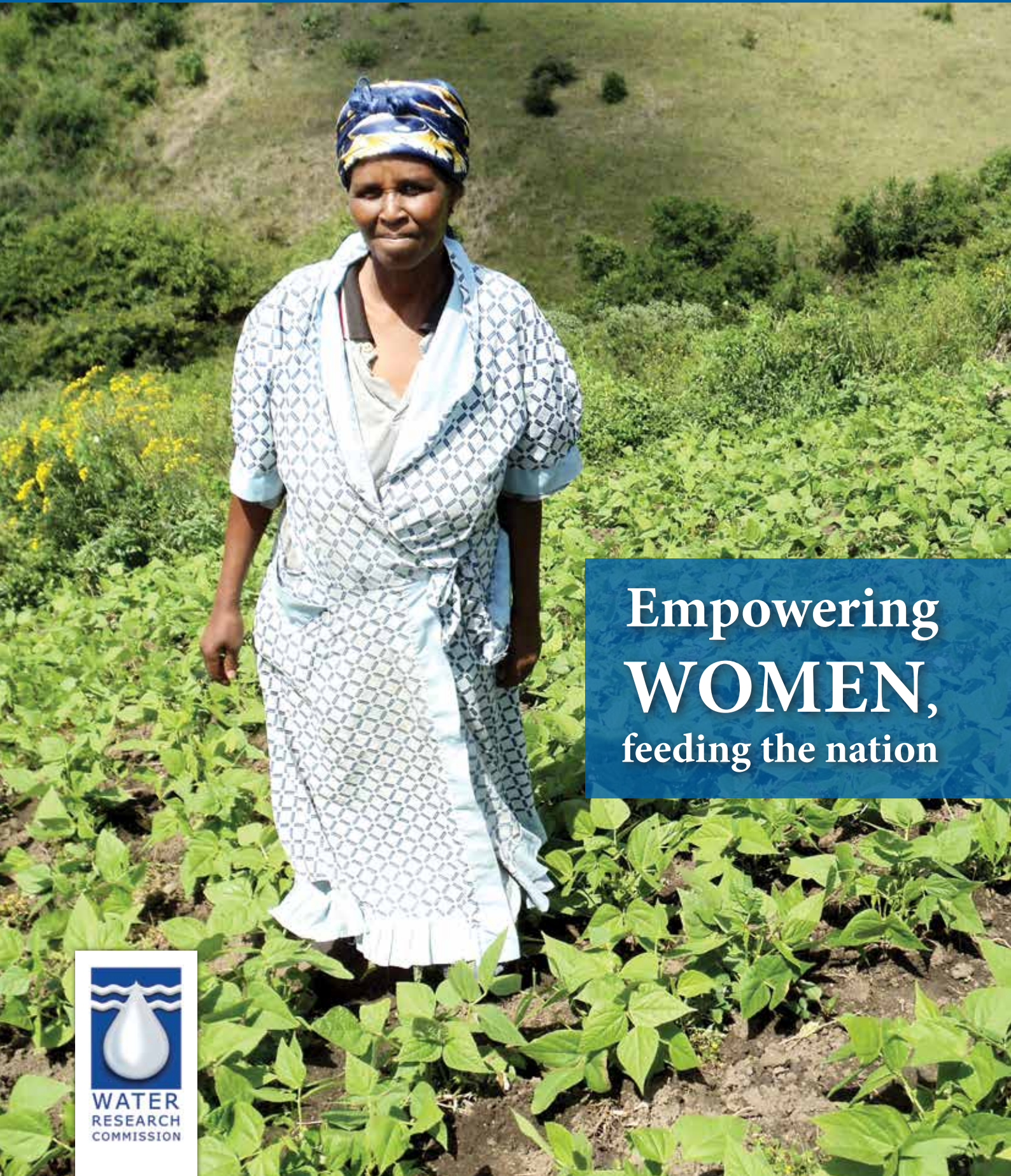


THE WATERWHEEL

ISSN 0258-2244

January/February 2016 Volume 15 No 1



Empowering
WOMEN,
feeding the nation



CONTENTS

- 04 **UPFRONT**
- 16 **WATER AND GENDER**
Increasing the benefits from rural agriculture for South Africa's women
- 24 **WATER QUALITY**
Satellite technology keeping an eye on South Africa's dams
- 27 **WATER AND HEALTH**
Pin-pointing pesticide contamination and the damage it can do to people
- 32 **INDUSTRY AND WATER**
From barley to bottle – water focus pays off for SA beer maker
- 36 **WATER AND THE ENVIRONMENT**
Jewel of the Northern Cape in fading due to pollution
- 38 **GLOBAL TREND**
Research at forefront of global race for sustainable development
- 40 **WATER KIDZ**
- 42 **LAST WORD**

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

Editorial offices:

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

Tel (012) 330-0340. 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;

Editorial Secretary: Dikeledi Molutsi,

E-mail: dikeledidk@wrc.org.za;

Layout: Dreamwave Design Solutions,

E-mail: info@dreamwavedesign.co.za



Cover: A recently completed Water Research Commission project researched ways to empower rural women through improved water use in agriculture. Article on page 16.



Fluid Thoughts

WRC CEO, Dhesigen Naidoo

2016 – Year of the Monkey

There was much hope for an *Annus Mirabilis* or miracle year in 2015.

In the run up to 2015, the United Nations system and most of the global Community of Nations fell into step with the idea of 2015 delivering the Big Three with respect to the global sustainable development agenda. This was embraced with an enthusiasm not seen since Rio 1992.

The run up to and preparation for the Big Three had been surprisingly convergent, and the spirits were high. The first step was the International Conference on Finance for Development (ICFD). This forum was going to be explicit on innovative and creative financial mechanisms for global development. And, but being held in Africa for the first time, in the capital hosting the African Union – Addis Ababa, it provoked an optimism that the North was finally going to make good on the long ignored commitment on ODA targets.

The second step was the Summit of world leaders to engage the proposed Sustainable Development Goals (SDGs) at UN headquarters in New York in September. The SDGs taking heart from the successes of the Millennium Development Goals (MDGs) was going to plot the global plan to attain a global eradication of poverty and ensure universal access to all basic services by 2030.

The third of the Big Three was of course COP 21 in Paris in December 2015. For the first time since Kyoto was there a sniff, indeed an alluring fragrance, of a global deal for climate change and carbon emissions with major movements from China, India and the USA in the preparatory talks. The clinching of this Big Three would indeed have organised for 2015's place in history as the miracle year for sustainable development.

Alas the reality bites of global economic contraction, the diversion of resources to global conflicts – in particular those under the banner of “the war on terror”, the structure of a global economy within which a high energy intensive industrial strategy remains the growth pathway of choice; all collectively ensured that the Big Three could not live up to its initial promise.

We had to settle for diluted outcomes. We can, however, claim an *annus mirabilis minor*. We could not collectively secure the more ambitious climate change deal, and the means of

implementation seem to be still locked in the debt capital paradigm with the Development Banks front and centre, and the rhetoric of domestic capital mobilisation punted as the paramount mechanisms. This is not particularly encouraging in a global austerity climate.

Still we have had a convergence of traditionally disparate political and ideological blocks to the point where we are at least agreed philosophically on our analysis of the global sustainable development challenge. We have universally accepted that human development choices and our carbon dependent economic growth paradigm are the major influencers of global climate change. And we collectively agree and accept that anthropogenically generated carbon dioxide and other greenhouse gas emissions are the major contributors to global warming. This is a big movement in the dialogue and one worthy of celebration.

The question is how we could use this *minor miracle* to catalyse a Great Leap Forward in 2016. As is characteristic of the 2016 mascot, the monkey, we have to be clever, very strategic, work as a team and perhaps have just the right spicing of simian mischief to make it all come together.

Team Water South Africa will be using the opportunities for scaling up of the game-changers like the Purple Pipe Revolution (reuse and recycling), New Sanitation and the War on Leaks to, in addition to the diversification of supply measures, increase both the water security status of the country and the region. This should not only make available the water we require to enable the achievement of the water and sanitation SDGs, but also make water available to enable further economic growth and empower more new entrants into the formal economy.

We will also do this from a scientifically sound and cutting edge technology enabled perspective that uses less energy with a radically diminished carbon footprint. We have a collective duty to ensure that Ma Dlamini not only has access to safe water and dignified sanitation, but it must be done in a manner that ensures that her great-grandchildren inherit from this generation a Planet Earth that is healthy and nurturing because we have enabled a sustainable development pathway.

wader

WATER TECHNOLOGIES
DEMONSTRATION PROGRAMME

A KEYSTONE FOR WATER
TECHNOLOGY INNOVATION

VISION

To bridge the gap between water research and the market to achieve a connected water innovation system that delivers socio-economic benefits for South Africa.

The Water Technologies DEMonstration ProgRamme (WADER) aims to bridge the gap between the R&D and commercialisation stages of the water innovation continuum by moving technologies out of the laboratories and proving them in real-world, test situations.

By coordinating the demonstration of water technologies in operational environments, WADER aims to increase the adoption of appropriate technologies and enhance the water innovation value chain. High-level demonstrations will serve to assess the technical, social, economic, regulatory and environmental attributes of the technologies. Each technology demonstrator will entail multi-player collaborations and a strong technology transfer component i.e. the transfer of skills, knowledge, methodologies, etc. to academia, government, business and civil society.



INNOVATE
COLLABORATE
DEMONSTRATE
EVALUATE
TECHNOLOGY TRANSFER

WADER WILL

- Collaborate • Coordinate demonstrations • Inform • Connect stakeholders • Assess and showcase technologies

WADER WILL NOT

- Provide funding • Endorse technologies • Accredit/certify technologies, individuals and/or organisations
- Generate standards • Commercialise technologies



science
& technology

Department:
Science and Technology
REPUBLIC OF SOUTH AFRICA



WATER
RESEARCH
COMMISSION

www.wader.org.za

Tel: +27 12 330 0340 | Tel: +27 12 330 9010 (direct)

A partnership between the
Department of Science and Technology and the Water Research Commission



Letters and Opinion

The Cuban engineer conundrum

The CEO of the Water Research Commission (WRC) saw fit in the July/August edition of *the Water Wheel* to attack the South African Institution of Civil Engineering (SAICE) and Consulting Engineers South Africa (CESA) for their strong objections to the employment of Cuban engineers by Government when there is a shortage of work in the country for engineers.

Contrary to official perceptions we do have considerable skills available in the private sector. The serious delays in implementation of the National Development Plan (NDP) being one of the prime factors. The other is the procurement process, which does not recognise the specific needs for the engagement of consultancies to assist the Government. I believe that a measured response is required as it appears that the CEO has a lack of understanding of the regulation of the engineering profession by the Engineering Council of South Africa (ECSA) in South Africa and what is happening in the industry.

The Washington, Sydney and Dublin accords are not designed to tie South Africa to the "Apartheid Era biases". I think it is unfortunate that the CEO should see fit to attach a racial connotation to these accords. They are much more a link with the wider international world of engineering for professional engineers, technologists and technicians.

The Institution of Civil Engineers London (ICE) qualifications (MICE and FICE) are over a hundred years old, and probably enjoy a greater worldwide recognition than any other professional engineering qualification. That is certainly my experience after more than 20 years working internationally, and over 40 years of membership of the ICE. The number of Chinese engineers from Hong Kong and Singapore who seek the MICE annually is growing every year. Membership of the American Society of Civil Engineers (ASCE) is also widely recognised.

It is therefore not surprising that ECSA has broadly followed the ICE and ASCE models in defining their regulatory system and membership of the Washington accord gives recognition to the standard of education and training of South African engineers. It says effectively that a South African Pr Eng will have his/her qualifications recognised by all countries that are signatories to the

accord. It also allows the qualifications of engineers from other countries to be assessed in line with the standards laid down so the comments on Peking university are essentially irrelevant. There is no indication that this process has been applied to the qualifications of the Cuban engineers. Until such time as it is and they meet the required standard they will be working at risk in this country. It must never be forgotten that the objective of the ECSA regulations is the protection of the public and not the protection of the engineers.

The comments by [SAICE incoming President] Dr Chris Herold in *the Water Wheel* (May/June 2015) highlight the shortage of skills in the water sector and particularly the loss of skills in recent years in the public sector. There are many contributory factors that have led to this shortage, among which are the over-zealous application of affirmative action and skilled engineers taking early retirement (encouraged by the government?) leaving the public sector desperately short of skills. The huge salaries of councillors and town managers in the medium and smaller municipalities have made it impossible for them to offer fair compensation to engineers and technicians to run their services. What happened to the position of the City engineer? There was a time, which older engineers will remember, when the public sector was the primary training ground of engineers.

Introducing Cuban engineers into this mix will not solve the problems. They will be on two-year contracts, will need to learn the language, become conversant with local procurement procedures and contract forms and local customs. Who is going to mentor the Cubans in the first instance? The same comment would apply to imports from elsewhere. Just about the time that they can contribute usefully their contracts will be up and they will return to Cuba. All the experience gained is lost. There is also a significant cost to the process and government has not been very forthcoming on this.

How many local engineers could have been hired? Would this not have been preferable as there is a greater likelihood of continuity and growth? The primary requirement is that the candidates must be able to see a clear career path and not be treated as temporary employees who can be moved

out with an irrational application of BEE or political deployment of improperly qualified personnel. This sadly has happened (the recent PRASA fiasco with inappropriate locomotives worth over R2.5 billion is a classic consequence). We need to provide opportunities for all the skilled people we can educate and train.

Clearly the CEO is not aware of the extent to which the major South African consultancies have been taken over by major international practices. It is fair to say that all our bigger firms are now foreign owned. Is this not a reflection on the skills and capabilities of South African engineers? At the same time it permits them to draw on in-house international skills whenever necessary.

As someone who has been involved in interviewing young engineers for their PR Eng qualification for some years now it is my considered view that we have the material and the skills, but these are being constrained by government policies that hamper the development of infrastructure programmes, such as the NDP. Our contracting fraternity completed the complex work for the 2010 World Cup and then construction projects died. Our contractors are now actively pursuing projects outside the country to maintain their business.

Much more can be written on this subject, but I think the CEO has to rethink his ideas fairly radically. We can and do produce excellent engineers. If we cannot provide them with good jobs and career prospects they will seek the international jobs which are available. The CEO acknowledges that all countries are short of the necessary skills. My own experience confirms that South African engineers are sought-after for their skills, work ethic and adaptability. Make it worth their while to stay and not have to compete with the short-term Cuban and other expatriate engineers. I know from experience that importing engineers is a most expensive option and does not produce the skills transfer that everyone expects. That is why the importation of Cuban and other expatriates is short-term, shortsighted and costly.

Robert Blyth
Pr Eng, C Eng, FSAICE, MICE

Drought – time for technically sound decision-making around water

Clearly, much of southern Africa is in the grips of an agricultural drought. In itself this is not alarming. Dry land farming has, and always will be, vulnerable to short-term seasonal droughts and this vulnerability increases when back-to-back drought years occur.

Irrigation farming is cushioned by dam storage that allows them to operate normally for a while – but not indefinitely. The portion of the dam storage assigned to irrigation is typically planned to bridge 5% probability droughts, which can typically be expected every 20 years or so.

Before the dams empty, water restrictions are imposed to reserve enough water to keep permanent crops, such as fruit trees and grape vines, alive through a prolonged drought. Seasonal cash crops will cease to be supplied until improved climatic conditions can justify the planting of a new crop. Typically decisions to impose such water restrictions are taken at the end of the rain season (i.e. May for summer rainfall regions) to give farmers the opportunity to make informed decisions about whether or not to plant for the following season. This is important since farming input costs are a large proportion of gross income. Hence a decision not to plant can substantially reduce the severe economic hardship suffered by irrigation farmers.

In cases where a dam, or system of dams, supplies both irrigation and industrial and domestic demand, different uses are assigned appropriate assurances of supply, typically 98% for domestic and industrial use, rising to 99% to 99.5% for strategic industrial use. In the case of domestic and industrial use progressive water restrictions are imposed as dam storage drops long before dams empty in an attempt to continue to meet minimum water requirements. Hence for the same dam irrigation use will face more severe restrictions that are also applied earlier than for other uses.

Reports are that flows at Victoria Falls are lower than usual and the level in the Kariba Dam lake is threatening to drop below the level of the power station inlets. This, together with events in KwaZulu-Natal and elsewhere raises the prospect of a more spectacular drought developing. While the recent hydrological conditions arising in South Africa are not yet unusual (of the order of a 1:20 year event), their effects have been seriously exacerbated by the long standing failure to implement sufficient

infrastructure to meet growing water demands.

Hazelmere Dam is a case in point, where the need to raise the dam was pointed out by competent engineers several years ago and consistently ignored. Ironically the works required to increase the capacity of the water purification works drawing water from the dam was implemented, but the need to raise the dam to normalise the assurance of supply to the new works was ignored. Instead the water level in Hazelmere Dam was drawn down recklessly.

The resolve to at last raise the dam is welcome and undoubtedly needs to be done as soon as possible so that the extra storage is in place to capture the flood waters when they eventually come. Unfortunately this laudable action will not help us until the current drought is broken. (Lots of additional storage with no water in it will not be much use to us until then.) The problem was made even worse by the failure to impose water restrictions until the dam storage had already dropped to alarmingly low levels. Hence poor management decisions have turned the consequences of what so far is a 1:20 year drought into something with much worse effects (Echoes of what happened recently in the Eastern Cape.)

If the drought continues to develop into a major drought sequence, then the unnecessarily reduced storage level at the beginning will continue to render the consequences of the drought significantly worse than they should have been.

The Hazelmere Dam debacle did not happen overnight. The management decisions that precipitated it were made (more accurately not made) over the course of several years. What makes it even less excusable is that decision makers had the well-publicised example of what happened during the recent Eastern Cape regional drought to focus their thoughts.

During the Eastern Cape's dismal event the panicked implementation of exorbitantly expensive seawater desalination was forced on decision makers, when timely implementation of very much cheaper groundwater resources and the imposition of water restrictions long before the supply dam was nearly empty would have sufficed. Evidently the obvious parallel to their own situation escaped the attention of the decision makers responsible for Hazelmere Dam. In this case it would appear that the

only thing to be learned from history is that people don't learn from history. The most immediate lesson here is that technically ill equipped decision makers have to heed the sound advice of our experienced water engineers. This lesson leads on to the second. Technically challenged managers are not the best people to hold sway over technical decisions. They should be replaced by the technically competent. It's just too iffy to hope that they might listen to their competent engineers, or failing that they might read about what happened elsewhere in the newspapers and see it on TV and might just recognise the danger that they are in.

Water management is not a lottery, it is a science. Their decisions should rather be based on their own competence to recognise what should be axiomatic to any competent water engineer. In a technologically sophisticated society we need more technically competent decision makers at every level of government.

It is of more than academic interest to note that when China's economic reforms began to flourish, many of the top politicians at the helm were engineers. It makes you think, doesn't it?

Dr Chris Herold
SAICE President



Working towards improved irrigation productivity in Africa

Capacity building featured high on the agenda at this year's meeting of the African Regional Working Group (AFRWG) of the International Commission on Irrigation and Drainage (ICID).

The group held its annual meeting in October in Montpellier, France.

Increased agricultural productivity is key to reducing poverty and increasing food security in many countries in Africa. One way of raising productivity is through irrigation both at a large- and small scale. In sub-Saharan Africa, only 4% of cropland is irrigated. But unlike many areas of the world, parts of the continent have large untapped reserves of water, which could be unleashed sustainably with some investment.

It is with the mandate of improving sustainable development in Africa that the AFRWG was established in 1994. The organisation promotes networking among African countries to support integrated river basin development and management, support training and improve information in the irrigation and drainage domain.

The AFRWG represents the national committees on irrigation and drainage of Africa in ICID. The two regional bodies that form part of the AFRWG are the Southern African Regional Association (SARIA) and Association Régionale pour l'Irrigation et le Drainage en Afrique de l'Ouest et du Centre (ARID). Water Research Commission Research Manager, Dr Sylvester Mpandeli, chairs the AFRWG.

South Africa is a member of SARIA. This association has held several workshops in various southern African countries in the last three years, featuring themes such as homestead food gardening, irrigation crop water use, training for extension officers and rainfed crop water use. The next meeting, to be



held in Malawi from 15-18 February 2016, will focus on rural freshwater aquaculture.

During its meeting in France earlier this year, the AFRWG adopted its strategy on capacity building in Africa. This strategy will be officially launched at the 4th African Regional Conference of ICID, to take place in Egypt in April. The main theme for this conference is 'Agricultural land and water management for sustainability under climate variability'.

Others topics to be discussed at the upcoming conference are water use management, food security, research, extension services and capacity development.

During discussions it was agreed by all participants that the strategy for capacity building in Africa is a living document, and that it should be reviewed every three years. It was also agreed that funds should be made available to support short irrigation-related training courses.

Eager participants get training in groundwater modelling

The Water Research Commission, together with UNESCO IHP, and the United States Geological Survey (USGS) hosted a three-day training course on groundwater numerical modelling with specific emphasis on the systems MODFLOW2006 and ModelMuse.

The course is held annually for early career hydro(geo)logists from three countries (South Africa, Botswana and Namibia). The training course is based on theory and hands-on exercise.

Presented by Eve Kuniandy and Richard Winston from the USGS the course forms part of UNESCO's drive to make available open source software under its Hydro Free and FOSS Platform of Experts (HOPE) initiative.

According to the WRC's Dr Shafick Adams, this specific course forms part of a three-part course to train the country participants in using MODFLOW and its related tools.

The ultimate aim is to train the students on an integrated platform called FREEWAT. FREEWAT will be an open source and public domain GIS integrated modelling environment for the simulation of water quantity and quality in surface water and groundwater with an integrated water management and planning module (<http://www.freewat.eu/>).



Comments invited for review of General Authorisations

The Department of Water and Sanitation (DWS) has invited comments for the proposed revision of General Authorisations in the National Water Act (NWA).

According to the department, the General Authorisations have been found to be too restrictive for specifically lower risk activities around rivers and wetlands. This has resulted in many low risk activities having to undergo extended water licensing processes, causing unnecessary delays.

More specifically the following revisions are proposed:

- A Risk Matrix is to be used to determine the level of risk being posed to the resource quality characteristics as defined in the NWA;
- All low risk water uses will now be Generally Authorised irrespective of whether it is located within the extent of a wetland or river or any other watercourse as defined in the NWA;

- Inclusion of maintenance activities for Existing Lawful Use;
- An emergency protocol for emergency situations for Existing Lawful Use;
- Various levels of river management plans (including stormwater management of urban river, Landcare projects, River maintenance and rehabilitation plans); and
- An appendix listing specific activities that are deemed to be low risk activities that are generally authorised.

During the revision process the DWS also embarked on a process of consultation with certain state-owned entities, such as Eskom, SANRAL, SANParks, Telkom, Transnet and Rand Water to draft specific General Authorisations for low-risk activities related to projects of state-owned entities. These state-owned entity General Authorisations are also now subject to comment.

To learn more about the proposed revisions, Visit: http://www.gov.za/sites/www.gov.za/files/39458_gen1180s.pdf. The deadline for comments is 26 January.

Dutch and SA water research institutions partner for water innovation



On 17 November 2015, an agreement was signed between KWR (Watercycle Research Institute, The Netherlands) and the Water Research Commission (WRC) of South Africa at a ceremony held at the Dutch Trade Mission in Johannesburg.

The agreement was signed in the presence of several South African Ministers including the Minister of Water and Sanitation, Ms Nomvula Mokonyane and the Prime Minister of

The Netherlands, Mark Rutte. Dr Wim van Vierssen, KWR CEO, and Mr Dhesigen Naidoo, WRC CEO, sealed the agreement.

KWR is the initiator and coordinator of Watershare, an international collaboration model for research centres focusing on applied research in the urban water cycle. The newly-forged partnership with KWR grants the WRC membership to the Watershare programme. Watershare is a family of

trusted publicly-financed institutes sharing knowledge and experiences in the global water sector.

“Both these knowledge institutions will from now on conduct joint research applying different tools from the Watershare platform”, said Van Vierssen during the ceremony. This agreement comes after many years of WRC and KWR working together. The WRC becomes the fifteenth official member of Watershare.

The tools are designed for areas like water quality and health, sustainability, water technology, asset design and management, and water systems. KWR will therefore assist the WRC in extending its understanding on specific topics included in the Watershare suite.

Naidoo said, “Through this collaboration, the WRC is in a position to better serve its end-user clients such as water companies, utilities, municipalities and water boards – so that these, in turn, can effectively meet the water needs of the people in South Africa”.



New from the WRC



Report No. TT 629/15

A framework for sanitation governance in South African municipalities (NP Mjoli)

The framework for sanitation governance in South African municipalities was developed in response to the problem of poor sanitation governance which was identified by several studies. Poor sanitation governance was identified as a stumbling block to

the achievement of universal access to basic sanitation services for all South African households. The development of the framework for sanitation governance is based on the capability, accountability and responsiveness governance framework. The framework has been informed by good sanitation practice identified from international governance experience and elements of good sanitation governance identified from five selected case study municipalities.

Report No. KV 338/15

The current state and future priorities of brine research in South Africa: Workshop proceedings (M Claassen & W Masangane)

This report provides a summary and outcomes from the workshop on brine research that was held in 2014 with a variety of stakeholders. The aim of the workshop was to provide a sector perspective of the current state of brine research in South Africa and the gaps that will define the future research portfolio as well as the priorities that the partners can pursue over the next ten years. This should enable the sector to consolidate, focus, support and drive relevant research initiatives with the aim of realising 'real' solutions to current and future brine challenges.

Report No. 2381/P/15

Exploring the issues around rural on-site school sanitation in South Africa (B Louton; DA Still; I Pearson; G Sitholimela; T Mphahlele & E Shaylor)

This document represents a preliminary exploration of school sanitation in South Africa as part of the study titled 'Evaluating the design of existing rural school sanitation infrastructure and developing a model and guidelines for optimal design' which is being conducted by Partners in Development on behalf of the Water Research Commission. The document explores the background and status of school sanitation in South Africa, its legal environment, and looks at best practice for the design and facilities, among others.

Report No. 2131/1/15

Quantifying the fertiliser value of wastewater sludges for agriculture (EH Tesfamariam; JG Annandale; PC de Jager; Z Ogbazghi; ME Malobane & CKA Mbetse)

The overarching aim of this study was to develop a user-friendly sludge application rate advisor computer model that takes into account both the fertiliser value of sludge and crop nutrient requirements. To achieve this objective the study tested existing analytical methods for rapid characterisation of sludge nitrate and phosphate pools; investigated nitrate release from sludge (fertiliser value) across South Africa agro-ecological zones and soil textural classes; and investigated the fate and dynamics of trace metals in sludge amended soils.

Report No. 2305/1/15

South Africa's water research, development and innovation (RDI) roadmap: 2015-2025

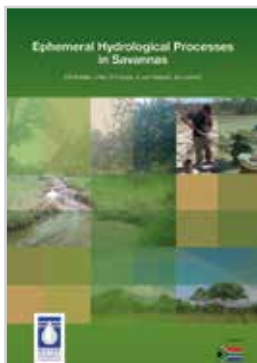
The National water research, development and innovation (RDI) roadmap provides a structured framework to focus the contribution of RDI activity to the implementation of national policy, strategy and planning in water resources management in South Africa. The vision of the roadmap is that South Africa is a leader among middle-income countries in the development and deployment of water management practices and technologies. It competes with leading countries in providing sustainable solutions. The roadmap was developed through an exhaustive, structured process of eliciting staged responses from the professional communities, reviewing the inputs, and assessing their implications. The result of this process is a set of seven plans which over the period 2015-2025 develop out pathways to progress from the 2015 situation to a much improved future state by implementing interventions in research, development, testing, demonstration and deployment of new technologies and know-how, as well as demonstration and deployment of emerging technologies.

Report No. 2115/1/15

Investigation into pollution from on-site dry sanitation systems (S Lorentz; B Wickham & D Still)

The impact of on-site sanitation on water resources has been the subject of much study with regard to conventional septic tanks and soak-aways. However, research of impacts from rural and peri-urban communities using pit latrines has been unconvincing. The objectives of this study were to develop an understanding of the conditions and processes that may lead to migration of pollute from on-site dry sanitation systems to that guidelines may be developed; identify techniques, methods and models used in evaluating groundwater pollution from

on-site sanitation; and to derive the necessary knowledge for input to best practice guidelines for monitoring and minimising the impacts from on-site dry sanitation.



Report No. TT 619/14

Ephemeral hydrological processes in Savannas (ES Riddell, J Nel, D Fundisi, F Jumbi, A van Niekerk & SA Lorentz)

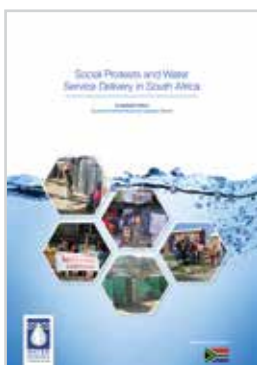
There is a tight coupling of hydrological, geological and ecological processes in the semi-arid setting of the Lowveld savannas of South Africa. In Kruger National Park (KNP) this has resulted in distinct landscape patterns closely organised around

the hierarchical drainage network of seasonal and ephemeral streams which dominate the landscape. Over time, this has led to the establishment of unique soil and vegetation assemblages in the landscape at both the hillslope and catchment scale. The aim of this research project was to quantify the role of hydrological inter-connectedness between hydrological process domains; and determining the spatio-temporal variability of this inter-connectedness in order to understand the hydrological fluxes that drive these savanna systems.

Report No. 2360/1/15

Islamic jurisprudence and conditions for acceptability of reclamation of wastewater for potable use by Muslim users (Al Tayob; H Deedat & AR Patel)

The main objective of this study was to address a set of questions emerging from the protests in Durban regarding municipal plans to supplement existing potable water supply with reclaimed water. The study asked if there was a deeper religious justification to these responses, and what it was. What does Islam say about water purification? More particularly, what do the authoritative teachers in Islam say about water?



Report No. TT 631/15

Social protests and water service delivery in South Africa (B Tapela; B Ntwana & D Sibanda)

This research report presents an outline of research findings on the pathways by which grievances over water services delivery conflate with other factors and develop into violent protest action. The report is based on a survey of the numerous social

protests that journalistic and social media reported from 2004 to 2014. This data was then identified, catalogued and analysed.

Report No. 2164/1/15

Developing methods for converting digitised rivers into a hydrological drainage network (HL Weepener; JJ le Roux; EC van den Berg; DR Tswai; JP Nell)

In this study techniques were investigated to create a South African river network that is repeatable and applicable to all the water catchments in South Africa. The methodology was implemented on two selected catchments and aimed at producing a network that will contain rivers similar to the 1:250 000 scale topographic maps at an accuracy that is equivalent to the 1:50 000 scale.

To order any of these reports, contact Publications at Tel: (012) 330 0340, Email: orders@wrc.org.za or Visit: www.wrc.org.za to download an electronic copy.

New drought portal now open

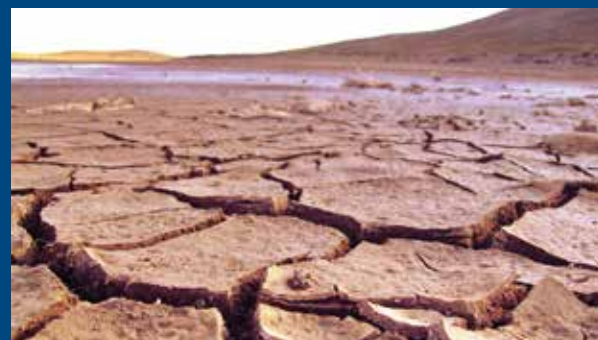
The Water Research Commission (WRC) with sector partners has established an online drought portal to provide water users with helpful information.

The portal, www.droughtsa.org.za, contains the latest news around the drought, as well as tips to save water, and guidance documents to use water more efficiently in various sectors. Various resource tools have also been included from the science behind droughts, to water conservation and water demand management, and water treatment and reuse.

There is also a FAQ (Frequently Asked Questions) section, which answers questions such as What is a drought?, What causes drought?, When did the drought begin?, What does it mean when a province is declared a disaster area?, among others.

According to WRC Group Executive: Impact and Innovation, Dr Mandla Msibi, South Africa has the capability and tools necessary to manage its scarce water resources effectively. The aim of the drought portal is to bring some of this information together in a single space.

All water-related institutions have been invited to contribute their knowledge to the portal.





Drought watch

Cape Town's reuse of effluent takes pressure off dams



In order to save water, the City of Cape Town is reusing over 6% of the effluent that passes through its treatment works, for irrigation and industrial purposes.

The use of treated effluent as a means to save water is viewed by the City as a key component of its strategy to ensure that Cape Town, a water-scarce region, has a secure water supply for the foreseeable future.

The City had aimed to treat and reuse around 4.7% of all effluent, but was in fact able to recycle around 6.3% in

the year to date. Contributing to this performance was higher than usual demand, mainly at wastewater treatment works, with demand from the Bellville, Athlone and Potsdam works contributing most significantly to these figures.

Treated effluent, or recycled water, is not used for drinking water but for irrigation and industrial purposes. "On average, around 3 300 m³ of this water is supplied every day. This water is much cheaper than potable water, and the City of Cape Town actively promotes its use in order to conserve Cape Town's limited potable water supply," explained City Mayoral Committee Member for Utility Services, Councillor Ernest Sonnenberg.

"There are more than 160 treated effluent consumers in the city, including schools, sports clubs, golf courses, farms, factories and commercial developments with large water features. The City also uses this water for irrigating parks and the flower beds along the Cape Town's Integrated Rapid Transport routes."

At present, 13 of the City's wastewater treatment works are equipped to produce treated effluent suitable for reuse, and a 230 km treated effluent pipe network conveys this water to customers. Give the success of this service, the City is looking to expand the treated effluent reticulation network to other areas of Cape Town, with Athlone, Bellville and Macassar being mostly likely to benefit.

"We hope that, going forward, we can continue to increase the percentage of effluent that we are able to reuse. Together with the City's increasingly intensive pipe maintenance and replacement programme, pressure management schemes, and the recent initiative to fix leaky plumbing for indigent customers for free, customers can feel confident that the region's water resources are being managed efficiently and sustainably," concluded Sonnenberg.

Source: City of Cape Town

Consultants warn against overuse of underground resources

As South Africa draws on its groundwater resources careful control must be taken to ensure that these resources are used sustainably.

This is according to Gert Nel, principal hydrogeologist in SRK Consulting's East London office. He notes that the current drought conditions being experienced in many parts of the country are re-focusing attention on the frequent lack of monitoring of groundwater use.

"Underground aquifers are fed by rainwater, so drought will impact on their abstraction capacity. We are also seeing more demand on groundwater as towns expand, and higher levels of service are required," he said.

While South Africa has developed a number of wellfields in recent decades, these are now facing the danger of careless use – this is unless water service providers are provided with better information about the policies and practices around sustainable management and use of groundwater.

"Each of the agencies in this field has their role to play, and consultants and scientists such as SRK are already making valuable technical contributions," said Nel. "We can, however, do more at a number of levels, such as raising awareness at district municipalities, and giving local municipalities practical training and ongoing mentoring."



Nel further emphasised the need to roll-out a scientific learning programme that relates directly to each town or region where it is presented – so that it can be applied immediately in addressing local groundwater challenges. "There are plenty of generic 'groundwater training' resources and documents available, but we need to move beyond the general to the specific, ensuring that role-players engage practically with their issues during these sessions and take back solutions they can implement with the help of mentors."

Southern Africa in for a 'bumpy, dry' ride



Southern Africa is in for a bumpy, dry ride. There is a 50% chance of a drought occurring this summer that could have an impact on the whole region which still bears the effect of last year's drought. Any new drought will have a compounding effect.

So writes Mathieu Rouault, Associate Professor in Oceanography at the University of Cape Town.

During the 2014-15 Southern Hemisphere summer, southern Africa suffered one of the worst-ever droughts. This severely affected the agricultural sector as well as the economies of the countries in the region. In addition, the drought seriously depleted water reserves.

The current drought in the region is as a result of a powerful El Niño event. El Niño is a natural and periodic phenomenon that comes back every three to five years and can last for up to two years. It increases temperatures in the Pacific and Indian Ocean which in turn can cause drought conditions.

During 2015 the Pacific became even warmer leading to one of the strongest El Niño events ever observed. Research shows that eight of the ten strongest droughts in southern Africa since 1900 occurred during the mature phase of El Niño. It has also been noted that El Niño events have led to a severe drought half of the time they occurred.

The effect of El Niño on droughts has been exacerbated over the past 50 years. This has been because continental and oceanic temperatures have risen globally but not uniformly due to the increase in carbon dioxide.

El Niño events leading to droughts in the region have been particularly marked since the late 1970s. Most have occurred between December and March. Recent studies show that El Niño has affected summer rainfall with increased dry spells, reductions in the flux of moisture from the Indian Ocean to the continent, and by shifting large-scale rain-bearing systems to the Indian Ocean.

Over the last century, southern Africa has suffered from dramatic year-on-year changes in climate leading to severe droughts and disturbance in the marine or terrestrial ecosystems. Such variability of climate affects the agricultural industry, water reserves, fisheries and as a result the broader economy. It also affects the flow of water in streams, vegetation and the fluxes of nutrients into the ocean.

It has a particularly detrimental effect on: rural subsistence farmers and fishermen; the health of people in rural areas; and the management of a sustainable natural environment.

During the last decades research projects have shed a great deal of light on how the oceans can influence the climate of

southern Africa. But more research is needed to find out the effects of El Niño.

Two critical questions in particular need to be answered, namely 1) why does El Niño sometimes not lead to drought; and 2) why a weak El Niño can trigger a severe drought while a strong El Niño can trigger a less severe drought.

In addition, more information needs to be gathered on how natural climate events such as El Niño and climate change interact. And there is a serious need to improve our understanding of the impact these large scale variations have on smaller scales. We must also keep in mind that describing the nature of climate variability's impact is essential to being able to anticipate future climate changes and the need to define adaptation strategies.

"Given that El Niño does not result in a drought 100% of the time, it is important to establish what measures should be taken in the case of a risk of drought. This would enable countries to prepare for major disturbances which are increasing in frequency as a result of climate change," says Rouault.

"El Niño could have dramatic consequences for southern Africa. Food shortage, famine, unrest, economic hardship and further decrease of the gross national product. Hopefully the region will not be hit as hard as it was in the 1997-98 El Niño effect. But we shouldn't gamble on that."

It is imperative for countries, and individual citizens, to take preventive measures for what is now known to be a recurring pattern in southern Africa. This includes selling cattle, restricting water, fixing leaks, planting drought resistant crops and getting ready for a drought.

THE CONVERSATION

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



Drought watch

South Africa must rise to its water management challenges



South Africa can do much more to manage its inherent water challenges. This is according to Mike Muller, Visiting Adjunct Professor at the University of the Witwatersrand.

According to Prof Muller, a country like South Africa, where rainfall is variable and unpredictable, has to plan for the worst. Specifically, it has to plan to manage the impacts of drought. For cities, present practice is to store enough water to supply the needs of each region during the worst conditions likely to occur in 50 years.

To meet that target for the growing population of Gauteng, the country's economic hub, a new dam must be built. The site has been chosen, the Polihali Dam, identified as Phase 2 of the Lesotho Highlands Water Project.

"As so often in South Africa, the problem is not the plan but the delays in its implementation. According to the original planning, the dam should be completed by 2018. Given slow progress, my understanding is that it is now not possible for it to deliver water before 2024."

"So, for at least six years, there is a risk that the water needs of Gauteng, which contributes more than one-third of the country's GDP, will not be met reliably," noted Prof Muller.

It only took a few days of hot weather in Johannesburg for two things to happen: suburban reservoirs ran dry, and residents panicked. City authorities introduced restrictions on watering gardens and washing cars, and residents reacted as though this had never happened before, which in fact it had.

The extreme weather can serve a useful purpose: it should focus the attention of people and policy makers on the deadline to build the new dam. If no action is taken, policy makers will have only themselves to blame when failure of another vital service disrupts people's lives, and the economy.

Given the electricity shortages in the country and what euphemistically became known as load-shedding, many people have started to assume that long feared water-shedding had begun. The commentators who sought a more strategic view talked about an intense drought and the impacts of climate change. They were wrong.

In fact most of the problems over the past few weeks have occurred in the domain of municipal water supply management.

The suburban challenge for planners has been whether to invest in larger local distribution reservoirs to allow people to water their gardens regardless of how hot the weather gets. In Johannesburg 46% of household water supply is used for swimming pools and watering gardens.

Says Prof Muller: "If they don't want to do this, municipalities have to improve their ability to persuade their citizens to use less water during times of stress. So far, they have singularly failed to do this."

THE CONVERSATION

To read the full article, which was originally published in The Conversation, Visit: <http://theconversation.com>

THE WATERWHEEL

SUBSCRIPTION

Request Renewal Address change

Contact Details

Name: _____

Company: _____

Designation: _____

Postal Address: _____

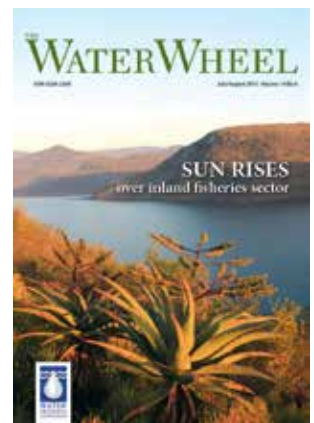
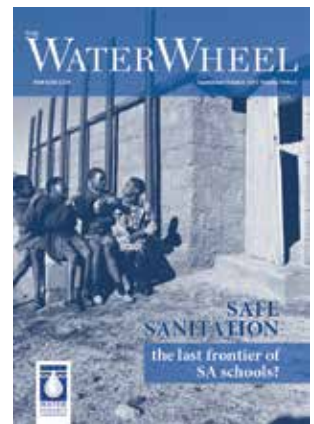
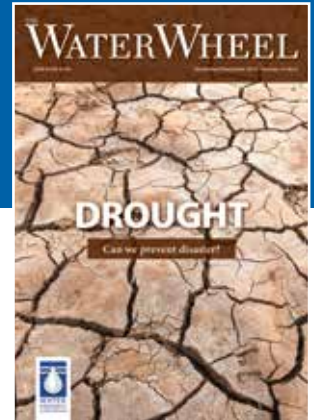
Tel: _____

Fax: _____

E-mail: _____

What would you like to read more about in the Water Wheel? _____

Would you be willing to pay for the Water Wheel? _____



The Water Wheel
Tel: +27 (0) 12 330-0340
Fax: +27 (0) 12 331-2565
E-mail: laniv@wrc.org.za / www.wrc.org.za
Physical address: Marumati Building, C/o Frederika & 18th Ave, Rietfontein, Pretoria
Postal address: Private Bag X03, Gezina, 0031

Water and gender

Increasing the benefits from rural agriculture for South Africa's women

A recently completed project funded by the Water Research Commission (WRC) has outlined the crucial roles of water and agriculture in the upliftment of specifically women in rural South Africa.

Article by Petro Kotzé.



All photographs courtesy Umhlaba Consulting

Researcher, Laura Conde (third from left) and members of the Lutengele Village food producers group.

The challenges of high levels of poverty and deep inequality in South Africa are compounded by the lack of opportunities for employment in the higher-density rural areas of the country. Here, livelihoods are mostly dependent on remittances and government grants.

The third most importance means of support is rainfed agriculture, which contributes some 10% to household survival. There is a general assumption that this sector can contribute more, though the ways and means to facilitate this is unclear. A recently completed WRC-funded study investigated exactly this question, and aims to tease out a strategy that can attain it.

Those that stand to benefit are multiple. About 3.7 million people in South Africa consider themselves subsistence-

oriented smallholders, and a further 200 000 to 300 000 are commercially-oriented, although categorisation and data is far from definitive. In this scenario, 60% of all black Africans involved in farming are women, outnumbering men by 65% in the category of 'farming as an extra source of food'.

The research project focused on that sector of farmers that could be most affected: Women. As such, researchers aimed to ensure a comprehensive understanding of the constraints, challenges, opportunities and interventions required for the empowerment of women to promote household food security and rural livelihoods through increased water productivity, with the focus on crop cultivation in, amongst others, the Eastern Cape Province.

The project started in 2011 involving researchers from the Umhlaba Consulting Group, the Wildlife and Environmental Society of South Africa (WESSA) and the University of Fort Hare.

According to project leader, Jonathan Denison of Umhlaba Consulting, promoting smallholder agriculture is a challenging task in the South African context but some simple lessons emerged from the research. "What the project uncovered was that we deal with many diverse farmers who have diverse needs, and this calls for different kinds of support strategies in parallel, not just a focus on one type of farmer. Typically, the approach has been to replicate the business farming style of the commercial sector."

Denison adds that for any successful intervention to maximise the use of available land and water resources, it is vital that this diversity in the purpose of farming and location of the farming activities is recognised.

Diverse farmers, diverse needs

Three rural villages in the Eastern Cape were selected as case-study sites. These were Lutengele (in the OR Tambo District), Sirhosheni (in the Amathole District) and Mbekweni (in the Chris Hani District). A total of 164 households were involved in various sample surveys and 30 households participated in detailed studies over three years.

The sites are characterised by substantial material poverty, with more than 80% of the people in all three villages living below the Lower Bound Poverty Line, calculated at R468 per person per month in 2012. There is high unemployment and a high incidence of social grants, while food insecurity and hunger are prevalent.

On average, 61% of the households are female-headed, and decision-making is shared between men and women in different ways. Typically, male household heads make the strategic decisions (e.g. major investments), generally in consultation with their families, whereas most operational decisions are made by women (e.g. day-to-day and most agricultural decisions).

The aspirations of the women interviewed were found to be diverse and tied to distinct farming practices situated on different parcels of land at their disposal. These are divided into three spaces, each with distinctly different crop-choices, levels of cropping intensity and water-use practices.

In isiXhosa these spaces are called *isitiya*, *igadhi* and *intsimi*. There are two spaces which fall within the boundary of the homestead, or the *umzi*. This space includes dwellings, kraals and outbuildings. It is the foundation of the family identity and is sacrosanct regards family rights. Here, you will find the *isitiya* (100 to 1000 m²), which is an intensive vegetable garden that is always watered; and the *igadhi* (usually around 0.1 to 2 ha),

which is more extensively farmed and typically rainfed but sometimes irrigated. Tenure of these spaces is never contested and is a family right. The third space, the *intsimi* or *amasimi* are the arable fields usually located away from the homestead.

The bulk of the respondents have access to an *isitiya*, about half had access to an *igadhi* and 69% had access to an *intsimi* with an average size of 1.32 ha. The closer to home the space is, the more intensively it is utilised, the researchers found. High cropping intensity takes place in the *isitiya*, moderate cropping intensity in the larger *igadhi*, and low cropping intensity in the fields.

When incidence of use is combined with cropping intensity this shows very low utilisation of the land resource in the fields (*intsimi*). Plus, though 30% and 55% of people practised farming in fields and homestead gardens respectively, it was found that their water and land resources are substantially underutilised.

"The reality is that the bulk of people really want to farm in their home gardens and fewer people want to farm at scale in fields but, these are equally important areas of focus," explains Denison. "While there are far fewer people that want to farm at scale, and there are many more challenges to successful farming in fields compared with home-gardens, they potentially have a larger impact in terms of the total size of land farmed. The very high number of home-gardens adds up to be significant in total potential area, and is quite clearly the first priority for response as the challenges are far fewer and can be overcome with much smaller investments."



Growing sweet potatoes in the *igadhi* in Lutengele.

Somewhat surprisingly given popular narratives, the researchers found that women at the three Eastern Cape research sites can get access to arable fields without any particular challenges that are different from those experienced by men. “Maybe because farming at field scale is perceived to be unprofitable, few people want the land, but women who are involved in farming listed numerous other challenges as more important than access to, and rights of use of land,” notes Denison. “Even so, tenure issues, particularly in regard to land-exchange remain an important issue to promote use of unused arable fields in particular,” he says.

So, Denison asks, how do you bring this together? “It is concluded that no single agricultural development pathway will respond to the diverse aspirations, or use the available set of livelihoods resources to their full potential,” it is stated in the final report. “The opportunity suggested by the constraints analysis, combined with the aspirational analysis, is that increased food production must be targeted through multiple parallel interventions prioritised with local participation and be tailored to locally resource opportunities, capabilities and predominant aspirations.”

Following on the research process and focus-group planning sessions, nine strategic interventions were identified that have the potential to catalyse crop-farming, with an emphasis on the empowerment of women (see sidebar). The strategies

form the basis for a coherent intervention plan that responds to individual aspirations and is based on people’s capabilities and their available resources. They meet the project aim for practical, cost-effective support mechanisms to smallholders, but can also be implemented at scale.

While a combination of the strategies is suggested, Denison says that, from the team’s perspective, the key to success is to implement a suite of agricultural support interventions rolled out at in watersheds of similar size to hydrological quaternary catchments.

“For any successful intervention to maximise the use of available land and water resources, it is vital that this diversity in the purpose of farming and location of the farming activities is recognised.”



Mixed leafy vegetables and mulching in the isitiya at Lutengele.

Implementing the necessary strategy at the right scales

In South Africa, most water institutional interventions are aimed at the macro-scale, as envisaged in the National Development Plan and other key strategies. Increased national water-stress, the capping of national agricultural abstraction volumes, increased urban demands and climate change realities mean that new interventions must optimise and focus on the areas of highest return.

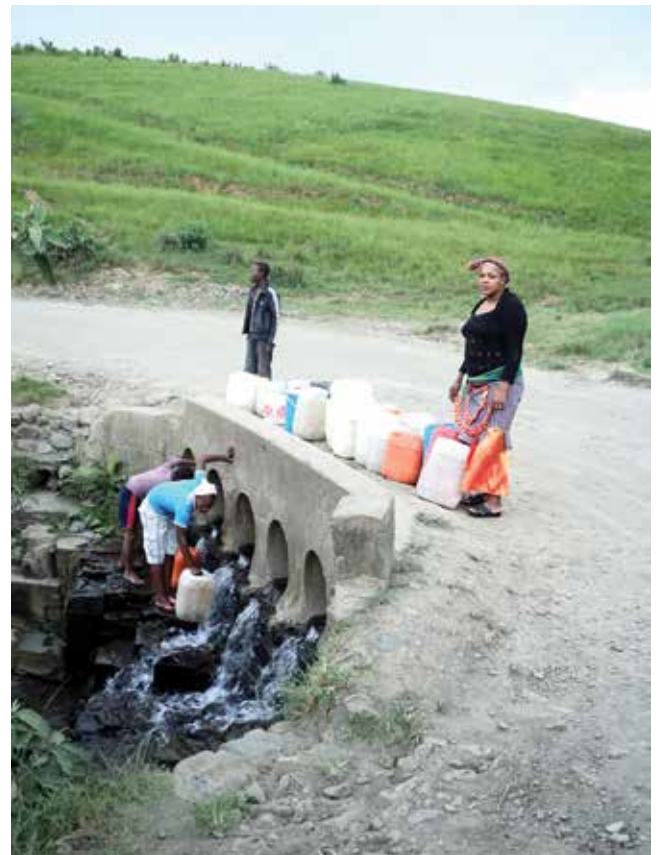
This is exactly what is called for in the research project results but at smaller scales. "The watershed planning approach provides an implementation framework to work in participation with 10 to 20 villages and to strategise and decide together where to spend financial resources most effectively," Denison says. "Successful watershed strategic planning cases were documented in the research, and can lead directly to meaningful actions at farm-level, implemented at scale through a programmatic approach."

The main advantage of the smaller scale is that the area of engagement is small enough to allow for participatory processes to be used and for consultative processes to align programme interests with those of local stakeholders and government officials. The strategy is particularly appealing as it is punted as one that can increase agricultural productivity, conserve natural resources and reduce poverty in semi-arid regions, especially where highly seasonal hydrologic climates are experienced.

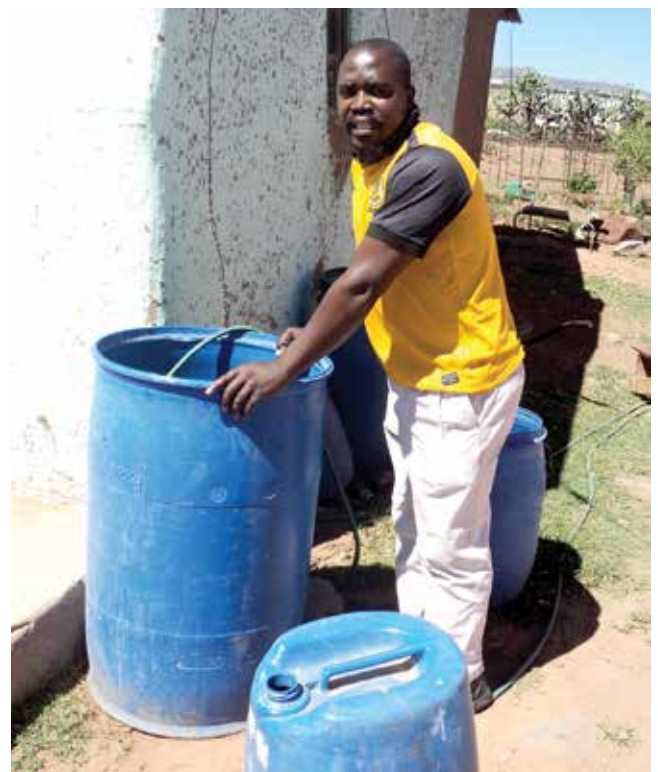
The Indian government, for example, implements watershed management programmes as strategies of reducing poverty by using various rainwater harvesting techniques to capture rainfall and runoff and using it to water rainfed agriculture. Water captured in the rainy season may be used in dry seasons for multiple purposes, including recharging ground moisture for crop irrigation, and domestic and livestock water supply.

In South Africa, the situations of smallholder farmers are widely diverse in relation to land-size, farming approach, aspirations and the contribution of farming to livelihoods. Site-specific opportunities and preferences count heavily and these need to be systematically identified so as to properly inform the intervention plan which must be locally appropriate, and therefore nuanced.

However, a highly localised (micro-watershed management) approach poses the danger that interventions are planned as isolated patchworks and are disconnected from the broader context and objectives of protecting the hydrologic system and managing negative downstream and groundwater effects. Regardless, the embracement of this approach to implementation planning is seen as crucial for water-supply security and to focus scarce resources on high-priority areas.



Household water collection challenges in Shirhosheni.



Researcher, Chenai Murata, of Umhlaba Consulting, measuring home water-storage.

Finding the right fit between opportunity and need

According to the study results, the land and water resources at the three sites are significantly underutilised, and there are parallel opportunities in the cropping spaces of the *isitiya*, the *igadhi* and the *intsimi*. However, Denison highlights that an important question the team had to ask themselves during the study was whether those smallholders with land and water resources really want to farm. It was identified that most people in the three villages do have a real interest in crop production in the future, but are acutely aware of their farming-resource inadequacies, of marginal profitability, and of the multiple risks involved.

Though the farming decision-makers in the 30 case study households demonstrated clear intent to derive agricultural benefits from their land, they also had widely differing aspirations. Most aspired to intensive home-food production, while a few aspired to small-scale farming for food and supplementary cash; only two were interested in farming as a business, and rather significantly, seven to leasing out their land or entering into crop-sharing arrangements.

In their conclusion, the researchers point out that the intervention strategies are not revolutionary in their individual

form, but present an alternative approach to engagement that facilitates multiple parallel avenues of smallholder development. This is expected to initiate synergies within the village resource and social systems and exploit the niches of smallholder opportunity that have thus far remained largely un-activated in South Africa. "We know with confidence what we need to do to meet policy objectives around smallholder food production and women in agriculture; all that is needed is political decisiveness to invest in a programme to get it done," Denison says.

The authors thus propose that when the combined set of strategies is implemented with intent, they will contribute to an agricultural transformation process that is practical, can be implemented incrementally as funds allow, and are programmatically scalable.

"Though the farming decision-makers in the 30 case study households demonstrated clear intent to derive agricultural benefits from their land, they also had widely differing aspirations."



Research project leader Johnathan Denison with Gertrude Ndabeni, leader of the women's food production group at Lutengele Village.

The nine strategies

- Strategy 1: Agricultural learning through knowledge networks**
Facilitate agricultural knowledge exchange and information access for crop farmers at all scales through dynamically driven linked networks of a variety of interested agricultural groupings. One example of this new agricultural learning approach is the WRC funded 'Amanzi for Food' project coordinated by Rhodes University Centre for Environmental Research and Learning.
- Strategy 2: Homestead water-storage and supply systems (location: *isitiya* and *igadhi*)**
A key limitation to home-food production in backyard gardens is water-supply. Within the homestead, storage tanks and ponds which collect water from roofs, drainage ditches and roadways can transform the food-production landscape.
- Strategy 3: Application of crop-water harvesting and conservation methods (*isitiya*, *igadhi* and *intsimi*)**
The suitability of water harvesting and conservation techniques and their contextual application to each local situation, must be explored as part of a wider set of intervention responses. The expansion of the concept of irrigation development to one of agricultural water development, which includes water-harvesting in its many forms (beyond storage tanks) is centrally important to achieving the desired impact at scale.
- Strategy 4: Linkage to commercial or local nursery (*isitiya*, *igadhi* and *intsimi*)**
Any intervention that aims to increase fresh vegetable food production needs to ensure that farmers have regular and cost-effective access to a seedling supply. While all inputs are important, seedling supply for fresh vegetable production was found to be critical.
- Strategy 5: Institutional responses to land access and control (*intsimi*)**
Demands for more land by rural communities often co-exist with large patches of arable lands lying idle in the same communities. A local land-exchange intervention, supported by Chiefs, regional government departments and local farmers, has the best and perhaps the only chance in the short-term, of liberating land that remains perpetually locked up and unproductive in the absence of enabling land institutions. The WRC has published reports on these successful methods.
- Strategy 6: Financed and trained mechanisation contractors (*intsimi* and *igadhi*)**
The strategic intervention is needed to establish local mechanisation contractors through structured, practical skills-development and business training.
- Strategy 7: Value-chain mapping and optimisation for smallholders (*intsimi* and *igadhi*)**
Identifying and developing market opportunities by mapping and assessing potential off-takers (agribusiness firms, key traders, major urban outlets, etc.) and developing a simple market information system for crops of interest (a register of suppliers and buyers). Major constraints must then be addressed.
- Strategy 8: Participative implementation planning at watershed scale**





WATER SAVING TIPS



Install **water-saving shower-heads** and try to **limit** your showers to **5 MINUTES**

USE full loads in your **dishwasher** and **washing machine**, use **Eco setting** if possible



DON'T leave **water running** if you are **brushing your teeth**, **saving** or **washing dishes**

WATER YOUR GARDEN **early** in the morning or **late** in the evening





TAKE USED ICE CUBES
and place them in **house plants** instead
of throwing them away

WASH your pets over **grass** in
need of watering



THAW FOOD NOT in the fridge or microwave
under running water

Install a **DUAL-FLUSH
toilet**



Water quality

Satellite technology keeping an eye on South Africa's dams



Remote sensing technology is being developed to keep a better eye on the quality of South Africa's dams.

Article by Sue Matthews.

Lani van Vuuren

Persistent algal blooms and dense mats of aquatic weeds are the easily observed signs of nutrient-enrichment of freshwater systems, but more insidious are the secondary impacts of such profuse growth. There's the light limitation due to turbidity and shading that hampers photosynthesis by other primary producers, the resulting habitat alteration that changes the species composition of the animal community, and the oxygen depletion that – at its most extreme – causes fish kills and mass mortalities of bottom-dwelling invertebrates.

Collecting information on the extent and prevalence of the problem is labour-intensive and expensive though. The National Eutrophication Monitoring Programme (NEMP) was launched by the

then-Department of Water Affairs (now the Department of Water and Sanitation – DWS) in 2002 following a two-year, Water Research Commission-funded project to develop an implementation plan. Today, NEMP officials coordinate the collection and analysis of water samples from about 160 sites in dams, lakes and rivers countrywide, but it's a logistically challenging undertaking, relying on DWS staff and local stakeholders in far-flung places to take samples and send them in for analysis.

The concentrations of chlorophyll a and total phosphorus are used to assess the trophic status of the waterbodies on a six-monthly (summer and winter) basis, and a number of other physico-chemical parameters are measured too. However, there's only one sampling site in most of

the large dams and lakes, which doesn't necessarily coincide with the most likely location of algal blooms, nor give useful information on nutrient inputs.

The frequency of monitoring and logistical challenges also preclude an effective early warning system for cyanobacteria – or blue-green algae – blooms. These cause taste and odour problems in drinking water supplies and may be toxic, resulting in skin and eye irritation on contact, and gastrointestinal illness or even death of people or animals drinking untreated water. Some cyanobacteria species have gas vacuoles that allow them to regulate their buoyancy and form unsightly scums on the water surface, discouraging non-contact recreational activity too.

How much simpler, then, to get a 'snapshot' of phytoplankton biomass for the entire waterbody every few days, with the ability to differentiate cyanobacteria from other phytoplankton blooms, and even locate large patches of aquatic plants – often invasive species such as water hyacinth, red water fern, salvinia or parrot's feather. This is essentially the modus operandi of a WRC project currently underway, except that the snapshots are remote-sensing images from orbiting satellites.

Project Leader, Dr Mark Matthews*, developed a method that allows satellite data to be used in this way during his PhD research at the University of Cape Town (UCT), under the supervision of Dr Stewart Bernard of the CSIR. His research showed that the majority of South Africa's 50 largest waterbodies are hypertrophic, with mean chlorophyll a concentrations exceeding $30 \text{ mg}\cdot\text{m}^{-3}$, and extensive cyanobacteria blooms are present in at least 10% of them.

Dr Matthews was capped with his PhD in June 2014, and four months later was awarded best business idea in the European Space Agency's Copernicus Masters Competition for CyanoLakes – the company he has set up to provide a public information and warning service for cyanobacteria blooms using satellite data. The service will rely on data from the Ocean and Land Colour Instrument (OLCI) on Sentinel-3, a European Space Agency satellite due to be launched in January 2016.

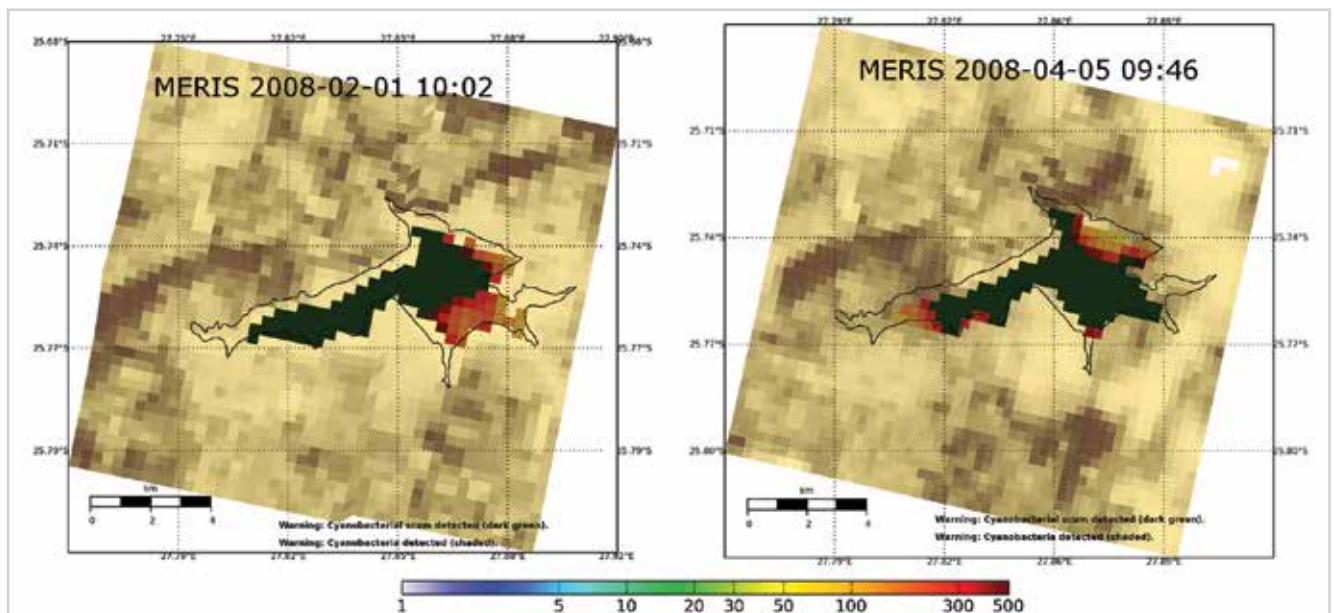
The WRC project, officially titled 'The integration of Earth Observation into the National Eutrophication Monitoring Programme' but generally referred to by the acronym EONEMP, will also make use of this data once it becomes available.

In the meantime, the focus has been on getting the most out of retrospective data from MERIS – the Medium Resolution Imaging Spectrometer on the European Space Agency's Envisat satellite. Launched in March 2002, Envisat's mission ended unexpectedly in April 2012 when communication with the satellite was suddenly lost. Nevertheless, MERIS provided a decade's worth of data at a spatial resolution of 260 m by 290 m every two to three days, and it's all available free of charge.

"The satellite scene is very large, but for each overpass we can subset the data out for the large waterbodies and do an analysis to calculate the chlorophyll average for the entire lake or dam," explains Dr Matthews. "There's more than a thousand images for some waterbodies, so we have a really good record and can resolve monthly and seasonal changes."

The added benefit of being able to determine how much of that chlorophyll is due to cyanobacteria blooms is the particularly novel feature of the MPH algorithm developed by Dr Matthews during his PhD research. The algorithm uses a spectral shape approach, relying on the 'maximum peak height' in the MERIS red bands at 681, 709 and 753 nm.

"Essentially, the algorithm separates the spectral features of cyanobacteria from those of algae, and then applies specific chlorophyll algorithms to that data," he explains. "So now you can get quantitative estimates of the biomass of cyanobacteria and algae respectively. This was the first algorithm in the world to distinguish cyanobacteria and algae in a quantitative way, so it was quite cutting edge in that respect, and was very well received by the remote-sensing community."



Time series of MERIS-derived chlorophyll a in Hartbeespoort Dam closely compares to that measured in situ by the National Eutrophication Monitoring Programme. The high chlorophyll concentrations are likely due to blooms of cyanobacteria and the associated surface scums, which are visible as bright green slicks on true colour Landsat images and as dark-green pixels on corresponding MERIS images.

* No relation to the author of the article

In fact, the MPH algorithm was one of several tested for 300 large lakes and reservoirs around the world by the Diversity II Project, a European initiative contributing to the assessment and monitoring of the Convention of Biological Diversity's targets for 2020. It was found to be the best-performing algorithm for eutrophic systems and so – following some tweaks to improve performance in oligotrophic waters – it was included as a plug-in for BEAM, the European Space Agency's open-source toolbox for viewing, analysing and processing MERIS data. The improved algorithm also allows identification of clear water affected by sun glint and stray light, and enhances detection of floating aquatic vegetation.

Within six months of the start of the WRC project – a collaborative initiative involving UCT, CSIR, DWS and the South African National Space Agency (SANSA) – in April 2015, the MPH algorithm had been applied to MERIS data for more than 100 waterbodies around the country. Most of these are dams, but there are also some natural systems such as Barberspan, Chrissiemeer, Lake Sibaya and Groenvlei, the proviso being that the waterbodies should be at least 600 m wide to reduce error caused by shoreline effects, and should not experience prolonged dry periods. The resulting database, covering the entire decade from 2002 to 2012, was provided to DWS for ingestion into the computerised Water Management System maintained by Resource Quality Information Services.

By February, Dr Matthews will have completed an analysis of that data in terms of trends, means and seasonality for each waterbody, and submitted a report “essentially saying this is the trophic status of our dams, this is the variability we're seeing, these are the worse affected by cyanobacteria. A website will also be set up to display this data in a very user-friendly way for the public.”

An MSc student is focusing on time-series analysis for selected systems in the Vaal catchment and starting to compare the MERIS-derived data to that of NEMP, while another MSc or PhD student will be taken on for OLCI-related work early this year. Fortunately, OLCI will have the same bands as MERIS plus some additional ones, so the MPH algorithm should still be applicable in future, but validation will nevertheless be necessary. This will be done using bio-optical data from dedicated fieldwork and laboratory analyses, as well as data from routine NEMP sampling.

There is also much work to be done on setting up the processing chains to acquire OLCI data and make it available in near real time to provide an operational monitoring system for estimating phytoplankton biomass, detecting cyanobacteria blooms and managing invasive aquatic plants. Data from OLCI will be available within three hours of the satellite overpass, but this will need to be converted to usable products, and products to value-added information, such as tables with weekly averages and graphs showing seasonal and yearly changes.

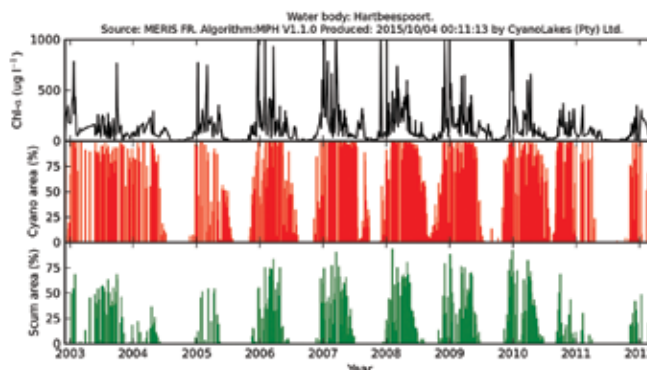
Programme Manager for NEMP, Elijah Mogakabe, is excited by the opportunities presented by this eye-in-the-sky approach to monitoring eutrophication, and recognises how the two programmes complement one another.

“We'll be able to get an idea of the water quality in waterbodies not currently being monitored by NEMP, while our monitoring data can be used for further calibration and improvement of the algorithm,” he says. “The remote-sensing information will allow us to optimise our monitoring network and streamline our activities, which is going to save money in the long term.”

Hopefully, some of those cost savings can be used for remedial measures to mitigate eutrophication, as well as preventive management. Ironically, though, in this day and age it is far harder to achieve results ‘on the ground’ than it is to view the problem from space.



Dr Mark Matthews analyses a water sample during a field trip on the Hartbeespoort Dam in October 2010 to collect in situ bio-optical data, which he used during his PhD research to develop and validate the MPH algorithm.



Time series for MERIS-derived chlorophyll a concentration and area coverage for cyanobacteria and surface scum at Hartbeespoort Dam for the period 2003-2012.

Water and health

Pin-pointing pesticide contamination and the damage it can do to people

In a South African first, a Water Research Commission (WRC) study has created agricultural pesticide maps for improved risk management.

Article by Petro Kotzé.



As with many developing countries, agriculture remains vitally important to South Africa's economy. Though it has decreased as a percentage of GDP over the past four decades, currently contributing around 2%, the sector formally employs 638 000 people, and an estimated 8.5-million people are directly or indirectly dependent on it for an income. The sector's significance is a key focus of the New Growth Path, a governmental strategy to create 5 million new jobs by 2020.

Yet, the sector is impacting negatively on the resource that it is most dependent on – our limited freshwater supplies. Regardless of limited monitoring studies, there is sufficient information to indicate that many currently used agricultural pesticides enter surface and groundwater.

According to the latest Department of Agriculture, Forestry and Fisheries (DAFF) database, there are in excess of 8 000 herbicide, insecticide and fungicide products registered for use in South Africa. Many of these include active ingredients that are either carcinogenic or classified as endocrine disruptors (EDs), while for most pesticides these endpoints have yet to be defined.

This is particularly concerning considering that many communities do not have any or reliable access to treated water, and often make use of water collected directly from the resource for drinking purposes. Given the potential human health effects associated with exposure to agro-chemicals and their intensity of use, in combination with the questionable supply and quality of drinking water in many South African communities, it is important to identify and prioritise pesticides that are particularly toxic, and areas where people may be exposed to these priority chemicals.

"We know that these things do enter the water and much research focus has been on the impact on the aquatic ecosystem," notes Dr James Dabrowski, Principal Researcher in Environmental Chemistry and Water Quality at CSIR. "We also need to focus on the potential effects on human health with water as the pathway, and in particular the impact of current pesticides," he says, pointing out that much work has rather been done on pesticides banned for agricultural use, such as dichlorodiphenyltrichloroethane, popularly known as DDT.

Dr Dabrowski is the principal researcher of a WRC initiated project to answer some of these questions. The five-year study, which concluded in 2015, aimed to determine the extent and the level of contamination by agricultural chemicals in selected water resources as well as determine their risk to animal and human health, both in terms of toxicity and ED effects.

The study was led by the CSIR together with collaborators from the universities of Pretoria and North-West, and made significant advances in addressing knowledge gaps in managing the risks of agricultural pesticides in South Africa. According to Dr Dabrowski, the study involved multiple aspects, including identifying the most problematic pesticides among the huge amount registered, looking at their potential impact on human health, identifying which ones are most likely to enter the resources and identifying where in the country these pesticides are being used.

Prioritising pesticides according to risk and locality

The project selected three agriculturally intensive catchments representative of important commercial crops produced in South Africa, namely maize, sugarcane, citrus and subtropical fruit.

The study areas were the Letsitele catchment in the vicinity of Tzaneen, an area dominated by tropical and citrus fruit production; the Lomati catchment which drains into the Komati River in the vicinity of Komatipoort (dominated by sugarcane production as well as by other tropical and citrus fruits); and the Vals and Renoster catchments in the Free State, both of which enter the Vaal River, in the vicinity of Kroonstad and Viljoenskroon. The latter is an area of intensive maize production.

Seasonal sampling for ED bioassays and organic and inorganic constituents from surface water resources, sediments and groundwater in the three selected sites were conducted.

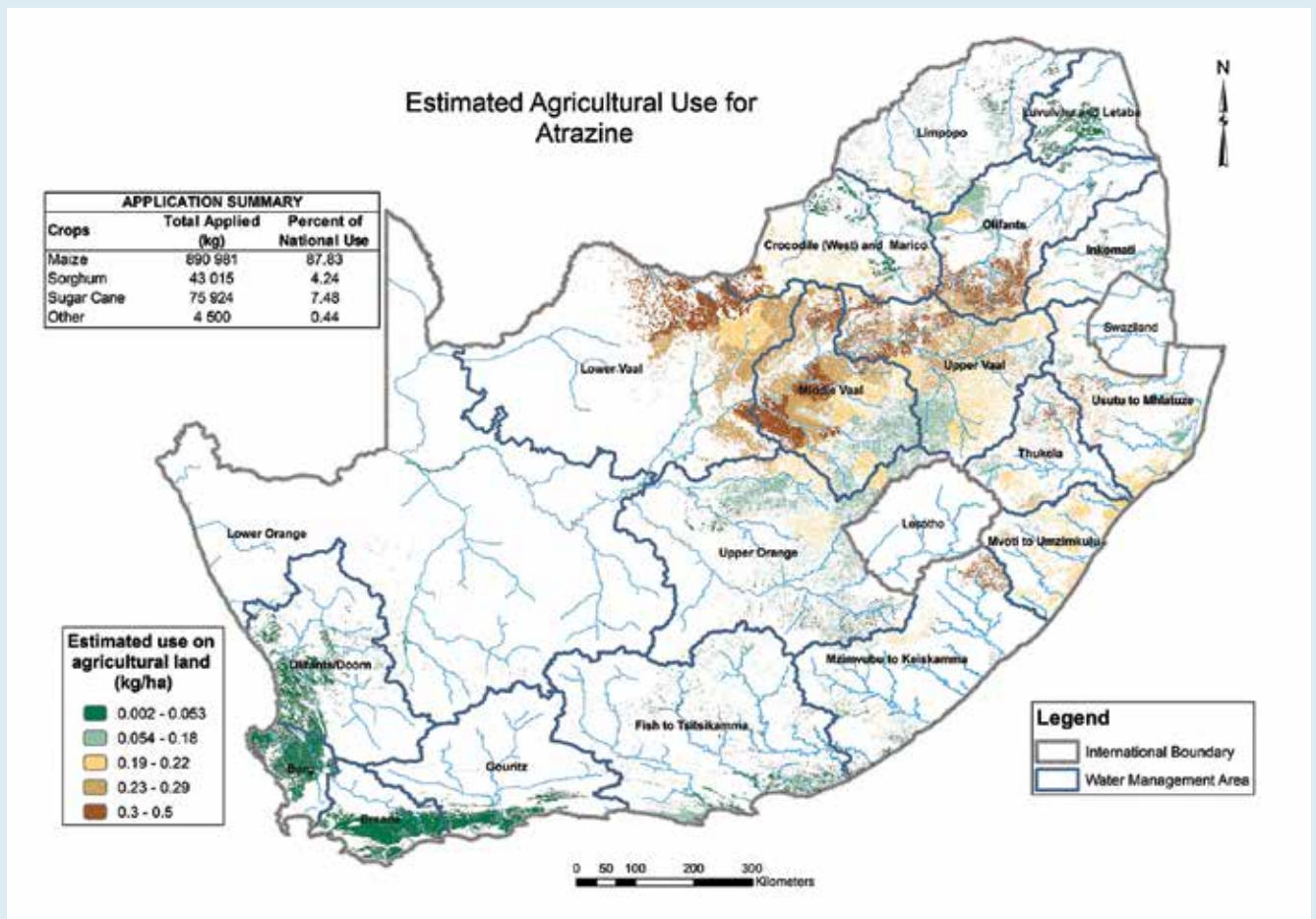
These results were interpreted against guideline values (in the case of inorganic constituents) or subjected to detailed risk assessment methodologies (in the case of pesticides) so as to assess the potential risk of agricultural chemicals to human and animal health. In addition, pesticides were prioritised based on quantity of use (QI), toxicity potential to human health (TP) and hazard potential (HP), which combines toxicity with environmental mobility. The data was fed into an Excel-based risk indicator. When all three are combined, you get the weighted hazard potential, which expresses the HP as a function of the quantity of use of the pesticide.

"It is a simple process enabling users such as water resource managers, catchment management agencies, water treatment works and farmers to prioritise pesticides at a national or crop-specific scale according to any one of these indices."

The importance of verifying models

The study proved to be a great example of the usefulness of models in human health and ecological applications. During the course of the study, researchers validated the AGDISP model, used to accurately predict the deposition of spray material released from spraying equipment. "We used the model to predict concentrations of pesticides in the air in various distances from the application," explains Dr James Dabrowski from the CSIR. Though the predicted cancer and toxicity risks based on exposure to pesticides in water in each of the case study sites is low, results from the spray drift study indicate that inhalation of airborne pesticide levels potentially poses a greater risk to human health than those derived from use of water resources.





One of the maps produced that give a spatial overview of the likely distribution of specific active ingredients (in this case atrazine), based on their application to crops and the distribution of those crops throughout the country.

According to the final project report, a major limitation associated with the sampling approach adopted in this study is that pesticide contamination in water resources is typically transient, with peak concentrations most often being associated with specific events (i.e. during actual spraying of pesticides or during heavy rainfall events when runoff becomes a major contributing factor). The sampling frequency adopted in all catchments in this study is therefore unlikely to represent peak concentrations, but these are likely to be present for relatively short periods of time (a few hours) and exposure of humans and livestock to these peak concentrations through

the water pathway is likely to be low. The concentrations detected in these study areas are therefore likely to be representative of a typical exposure scenario.

A further outcome of the study is a set of maps that give a spatial overview of the likely distribution of specific active ingredients, based on their application to crops and the distribution of those crops throughout the country. It's a first for South Africa. While a number of geographical and physico-chemical factors influence the movement of pesticides into surface waters, the quantity and rate of application of pesticides used in an area is the most

important indicator of the potential for contamination of non-target environments. In this respect, the maps provide important information not only in terms of estimated application rates but also in terms of identifying where in the country specific pesticides are most likely being applied.

The maps thus prioritise those areas that are likely to be of greatest concern and can therefore make useful contributions to the design of water quality monitoring programmes, interpretation of monitoring data and as input into regional human health and ecosystem risk assessments.

The impact of pesticides on human health

In regards to pesticides' risk to human health, researchers actually found levels to be "pretty low, with negligible risk associated with consumption or use of water from the study areas". Yet, there are some warning signals. Despite the monitoring limitations mentioned, the study revealed relatively high concentrations of particularly atrazine, terbutylazine and simazine (all known EDs) in maize and sugarcane areas. Samples collected in the Vals and Renoster rivers in particular showed comparatively higher values than other study areas. Furthermore, atrazine in particular was detected at similar concentrations over different seasons (wet and dry) indicating that it has essentially saturated water resources in these catchments.

"Pesticides are often only present after events such as application but atrazine, for example, is found constantly in the water," notes Dr Dabrowski. "This is because it is used so much, and has high

environmental mobility in comparison to other pesticides." Their ubiquitous presence in water resources warrants further investigation in areas where use is high. In particular, more detailed surveys of groundwater resources and boreholes that deliver drinking water and for human and animal consumption should be surveyed in more detail.

Though there was not much risk found from a human health perspective, it does require more research, particularly regarding their potential ED effects, adds Dr Dabrowski. Bioassays conducted on water and sediment samples collected in the study areas indicated ED activity on many occasions.

Dr Dabrowski cautions that it must be kept in mind that the researchers did not look at all the listed pesticides and, where bioassays indicated ED effects, it was not possible to link these to the use of a specific pesticide. "This would be very difficult to do," he says, referring to the range of other contaminants such as sewage flows, which also contribute to the contamination of water resources.

Dr Dabrowski suggests that a possible approach could be to link or prioritise land use types or activities to ED effects instead of to specific pollutants.

He also points out that the ED science is still relatively new and guidelines for safe levels of ED response to human health do not yet exist, making it challenging to say how problematic the situation is. "It's not to say that there is a problem, or that there is not a problem, but rather that the bioassays provide a screening level assessment indicating that contaminants may be causing an ED response, and a cautionary approach should be applied and further research conducted where necessary."

On a positive note, the detection of pesticides was well predicted by indices used in the prioritisation procedure in all study areas, particularly quantity of use and mobility. The frequent detection of atrazine, terbutylazine and simazine in maize and sugarcane areas is undoubtedly a reflection of their high quantity of use as well as their high mobility in the environment. Similarly,



Photographs courtesy CSIR

The Letsitele River, with locals collecting water and doing washing.

imidacloprid, which was also highlighted as being highly mobile in the environment, although not detected as frequently, was also found in comparatively high concentrations when detected. Other frequently detected pesticides (e.g. carbofuran, diuron and hexazinone) were also well predicted by outputs from the prioritization procedure (i.e. crop specific use and mobility). These results indicate that indices of use and mobility are very useful in terms of prioritising specific pesticides for detailed monitoring in study areas of interest.

Moving forward

The pesticide use maps and supplementary data developed in this study provide the most detailed overview of pesticide use in South Africa produced to date. This information can be used to make national, provincial and catchment-based assessments which are essential for performing spatial assessments of human and environmental risk associated with pesticide use. Yet, according to Dr Dabrowski their application can be much broader, and can be developed as a prioritisation tool for the monitoring of aquatic ecosystems that could potentially be at risk. "For example, we can look at where endangered fish species occur in relation to the maps," he says.

The team's work is not over, as there are a number of recommendations that flowed from the study. For example, passive monitoring, which measures contamination over time could be applied, in order to include peak pesticide concentrations associated with certain events.

Furthermore, "despite getting the maps and information out, we need to have a more proactive approach," notes Dr Dabrowski. "The regulation of pesticides from a risk assessment perspective is not that great. We do not have a good idea of how much is used where, and there are currently no water quality guidelines for most pesticides being used in South Africa."

Though the current project results are of particular use to policy makers, a follow-up study is in progress to produce products that can be used by farmers. In the meantime, the project results have been published. All data collected and produced during the course of this project (including the maps) is available in the final reports or from the CSIR, Natural Resources and Environment in Pretoria.

To order the reports emanating from this project, *Investigation of the contamination of water resources by agricultural chemicals and the impact on environmental health Volume 1: Risk assessment of agricultural chemicals to human and animal health (Report No. 1956/1/15)* and *Volume 2: Prioritising human health effects and mapping sources of agricultural pesticides used in South Africa (Report No. TT 642/15)* contact Publications at Tel: (012) 330-0340, Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.



A rural residential area with fruit orchards in close proximity.



Maize is the most highly produced crop in South Africa, and is associated with high atrazine application.



Air sampling and spraying for AGDISP validation.

Industry and water

From barley to bottle – water focus pays off for SA beer maker



When sipping on an ice cold beer during a scorching summer's day, few people take time to contemplate how many litres it took to produce this refreshment. Yet it was exactly that question which prompted South African Breweries and its parent company, SABMiller, to implement a number of initiatives aimed at safeguarding water resources, both in this country and abroad.

Article by Sue Matthews.

Water used in the actual brewing process – including that making up the bulk of the final product, for cleaning, or lost as steam during boiling and through evaporation during cooling – is only a minor component of total water use in the supply chain. Nevertheless, in 2008 SABMiller's breweries were using a global average of 4.6 l of water to produce a litre of beer, and it was decided that this should be reduced to 3.5 l/l by 2015.

That milestone was reached a year early, in April 2014, by which time 59% of the breweries worldwide were using less than 3.5 l/l, compared to just 5% in 2008. The water savings amount to 23 billion litres of water – enough to fill an Olympic-size swimming pool ten thousand times! Since then, SABMiller has set a new target to reduce the global average to 3 l/l by 2020, while SA Breweries is aiming for 2.89 l/l at its own operations.

That sounds promising, but improving water efficiency in the brewing process is really the easy part. What about the water used to produce the raw materials needed for brewing? Prof Arjen Hoekstra created the water footprint concept in 2002 as a way of measuring the amount of water consumed along the entire supply chain, and in 2008 he co-founded the Water Footprint Network with leading global players from business, civil society, multilateral organisations and academia.

Noting conflicting figures for the footprint of beer on the network's website and in the academic literature, SABMiller conducted its first water footprint exercise that year at its South African subsidiary, which at that stage distributed about 2.6 billion litres of beer annually from its seven breweries. The following year a second water footprint exercise was undertaken in the Czech Republic, where Plzeňský Prazdroj's three breweries contribute some 20% of SABMiller's overall European beer volume.

The results, presented together in the 2009 report, *Water footprinting: identifying and addressing water risks in the value chain*, showed that while the Czech operations used approximately 45 litres of water per litre of beer, the South African footprint was significantly higher at 155 l/l. This could be attributed largely to the different evapotranspiration profiles and the greater reliance on irrigated and imported crops in South Africa. In fact, 98.3% of the SA Breweries water footprint was related to the growth of crops, with 84.2% of this due to local cultivation.

The SABMiller water footprinting report had been published in partnership with WWF, and in the same year the two organisations established the Water Futures Partnership with

the German sustainable development agency GIZ to address water security through action-orientated partnerships around the world. In light of the report's findings about the high contribution of local crop cultivation to SA Breweries' water footprint, the first project to be conducted by the Water Futures Partnership was a water risk assessment of the local hops industry.

Hops are a minor ingredient in beer, but key to aroma and flavour and for imparting a bitter taste. In South Africa they are only grown commercially at about a dozen farms – three of them owned by SA Breweries and the rest under contract – on the slopes of the Outeniqua mountains near George in the southern Cape. The area was chosen in the 1930s because it most closely met the growing preferences of European varieties (recall the quip that the prefix CAW on George's old car number plates stood for 'cold and wet'), but since the 1970s the industry has increasingly relied on locally developed cultivars that are more suited to our shorter summer days and warmer weather.

Hop-growing remains a water-intensive process though, and the drought experienced in the southern Cape between 2009 and 2011 highlighted the precarious nature of water availability. The hops industry was therefore an obvious candidate for a water risk assessment, which was conducted with

the technical assistance of the CSIR and the involvement of local stakeholders.

The hop farms, which fall mainly within two sub-catchments referred to as the Waboomskraal and Herold catchments for the purposes of the study, were found to have an annual water requirement of about 5 million m³, of which about 2.2 million m³ needs to be irrigated. Surface water storage capacity is only about 1 million m³, with few options for expansion, and registered groundwater usage a fifth of this. This means it is vital that dams are filled during the dormant season and at least once during the growing season if crop failure is to be avoided.

"We expected climate change to be the big issue, but when we did the hydrological modelling for the catchments, we realised that an even greater threat was from alien invasive vegetation," says Christine Colvin, who was part of the CSIR project team and now heads up WWF's Freshwater Programme. "The modelling showed that if the invasion continued unabated, the new normal for those catchments would be a 40% reduction in water flow."

Hakea, pine and black wattle cover some 2 800 ha, mainly in the Waboomskraal catchment, and apart from reducing runoff they increase the risk of intense fires, and hence erosion and consequent shallowing of dams through

sedimentation. WWF has since assisted in getting an alien-clearing programme underway, playing an important part in its planning and facilitation.

"We decided our role would be to help convene and catalyse collective action, because in the past few years WWF has been very involved globally in developing a framework for water stewardship," explains Colvin. "The crux of that is it's not just about reducing your own water footprint and maximising your own water use efficiency, but it's also about getting involved with your catchment neighbours – who might be completely unrelated to you in different supply chains, but who share the same 'water-scape' with you – for those big issues that you can't address alone. The big issue for this catchment was alien invasive [plants], and we realised that this was an area where farmers needed to act together."

"Hop-growing remains a water-intensive process, and the drought experienced in the southern Cape between 2009 and 2011 highlighted the precarious nature of water availability."



Lani van Vuuren

Barley is South Africa's second most important grain after wheat, with 85 000 ha planted and an annual production of about 300 000 tons.



Wikimedia commons

Hops is grown commercially at only a few farms in South Africa.



Barley being harvested in the Western Cape

"In addition, we discovered during the water risk assessment that there was a low level of measurement of water use – not just on the hop farms but throughout the catchment – so we've tried to support farmers in increasing their level of monitoring. We've installed data loggers in about 12 boreholes to help them to start monitoring their groundwater resources, and that's going to be an important baseline, especially once pumping starts from the Blossoms Wellfield at Oudtshoorn. We've also done evaluations on farms to help them see where they can operate more efficiently, in terms of both their own irrigation systems and the shared irrigation scheme."

While the hops sector may be locally important in George, the area cultivated is less than 500 ha in total, and the annual crop amounts to less than a thousand tons. By contrast, barley is South Africa's second most important grain after wheat, with 85 000 ha planted and an annual production of about 300 000 tons. Barley is as fundamental to beer as grapes are to wine, both providing the source of fermentable sugars needed by yeast to create alcohol, although barley must first undergo a process known as malting, which allows the grain to partially germinate.

SA Breweries helped to establish the local barley industry in the 1970s and is to this day the only major buyer of the crop. Initially, cultivation was limited to dryland farming in the Overberg area of the south-western Cape, and the bulk of production still occurs there in three nodes surrounding Caledon, Bredasdorp and Swellendam. Since 1994 a second production area has been developed in the irrigation areas around Vaalharts, Barkly West and Douglas in the Northern Cape, as well as Taung in the North West Province, where SA Breweries initiated a project to create a sustainable source of income for smallholder farmers. Harvested crops are delivered to the closest of two malting plants, located in Caledon and Alrode, Gauteng.

Clearly, barley-farming makes up the largest share of SA Breweries' water footprint, so improving water efficiency and encouraging stewardship is a major part of another programme run in partnership with WWF. Called 'Better Barley, Better Beer' (BBBB), the programme is essentially a voluntary framework based on a guideline document, which was adapted from the GreenChoice Living Farms Reference published by WWF-SA, Conservation International and the GreenChoice Alliance in 2009. The guideline outlines

criteria and indicators for sustainable farming practices in terms of economic, social and environmental principles, and includes a checklist that allows farmers to self-audit their performance.

The programme has been piloted since mid-2014, with 15 barley farmers in the dryland areas and 11 in the irrigation areas. Jan Coetzee was appointed as the BBBB extension officer, based at SAB Maltings in Caledon.

"I go out and visit the farmers, give them alternatives, we focus on certain risks and fix that first," he says. "One aspect we're really working hard on at the moment is chemicals management, so we're doing practical things like ensuring safe disposal of used pesticide containers, fixing up chemical storerooms, upgrading wash bays, and investigating recycling options for wastewater. We're also going to be sampling farm dams and streams that might be polluted by runoff."

"There's a huge focus on wetland and watercourse protection – educating the farmers about the value of buffer zones – plus we're helping with alien-clearing in the catchments and along the rivers. We're trying to combine that with minimum tillage to make it a holistic water management scenario."

Most of the dryland farmers have adopted minimum tillage techniques, where seed is planted in the stubble of the previous crop. Apart from being cheaper than ploughing, which over time degrades soil structure and organic content, the stubble provides a protective mulch that reduces runoff, erosion and evaporation.

Up north, the focus is on optimising irrigation processes, and considerable water savings are being achieved through the Precision Irrigation of Barley Project. Based largely on research conducted by SAB agriculturist, Frikkie Lubbe, for his PhD at the University of the Free State, it includes an irrigation-scheduling computer programme and a crop factor, which identifies the proportion of evaporation that must



Lani van Vuuren

Barley under irrigation in Taung.

be replaced with irrigation for a crop to produce a commercial yield.

“Of course, by irrigating more efficiently the farmers are also reducing their electricity usage, which is a major input cost,” says Coetzee.

More recently, the BBBB guideline document has been translated into Tswana and the programme is being rolled out to about 100 small-scale and emerging farmers in Taung, but Coetzee notes that the focus there is primarily on social aspects, using a ‘from the farm to the house’ approach.

“Not a lot of the money earned from farming is benefiting the household, so that’s something we’re trying to address. For example, there’s huge potential for other business avenues that the women could get involved with,” he says. “On the water side, the main concern is the quality of water, but the farmers have

recognised its importance and are starting to manage that.”

In mid-November, news broke that SABMiller had formally agreed to a \$108 billion buy-out by Anheuser-Busch InBev. The deal still needs to get regulatory approval around the world, from countries such as the United States, South Africa, China, Colombia, Australia and India, as well as the European Union, which is expected to take about a year.

Fortunately, if this succeeds it is highly unlikely that SABMiller’s water wise initiatives would go down the drain, because AB InBev has its own very successful water management programme. All its breweries and manufacturing facilities throughout the world are subject to annually updated water risk assessments, an irrigation scheduler system called AgriMet has recently been piloted with 25 barley-growers in Idaho,

conservation agriculture practices are being promoted in Mexico, and some 2000 growers worldwide are participating in a benchmarking process called SmartBarley. This is an online and interactive dashboard that allows growers to anonymously compare their crop practices and outcomes against other growers through more than 40 performance metrics, ranging from yield to irrigation productivity.

According to AB InBev’s website, “SmartBarley is playing an important role in helping us achieve our water-management goals by identifying opportunities to improve resource management, reduce water risks, increase efficiency and water productivity, and measure the success of soil and irrigation management pilot initiatives.”

We can all raise our glasses to that!

Water and the environment

Jewel of the Northern Cape in fading due to pollution



Kamfers Dam – tourism jewel and once birders' paradise of the Northern Cape, is dying. Raw sewage and stormwater from nearby Kimberley is turning this once endorheic salt pan and important avifaunal habitat into a permanent cesspool.

Article by Phetole Peter Ramollo*.



Around 400 ha in size, Kamfers Dam is an endorheic saltpan situated about 4 to 6 km outside Kimberley in the Northern Cape Province. It is fairly shallow, with a maximum depth of less than 4 m. The wetland, a recognised National Heritage site, is home to a variety of waterfowl, but is dominated by flamingos, which attract tourists and generate valuable economic income for the area.

The pan is one of only four breeding areas in the world (and the only one in South Africa) where the Lesser Flamingo breeds. These beautiful birds, which are classified as 'near threatened' can be seen in their flocks feeding in the pan.

Outside South Africa, flamingos can be found frequenting the pans of countries such as Botswana, Namibia and Kenya where they filter planktonic cyanobacteria together with shallow littoral diatoms as well as a wider range of cyanobacteria and diatoms in temporary wetlands.

They feed by wading in shallow water with their bills upside down and filtering the tiny cyanobacteria from the surface. They also eat small crustaceans such as shrimps and other invertebrates. It is the carotenoids in their food sources that give them their distinctive pink colouring.

Flamingos are nomadic, moving between pans in which they feed in numbers. Their nomadic behaviour at Kamfers Dam has probably changed as a response to the unpredictable dynamics of their food supply in the short term, and the unpredictable status of the pan due to constant pumping of water into it.

Generally flamingos are sensitive to disturbances, and only breed when environmental conditions are favourable. The once safe haven offered to them by Kamfers Dam is now being threatened by urbanisation and resultant pollution. The pan has shown major water quantity

and quality changes with regard to high levels of nutrients and *E.coli*.

The Sol Plaatje Municipality is the management authority of the pan, and is trying to reduce the water levels. At present, water is being directed to Langleg Pan to maintain the water volume of Kamfers Dam.

Avian botulism outbreak

The seriousness of the situation is illustrated by the fact that, in 2013, about 1 500 waterfowl, including flamingos, died at the pan due to avian botulism. Avian botulism is a paralytic disease caused by a toxic produced by the bacteria, *Clostridium botulinum*, when it is ingested. This bacteria is naturally available, widespread and dormant as spores in the soil, especially in areas with high concentrations of organic material – such as with wastewater treatment.

* Phetole Peter Ramollo works at the Northern Cape Department of Environment and Nature Conservation.

If conditions are favourable, the bacteria becomes active, the spores germinate and the active bacteria produces toxins. The birds then either ingest the toxin directly or eat invertebrates containing the toxin. The toxin affects the nervous system by preventing impulse transmission to muscles.

The decomposing vegetation at Kamfers Pan, the high recorded water temperature (30 °C), alkalinity (pH 10), high salinity (1 559 mg/l), total dissolved salts of 7 269 mg/l and low concentration of dissolved oxygen (2.4 mg/l) created an ideal environment for the bacteria to become active and start producing toxin. During the outbreak in 2013, the affected birds were unable to propel themselves with their wings, showed failure to use their legs and to keep their heads above the water as they tried to escape – many of them drowned. Others were found close to the water's edge.

Birds were found stuck between the reeds and sedges. At least nine species of birds were affected, particularly the Yellowbilled Duck and Egyptian Geese. In addition to migrating waterfowls, several dead shorebirds and flamingos were also recorded.

During the outbreak it took officials from Sol Plaatje Municipality, as well as the provincial departments of Agriculture, Land Reform and Rural Development and Environment and Nature Conservation to remove the dead and dying birds from Kamfers Dam. The dead birds were collected and incinerated to prevent further outbreaks while live individuals were taken to the Society for the Prevention of Cruelty to Animals (SPCA) where they were treated and later released.

Catfish in Kamfers Dam

A characteristic of the changing nature of Kamfers Dam is the fact that the pan now serves as a home for catfish. No previous studies ever recorded any fish species in the pan, and it was thought that the salinity in the pan would not make it conducive for the survival of fish.

Though it is not known how the catfish got introduced to the pan, during the outbreak of avian botulism, communities

residing next to the pan were seen fishing and collecting some of the sick fish. This was extremely disconcerting to officials as the decaying fish can create a conducive environment for *Salmonella spp.*

However, it proved very difficult to discourage the community from eating the fish due to the possible health risks. Residents simply responded that they had been eating the fish for the last ten years and never got affected.

From 2010 to 2012 the area experienced flooding. The floods coupled with constant inflow of urban waste overflowed. On the western side of the Pan the overflows created a big pool. In 2013, the water levels dropped and a pool was being linked to the main pan through a channel that passes through a culvert over the railway line. The pool is now a breeding place of catfish.

In 2015, the water levels further dropped significantly across the pan and the pool due to extremely high ambient temperatures of the area and the divergence of treated sewage being pumped into Langleg Pan.

In the western side massive fish death occurred due to water level decline that made the pool too shallow (3 cm in depth). At this stage the pool and main pan was no longer connected, so the fish in the pool got trapped in the shallow water. Thousands of fish were gulping for oxygen at the water edges and thereafter started dying in numbers due to lack of oxygen, space and competition of food. Most of the fish that were in the channel survived for days while others managed to move into the main pan.

By the time they reached the main pan (connected through a small furrow/channel) they were already too stressed and started dying. More than 3 000 fish died and three different water bird species. Some started rotting in the channel area further polluting the water. Around 750 fish were translocated to a nearby farm, while the dead fish were removed from the pool and burnt.

The residual carcasses that remained on site triggered a secondary outbreak of avian botulism. During this event only dabbling species died while no sole filter feeders were affected.

The Department of Agriculture & Rural Development and Department of Environment & Nature Conservation officials will continue educating the people especially those living close to the pan and those who fish at the wetland, regarding the dangers of consuming birds and fish in polluted waters.

The pan is not fully researched and more studies like ecology of flamingos, bioaccumulation of metals in fish and flamingos, Persistent Organic Pollutants (POPs) and water quality are needed.

The future of nature is our future, let's protect our nature for our wellbeing and the future of next generations.

Anyone who has interest to conduct future scientific studies at Kamfers Dam can contact the unit manager Ms Elsabe Swart on
Email: eswart@ncpg.gov.za,
Tel: (053) 807 7430 or
Dr Macdonald Gayakaya on
Email: mgayakaya@ncpg.gov.za,
Tel: (053) 802 5639.



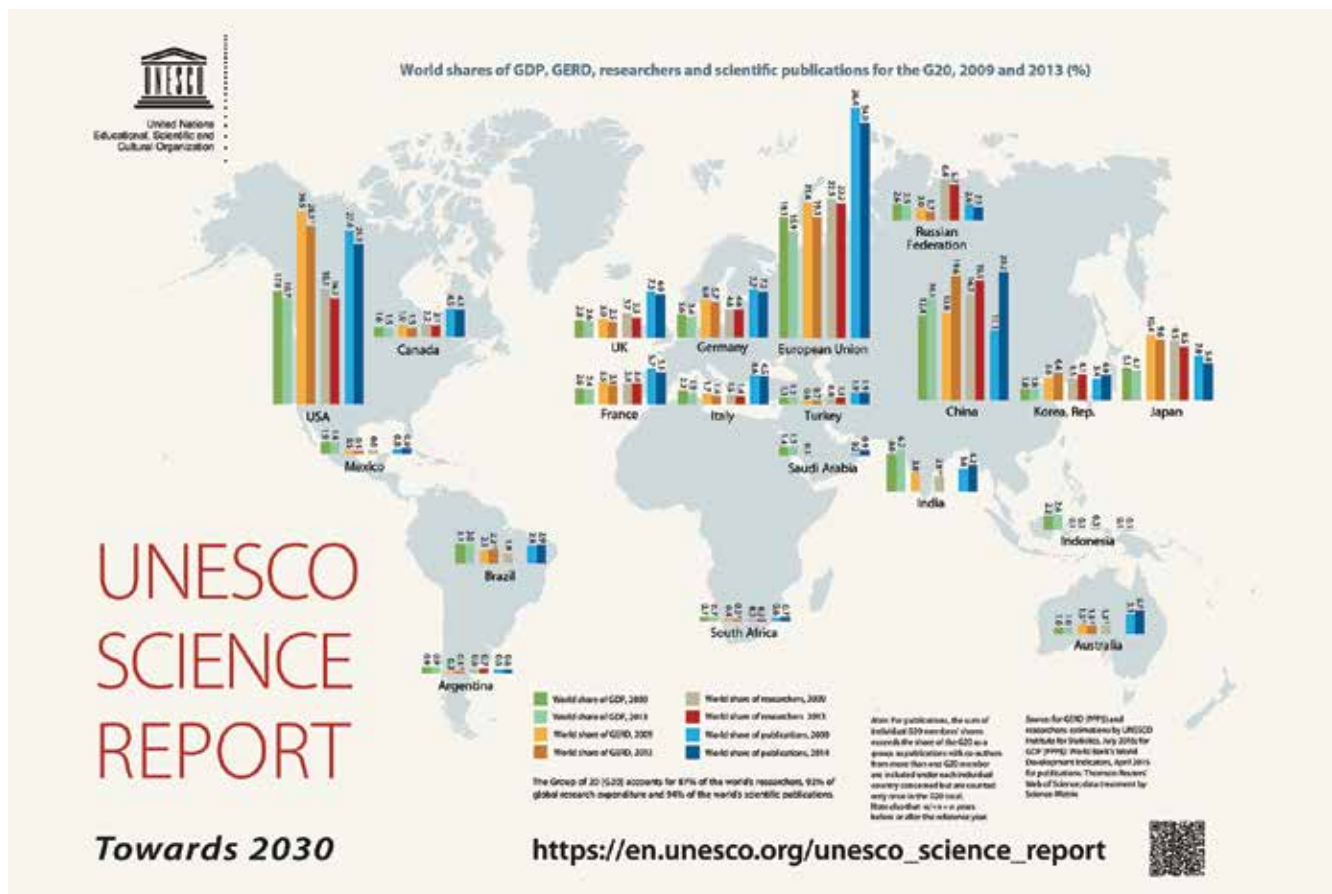
Officials collected at least 1 500 dead waterfowl during the outbreak of avian botulism at Kamfers Dam in 2013.



Communities collecting catfish from Kamfers Dam, despite the health risk.

Global trend

Research at forefront of global race for sustainable development



Most countries, regardless of their level of income, now see research and innovation as key to fostering sustainable economic growth and furthering their development. This is one of the conclusions of the United Nations Educational, Scientific and Cultural Organisation (UNESCO) *Science Report: towards 2030*, launched on World Science Day, on 10 November. The report is published every five years.

“In the wake of the adoption of the Sustainable Development Goals to 2030 by the UN General Assembly, the UNESCO *Science Report* clearly shows that research is both a motor

for economic development and a cornerstone in the construction of societies that are more sustainable and more respectful of the planet,” said UNESCO Director-General, Irina Bokova.

The report’s first lesson is that, despite the economic crisis that hit industrialised countries in 2008, gross domestic expenditure on research and development (GERD) increased globally by 31% between 2007 and 2013, rising from US\$1,132 billion in 2007 to US\$1 478 billion in 2013. This increase was more rapid than that of global gross domestic product (GDP) during the same period (20%).

Cuts in public investment

The increase in research and development (R&D) spending owes a great deal to the private sector, which has compensated for frozen or reduced public spending in a number of industrialised countries, such as Italy, the UK and France. This trend is particularly apparent in Canada (whose world share of R&D spending dropped from 2.1% in 2007 to 1.5% in 2013), and Australia, where significant cuts were made to research funding and applied sciences were prioritised to the detriment of basic research.

If global spending on R&D has increased despite the economic crisis, it is largely because it has been identified as a key factor in promoting economic growth and development. As a result, a great many countries, regardless of the size of their income, now see research and innovation as a way to keep up in a highly competitive world or find their place in it.

This is the case in Africa, where there is a growing recognition that the development of modern infrastructure, such as hospitals, roads, railways, etc. and a more diversified economy require investment in science and technology, as well as the constitution of a skilled workforce. Kenya, for example, devoted 0.79% of its GDP to R&D in 2010 compared to just 0.36% in 2007. R&D spending is also increasing in Ethiopia, Ghana, Malawi, Mali, Mozambique and Uganda.

More scientists, greater mobility

The investment in research also translates into an increase in the number of scientists, estimated at 7.8 million worldwide, which is up by more than 20% since 2007. The European Union as the most (22% of the world share), followed by China (19%) and the USA (16.7%).

There has also been a parallel explosion in the number of scientific publications, which have increased by 23% since 2008. In 2014, there were around 1.27 million per month. Europe also leads in this field (34% of world share), followed by the USA (25%), although their respective shares have seen a slight decrease.

As well as being more numerous, scientists are also more mobile. Despite the development of the Internet and the multiplication of online networks, doctoral-level researchers still feel the need to travel. The increasing mobility of PhD students, in turn, influences the mobility of researchers. "This is perhaps one of the most important trends of recent times," say the authors of the report.

Students from the Arab States, Central Asia, sub-Saharan Africa and Western Europe are the most likely to study abroad. Europe and North America are still the preferred destinations for students. The USA alone receives almost half (49%) of international students enrolled in doctoral science or engineering courses. The UK comes second (9%), followed by France (7%), and Australia (4.6%).

Research is still a male world

While, globally, women have achieved parity at Masters level, their share diminishes at PhD level to 43% of all doctoral graduates. The gap continues to widen after this, as women only represent 28.4% of the world's researchers. They also have more limited access to funding than men, and are less well represented in prestigious universities. They remain a minority in senior positions, whether on faculty boards or at the higher levels of decision-making in universities.

The regions with the greatest number of women researchers are Southeast Europe (49%), the Caribbean, Central Asia and Latin America (44%). Interestingly, in the Arab States, 37% of researchers are women, which is a higher proportion than in the European Union.

Investing in R&D – some difficult choices

"Formulating a successful national science and innovation policy remains a very difficult task," conclude the authors of the report. This will require simultaneous action on several fronts, whether it is education, basic research, technological development or indeed private investment in R&D. The 2008 economic crisis, which made many industrialised countries tighten their budgets, has rendered this task more difficult.

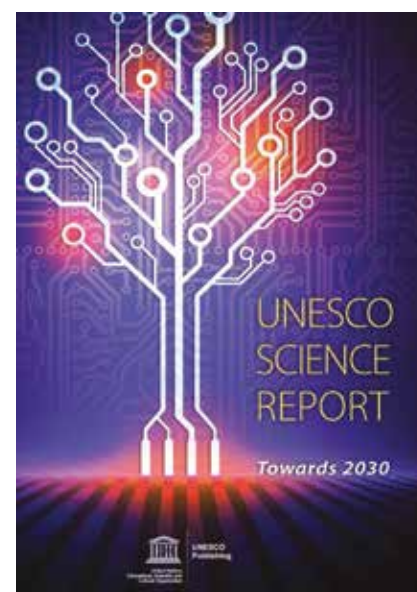
While most R&D takes place in high-income countries, innovation is now occurring in a large number of countries, whatever their income level. Some

innovation is occurring without any R&D activity at all. The authors of the report therefore encourage policy-makers not to focus exclusively on designing corporate incentives for R&D, but also to target innovation, in the form of technology transfer and the acquisition of machinery, equipment and software, which are all key elements in the innovation process.

While most science policies advocate stronger links between the private sector, universities and public research institutions, these commitments often come to nothing, the report observes, quoting a 2013 survey carried out by the UNESCO Institute for Statistics in 65 countries. The report encourages policy-makers to draft strategies to try and reverse this trend.

The UNESCO Science Report also emphasises the importance of good governance for innovation-driven development. Corruption in the university system is an obstacle to the education of qualified graduates. It is also a disincentive for the private sector. Companies will have little interest to invest in R&D if they cannot rely on the justice system to defend their intellectual property.

To access the full report, Visit: https://en.unesco.org/unesco_science_report





Water KIDZ

Climate's
troublesome kids
– El Niño and
El Niña

South Africans are hearing a lot about El Niño these days, especially in the areas affected by hot, dry conditions. But what is this weather phenomenon exactly?

We don't often think about the ocean and its influence over our climate, even though it covers so much of the Earth's surface. While the sun is the engine that drives all weather on Earth, the ocean and atmosphere steer the sun's energy along certain paths to produce both regional climate and individual weather phenomena.

The ocean plays a crucial role in determining climate because of its ability to absorb, store and transport heat from the sun. Ocean water also affects atmospheric temperature and circulation around the world. In addition, seawater is the source of most precipitation (e.g. rain).

Normally trade winds blow from east to west across the tropical Pacific, pushing water away from the South American coast and piling it up around Indonesia. As a result, the sea level is usually about half a metre higher in Indonesia than it is on the coast of Ecuador and Peru. The offshore movement of surface water causes cold, nutrient-rich water to well up from the ocean depths to replace it. This upwelling accounts for the high productivity of Peruvian waters, as the nutrient-rich water encourages the growth of phytoplankton, which is a food source for many fish species.

But sometimes ocean phenomena, called El Niño and El Niña, disrupt these normal patterns, exerting dramatic influences on the world's climate.

Hundreds of years ago, South American fishermen observed that some years around Christmas, coastal waters of the Pacific Ocean became warmer as a current flowed from north to south. This change often meant a smaller catch, but more rainfall inland. And that translated into more abundant crops. They said the current came from El Niño (pronounced EL-NEEN-yo), which is Spanish for 'the boy'.

During El Niño, trade winds slacken and may even reverse direction. The warm water sloshes back across the Pacific and the thermocline (the transition layer between warm surface water and cold bottom water) flattens and deepens. Together with the cessation of wind-driven offshore movement of surface water, the thermocline inhibits upwelling, so sea surface temperatures rise rapidly.



South Africa is experiencing a hot, dry summer, which could affect production of crops such as maize.

Evaporation from warm sea surfaces increases moisture content in the air above, resulting in cloud formation. In normal years, this leads to monsoon rains over Indonesia and dry conditions along the west coast of South America. During El Niño, however, the rain clouds follow the warm water eastward, bringing heavy rain to Chile and Peru and leaving behind drought, dust storms and wildfires in Indonesia and Australia.

The dense tropical clouds also distort the flow of high-altitude winds, or jet-streams, which affect global atmospheric circulation, causing unseasonable weather patterns as far afield as North America and southern Africa.

The warming in the central and eastern Pacific Ocean triggers changes in air pressure across the ocean. Air pressure is the force of the weight of the atmosphere pushing down on a place. Scientists call these pressure changes the Southern Oscillation (oscillation means fluctuation).

These are triggered by the temperature changes brought on by El Niño. So the phenomenon's full name is El Niño-Southern Oscillation or ENSO. Climate scientists usually detect El Niño

toward the end of a year. Its major effects, however, typically are not felt until the following year. In countries such as South Africa, El Niño could lead to warmer-than-usual temperatures, and lower-than-normal rainfall.

Today, researchers use the term El Niño only for those periods when the surface water around the Equator in the eastern and central Pacific Ocean warms for an extended period of time. Scientists declare the development of an El Niño when they observe a temperature increase of at least 0.4 °C for five months in a row in the eastern Pacific near the Equator. An El Niño event occurs every seven years or so and usually lasts about a year.

At other times, the surface water in the eastern Pacific instead may cool down for long stretches of time. When the average temperature drops by at least 0.4 °C, climate scientists will announce the arrival of La Niña (Lah-NEEN-yah). This is Spanish for ‘the girl’. In general, effects of a La Niña run opposite to those triggered by an El Niño. This means South Africa might face higher rainfall and even floods.

It is important to realise that El Niño and La Niña are natural climate phenomena, and are not due to climate change. However, it is thought that these phenomena might be influenced by a rise in global temperatures. However, scientists are still working



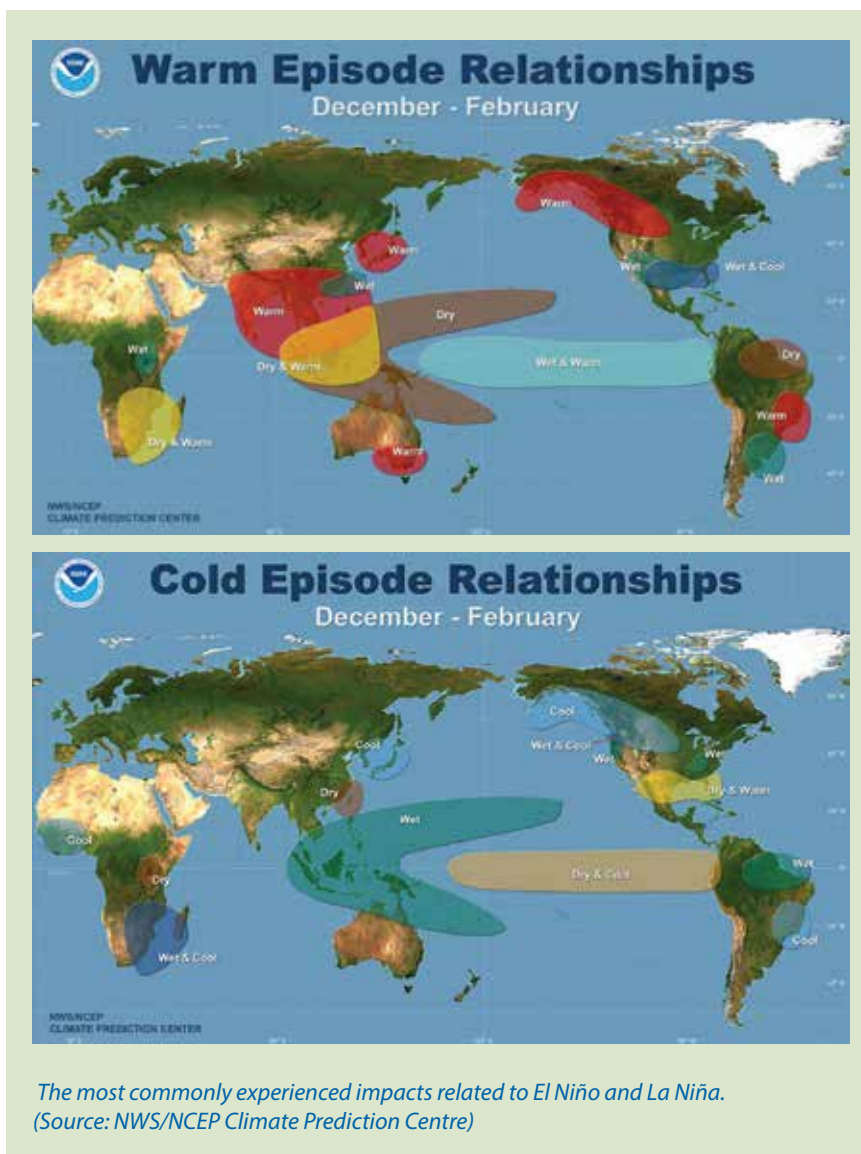
Ocean phenomena such as El Niño and La Niña lead to flooding in some areas and drought in others.

on exactly what this influence might be. Some experts say, however, that the combination of El Niño and global warming could be reason why the year 2015 was the warmest year on record.

The present El Niño is expected to have an effect especially on South Africa’s agriculture sector, particularly for rainfed crops such as maize. El Niño is expected to affect the region at least until March, and indications are that the country will receive lower than average rainfall. It is not only South Africa which is affected, but our neighbouring countries as well, including Botswana, Zimbabwe, and parts of Mozambique.

Climate scientists say the present El Niño might be one of the strongest ever recorded. This has come in a year that has been the warmest on record. So, we have a combination of drier season, with temperatures higher than they have ever been.

The good news is that El Niño and La Niña work in very predictable cycles. Once we get through this season, the Pacific will cool down again and conditions for a more normal summer should return again.



- Web sources**
- www.howstuffworks.com
 - www.climate.gov
 - www.societyforscience.org
 - <http://climatekids.nasa.gov/el-nino/>
 - <http://news.nationalgeographic.com/2015/11/151125-el-nino-hurricanes-drought-climate-science/>

Water-energy-food nexus under the spotlight

Delegates from various institutions met late last year to strengthen the South African research agenda around the interconnections between water, energy and food. While the relationships between these three vital commodities are increasingly being recognised their interdependence is not always understood. In order to grow South African knowledge in this arena the Water Research Commission created a Water-Energy-Food (WEF) Lighthouse or flagship research programme around this issue. The Commission is currently funding 22 projects in this domain. The aim of the dialogue was to raise the profile of the WRC's WEF nexus Lighthouse and to highlight the direction the WRC is taking on this issue; as well as to highlight current activities at the project level. Two important studies were discussed at the dialogue, namely the study focusing on water use of strategic biofuel crops; and the study investigating trade-offs between water use efficiency and renewable energy options for South Africa.



Speakers at the dialogue were WRC CEO, Dhesigen Naidoo; former WRC Executive Manager Dr Inga Jacobs-Mata, Dr David Tinarwo of the University of Venda; Dr Tafadzwa Mabhaudi of the University of KwaZulu-Natal and WRC Group Executive, Dr Mandla Msibi.

DEEPLY ROOTED IN SOUTH AFRICAN WATER SOCIETY

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 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, and innovative water solutions through research and development for South Africa, Africa and the world.

FOLLOW US ON



THE POWER OF
KNOWLEDGE
TO THE PEOPLE