing the system over the edge, thus limiting the ability of the system to continue to provide the goods and services that were available before the drought or flood.

The recovery process also involves succession ecology, where there is a transition of species that has a similar function in the system. Merely recording species lists is not particularly useful in this context, where a focus on functional elements will provide a more realistic perspective of development opportunities and constraints.

Getting back to Olivia's story and the preceding perspectives on ecological infrastructure, we can identify the following goods and service:

- "after a quick shower" – Provision of household water
- "hearty bowl of cereal" – Good quality water for irrigating cereals
- "and milk" – Water for livestock watering
- "the factory" – Water provision and waste assimilation for industry
- "where her father converts wood to paper" – Water for forestry
- "scenic route along the stream" – Aesthetic value of water-related ecosystems
- "rain didn't flood the fertile valley" – Flood control by intact riparian systems
- "filled the dam" – Multi-purpose dams for hydropower, irrigation, potable supplies, recreation
- "supplies the nearby mine" – Water supply and waste assimilation for mining
- "provides jobs for many people" – Water-dependent economic activities
- "supply of water" – Good quality water for social services
- "and electricity" – Water provision for cooling at power plants

The above benefits that Olivia is experiencing depend on the underlying structure and function and the effective management of the ecological infrastructure that provide these benefits.

In summary, we need to distinguish and understand the importance of ecological infrastructure in natural and modified systems. We will rarely have complete information about the structure and function of a water-related ecosystem, and therefore need to make the best decisions we can with partial information, but embark on a continuous learning process and facilitate feedback loops in an adaptive management process.

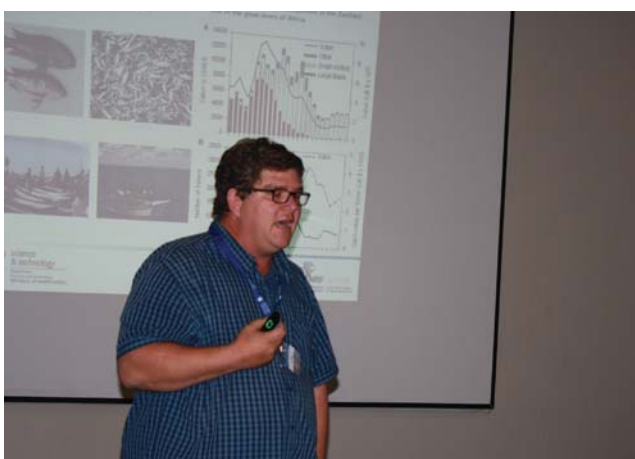
The end goal is to optimise the structural and functional aspects through an ecological infrastructure perspective to increase goods and services and thus supporting development outcomes. Ultimately we need "protection for development", rather than "protection vs. development"

# Let the fish swim – Workshop celebrates World Fisheries Day

Besides pollution, habitat degradation, threats from alien and invasive fish, drought and climate change, the disruption of fish migratory routes poses a serious threat to many fish. South African conservation authorities, led by South African National Parks (Sanparks), in partnership with the World Fish Migration Foundation, have launched the South African Swimway Programme. The programme is aimed at the protection of migratory fishes and their ecosystems in South Africa. The programme was one of the themes discussed at the Water Research Commission Dialogue, held on 21 November 2016 to celebrate World Fisheries Day. Other themes included celebrating the role of fish in society and, particularly the role of freshwater fisheries and fishing in the economy. The dialogue further reviewed existing information and explored existing and future research opportunities.



*Sanparks' Robin Petersen presented on the rich biodiversity of the Kruger National Park's rivers. More than 50 species of fish have been recorded.*



*Prof Olaf Weyl, principal scientist at the South African Institute for Aquatic Biodiversity presented on the importance of inland fisheries in creating jobs and providing food for communities.*



*Delegates at the workshop.*

# Wetlands Training Course

## Workshop and site visit on the taxonomy of wetland plants 2 February 2017, Gauteng

**Rationale and objective:** Wetlands are fascinating and dynamic ecosystems that provide indispensable ecosystem services. Commonly referred to as marshes, swamps, bogs or vleis, they constitute about 7% of South Africa's surface area. They support a range of specialised plant, insect, bird and mammal life and also supply wild food, grazing, building and craft materials to people. They absorb flood waters, improve water quality and regulate streamflow, helping to maintain ecosystem functioning downstream.

Like many countries in the world, South Africa's wetlands are threatened by anthropogenic activities. The country has already lost an estimated 50% of its wetlands to mining, agri-culture and industrial development, urbanisation and pollution.

South Africa possesses a large body of research on its

wetlands, much of which has been funded by the Water Research Commission (WRC). One of the Commission's most popular products are its Wet-Series – a set of integrated tools for assisting users to achieve well-informed and effective wetland management and rehabilitation. A recent addition, Easy identification of wetland plants (Report No TT 479/10) has proved especially popular.

This has prompted the WRC to host a training workshop on the taxonomy of wetland plants in South Africa. The training will include a site visit to practice plant identification in the field.

- **Due to the nature of the training limited space is available. Delegates have the option of attending the technical training only (excluding the field trip).**

# DEEPLY ROOTED IN SOUTH AFRICA WATER SOCIETY

[www.wrc.org.za](http://www.wrc.org.za)

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

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

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

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