# WATERWHEEL

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## SUN RISES over inland fisheries sector





Dam safety, maintenance & rehabilitation of dams in Southern Africa

## **CAPE TOWN** 1 to 3 September 2015

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Cover: The WRC, with Rhodes University, have completed the most extensive study yet on the inland fisheries sector in South Africa. Read more on page 14. Cover photograph by Lani van Vuuren









WRC CEO, Dhesigen Naidoo

### The Cuban engineer conundrum

Beware – the Cubans are coming! That's the clarion call from some of the most important umbrella engineering organisations in South Africa.

One has to wonder if the response would be the same if the US Army Corps of Engineers made a similar offer of partnership or would we have rolled out the red carpet with lightning speed. Manglin Pillay, CEO of the South African Institution of Civil Engineering (SAICE) pulls no punches – he wants the "Cubans to go home". One of the principle reasons he cites is echoed by the president of CESA (Consulting engineers of South Africa), Abe Thela, namely that South Africa's engineering registration body ECSA (Engineering council of South Africa) does not recognise Cuban engineering skills and qualifications as Cuba is not a signatory of the Washington, Sydney or Dublin Accords.

While this is true, it is also true that there are protocols to examine and accredit professionals from beyond the Accord signatories. The reality is that we sometimes forget how deeply entrenched the well propagandised Apartheid era biases continue to be. Biases that dictate that only the West, in particular the Washington-London Axis, dictates what is acceptable and good.

I recall similar conversations about engagements with India and China not too long ago. Where, in the same vein, serious and somewhat insulting questions were asked about a candidate scientist who had a PhD from Peking University, as to whether it would be good enough for South African standards. This is the same Peking University that is ranked 41st in the THES (Times Higher Education Supplement) world university rankings. The highest ranked South African institution by comparison is UCT ranked at 124. The irony is that it is these very same Western capitals that are beating an enthusiastic path to Beijing, New Delhi and Havana to set up new collaborations and business relationships.

We cannot escape the fact that South Africa is desperately short of engineering skills. A 2005 ECSA study reveals that South Africa's ratio of engineers per population stood at 1 engineer for every 3 166 people compared to Brazil at 1 per 227 people, the UK at 1 per 311 people and Australia at 1 for every 455 people. Allyson Lawless' study on behalf of SAICE in 2007 showed that we had three civil engineers for every 100 000 people at local government level. The Sector Skills report from the Water Sector Leadership Group (2009) put the engineering skills shortage in the water sector at a deficit of 3 000 civil engineers, and revealed that the sector was operating at 43% capacity.



South Africa is still desperately short of civil engineering skills.

In spite of the gallant efforts of the Department of Water and Sanitation's (DWS's) Learning Academy, the DWS/Development Bank of Southern Africa Siyenza Manje project and the government SAICE partnership, we are still desperately short of civil engineering skills, particularly at local government level. In addition, 55% of the engineers in the system are over the age of 55 according to the ECSA 2013 skills survey. The survey also reveals the strong need for more diversity with the African: White ratio standing at 2:9 overall. There is definite movement in this regard as this ratio now stands at 2:7 for the engineers below the age of 30.

In the wake of these facts, are we having the right conversation about the Cuban engineers? Should we not be looking at the opportunity of an even wider range of international partnerships like the Cuban one to both expand our immediate capacity as well as to increase our teaching and mentorship pool to vastly increase our engineering and other skills base? It is no co-incidence that the countries at the top of the World Competitiveness index in the WCY 2015 are all net importers of skills and professionals. These international partnerships must fit into an innovative strategy that empowers and expand both the local skills base as well as the national industry players.

One of the strong arguments is that this presents risk to the South African engineering fraternity. It can if we are unimaginative. A little bit of creativity, a dollop of innovation and lots of hard work can result in a strategy to significant build both the South African skills base as well as the competitiveness of the South African engineer and South African engineering companies through smart and well-crafted international partnerships. Through this we can develop an effective engineering sector that is better able to assist with delivery of basic goods and services to the country and increase South Africa's global market share. It is a model that South Africa needs and one that South Africans deserve.

#### Making learning about water fun in the Middle Olifants



The Phalaborwa region saw some exciting benefits of collaboration between the Kruger National Park and the Middle Olifants South Africa (MOSA) programme earlier this year.

MOSA, funded by the German Federal Ministry of Education and Research, is a consortium of water science and management institutions from Germany and South Africa developing integrated water resource management options within the Middle Olifants catchment area. This bilateral cooperation has now extended to the lower Olifants, in particular with the Kruger National Park, where a variety of applied works have taken place including using a mobile water quality laboratory to undertake spatial snapshot sampling of the lower Olifants and Ga-Selati catchments.

As part of this collaboration MOSA and the KNP joined forces to provide outreach to both schools and neighbouring institutions in the Phalaborwa region, both of which were hugely successful. Two local schools were invited to the event and received training in the field on aquatic bio-monitoring from SANParks and SAEON scientists and were then able to play the DHI Middle Olifants Water Game (mosa.aquarepublica.com) on computers sponsored by Gijima, remembering of course that the Water Research Commission funded the hugely successful National Water Competition during 2014 using the same Serious Game.

The students really enjoyed their experience and benefited greatly from their exposures to these events as demonstrated.

There then followed two days of intensive water resource management lectures on sustainable operations and maintenance of waste water treatment works, hydrological modelling and new decision support technologies that can be used to analyse and map hydrological risk at a catchment scale. With significant attendance from the local municipalities, mining companies and provincial operations office of the Department of Water and Sanitation the organisers believe that the outreach had the desired effect of enlightening a broad suite of stakeholders to be exposed to new and innovative matters in the field of integrated water resource management in their region.

#### Rhodes University celebrates honorary appointments in fish science

Rhodes University have welcomed two new Honorary Professors into the Department of Ichthyology and Fisheries Science (DIFS).

Drs Paul Cowley and Olaf Weyl, principal scientists at the South African Institute for Aquatic Biodiversity (SAIAB) were appointed following their prolonged and ongoing teaching and supervision of large numbers of post-graduate students at Rhodes University.

The staff of SAIAB expressed their pride of this recognition and wish to continue this mutually beneficial relationship with DIFS and other departments in the university. In the words of SAIAB MD, Dr Angus Paterson, "National Research Foundation facilities, such as SAIAB are required to be highly integrated into the higher education system, and these honorary appointments indicate that our organisation is indeed playing a significant role in this sector. Rhodes, along with a number of other universities, are our stakeholders and we look forward to ongoing fruitful collaboration." Source: SAIAB

## Ø Diary

#### Irrigation: August 3-6

The South African Irrigation Institute (SABI) will be holding its national congress 2015 at the Protea Hotel Ranch Resort in Polokwane, Limpopo province. The event kicks off the celebrations of the organisation's 40th Anniversary year with the theme '40 Years of Irrigation Development – Quality through Innovation'. Enquiries: Isobel van der Stoep (isobel@sabi.co.za) or Annemarie van der Westhuizen (annemarie@sabi.co.za); Tel: +27 (0) 21 850-8220 or Visit: www.sabi.co.za.

#### World water: August 23-28

The annual World Water Week will take place in Stockholm, Sweden, as usual. This year is the jubilee year for both the Week and the Stockholm Water Prize. The theme is 'Water for Development'.

Visit: www.worldwaterweek.org

#### Large dams: September 1-3

The South African National Committee on Large Dams (SANCOLD) is hosting its annual conference in Cape Town with the theme 'Dam safety, maintenance and rehabilitation of dams in southern Africa'. Apart from the technical presentations, the conference also includes the SANCOLD Young Engineer's Forum as well as technical site visits to the Clamwilliam and Bulshoek dams, as well as the Table Mountain Dams. Enquiries: Nom Buthelezi (Conference Secretariat) at Tel: +27 (0)11 676-3417; Email: secretariat@sancold2015.org.za or Visit: www.sancold.org.za

#### Land rehabilitation: September 8-15

The Third Annual Conference of the Land Rehabilitation Society of Southern Africa will be held at Glenburn Lodge, Muldersdrift. The theme is 'productive value from rehabilitated land'. Enquiries: Glaudin Kruger (conference organiser); Tel: +27 (0)28 316-2905; Kruger@krugerassociate.com; Visit: http://www.larssa.co.za/conference

#### Social science: September 13-16

The World Social Science Forum will be held in Durban. A broad range of topics will be discussed under the theme of 'transforming global relations for a just world'. Visit: www.ssf2015.org

#### Groundwater: September 21-23

The 14th Groundwater Conference will be held at Muldersdrift with the theme 'From theory to action'. This conference aims to highlight the issue of improving the uptake of existing knowledge and experiences of groundwater in South Africa to assist in solving environmental and societal problems. Email: info@gwd.org.za or Visit: www.gwd.org.za

#### Aquaculture: September 28-30

The 2015 conference of the Aquaculture Association of Southern Africa will be held in Polokwane with the theme 'Aquaculture: Shaping the future'. Enquiries: Mandy Jordaan (conference organiser); Tel: +27 (0)71 874-5200; Email: info@aasa-aqua.co.za

Environment and health: October 1-2 The 6th Annual Ecohealth and Wellbeing Conference will be held at UNISA, Pretoria with the theme 'Community studies: Team engagement in ecohealth and wellbeing research'. The conference will address a range of inter-disciplinary, and inter-institutional disciplines related to sub-themes such as communities and nature-related issues, communities and tourism, communities and the value of traditional beliefs, community engagement and municipal governance. Enquiries: Petra Lawson; Tel: +27 (0)83 231 6538; Email: conferencepl@gmail.com Water and Development: October 18-22 The International Water Association is holding its Water and Development Congress and Exhibition in Jordan with the theme 'Water security for sustainable growth'. The Congress features a range of topics and a diverse set of viewpoints from global water leaders. Visit: http://www.iwa-network.org/ WDCE2015/congress/

Municipal engineering: October 28-30 The annual conference of the Institute of Municipal Engineering in Southern Africa will take place at the Grand West Hotel and Casino, in Cape Town. Visit: www.imesa.org.za

#### Young Water Professionals: November 16-18

The theme for the 4th YWP South African biennial conference, which will be held in Pretoria, is 'Stop talking, start doing'. Conference topics include domestic and municipal water and sanitation; drinking water and bulk water supply; industrial and mine-water; environment water; and capacity building and training. Enquiries: Jaco Seaman (Conference organiser), Tel: +27 (0)11 805-3537; Email: events@wisa.org.za; Visit: www.ywp-za.org/

## Race still on to eliminate use of bucket toilets in South Africa

The Department of Water and Sanitation will spend close to a billion Rand to replace 30 000 bucket toilets with alternative, safe sanitation during the 2015/16 financial year.

This is according to the Minister of Water and Sanitation, Nomvula Mokonyane. She was speaking at the National Council of Provinces Budget Review in Parliament earlier this year.

Currently, it is estimated that some 88 127 households in formal settlements are still utilising the bucket system as a form of sanitation. This backlog is found predominantly in the Eastern Cape, Free State, Northern Cape and North West.

Mokonyane further announced a budget of R115-million to be invested in 11 000 dry sanitation units to eradicate rural sanitation backlogs through the Rural Household Infrastructure Grant.

"In pursuit of sustainability of the programme, we shall also strive to standardise sanitation costs, align sanitation projects amongst the various government departments, and ensure that adequate budgets are set aside for the operations and maintenance of the infrastructure," she noted.

#### SA's bilateral research chair sees funding from Switzerland

Minister of Science and Technology, Naledi Pandor, launched the first bilateral research chair at the University of Cape Town (UCT).

She was joined by Swiss State Secretary for Education and Research, Dr Mauro Dell'Ambrogio and Swiss Ambassador to South Africa, Christian Meuwly.

This is the first time another country has been involved in funding a chair under the South African Research Chairs Initiative. According to the Department of Science and Technology (DST), this is expected to provide a model for other countries to participate in the department's flagship programme.

The joint research chair will focus on mitigating environmental health risk in South Africa, particularly in the communities that are most vulnerable to the effects of environmental exposure. The fiveyear Swiss-South Africa Global Environmental Health Research Chair will incorporate epidemiological, clinical, molecular-biological and social science approaches. Emphasis will be placed on putting the research findings to use through proactive engagements with communities.

Headed by Prof Mohamed Agiel Dalvie of UCT, work will include a focus on major drivers of environmental health, such as exposure to chemical and biological pollution and climate change, as well as the interactions between them. Human rights and environmental justice issues will also be addressed.

The research chair will be supported and managed by the National Research Foundation, the University of Basel, and the Swiss Tropical and Public Health Institute (TPH). The latter two organisations will fund the first year of the chair to the tune of R1.3-million. The remaining four years will be covered through funding arrangements with the Swiss School of Public Health, the Swiss TPH and the University of Basel. South Africa will contribute R1.5-million per annum for the fiveyear duration of the research chair.

Source: DST

#### Enhancing water quality in the Western Cape

The Department of Water and Sanitation supported 17 municipalities in the Western Cape to enhance water security and improve water quality through the Regional Bulk Infrastructure Grant programme.

This was highlighted during a Minister and Mayors (MinMay) meeting of the Western Cape Province meeting earlier this year attended by Minister of Water and Sanitation, Nomvula Mokonyane, in Worcester. The meeting follows an invitation by Western Cape MEC of Local Government, Environment and Development Planning, Anton Bredell, with an aim to share with both provincial and local government the national government's plans on water and sanitation as they relate to the province.

The Western Cape is one of the provinces most affected by rapid urbanisation. Population growth figures in the province have had a direct impact on the ability of government to deliver water and sanitation services. Speaking at the meeting, Mokonyane informed the MEC and mayors that the department has recently completed a study on the bulk water and sanitation infrastructure needs for the province for the next 15 to 20 years.



In this regard, Minister Mokonyane said 1 641 bulk water and sewerage infrastructure projects have been identified and require the pooling of resources, both capacity and financial resources between all three spheres of government to ensure delivery. "As the department we have identified three key priorities, namely, water resource management, solutions to service delivery challenges and the finalisation of a long-term master plan for South Africa on water and sanitation. Our engagements must direct us towards servicing un-serviced communities and maintaining our infrastructure adequately in serviced areas," the minister added.

## Freshwater biodiversity

#### New freshwater species discovered in Eastern Cape waters

After more than a hundred years of scientific discovery one would think that all is known about South Africa's freshwater fauna. Not so it seems as researchers from the South African Institute of Aquatic Biodiversity (SAIAB) report the discovery of a species of copepod, a type of crustacean.

The new species was discovered in the Eastern Cape, and has just been described. Despite Grahamstown being a hotspot for southern African aquatic biodiversity research, this little crustacean had managed to fly under the radar and avoid attention until now.

It was in June last year that research collaborators from SAIAB and Rhodes University collected copepods from a temporary (ephemeral) pond on a farm outside Grahamstown. Immediately suspecting that the species had not been described, samples were sent to Dr Eduardo Suárez-Morales, a freshwater copepod specialist based at El Colegio de la Frontera Sur in Mexico.

Copepods are tiny crustaceans that average two millimetres in length – about the thickness of a coin. They are an important ecological component in most aquatic habitats around the globe. They are a key trophic group often forming the intermediary link between the primary producers (algae) and secondary consumers such as fish, frogs and birds.

Scientists have studied copepods for centuries given their importance in the sustenance of many organisms higher up the food chain (such as commercial fish stocks), which ultimately link to the feeding and survival of humans. Scientists have found copepods living in waters around the globe.

They are found in fresh water and oceans from the surfaces to the depths. They're in frigid polar waters as well as hot springs, rivers, lakes, streams and caves. Conservatively, there are more than 10 000 species of recognised copepods, and they are the most abundant multi-celled animal on the planet, even more than insects.

This latest discovered copepod was identified as belonging to the group *Paradiaptomus* and the genus *Lovenula*. Prior to this discovery there were four species of *Lovenula* known, namely *L. falcifera, L. africana, L. excellens* Kiefer and *L. simplex* Kiefer. The new species was named *Lovenula raynerae*, after Dr Nancy Rayner for her outstanding contributions to the taxonomical knowledge of this particular group of copepods. (To read more about Dr Rayner and her work see the *Water Wheel* May/June 2014).



The male (lower left) and female (upper right) Lovenula raynerae sampled from the Grahamstown region. Note the eggs carried by the female. (Credit: SAIAB)

Most of the knowledge on the South African paradiaptomines gathered to date is from the Western Cape Province; relatively few records are from the Eastern Cape Province, which makes this discovery a real find.

Perhaps the most striking thing about *Lovenula raynerae* is its size (it is 4 to 5 mm long). This makes it one of the world's largest freshwater copepods, and it is likely the largest of all African copepods. Even more impressive is that this group of crustaceans produce eggs that are capable of withstanding dry conditions for extended periods of time.

The many sites around Grahamstown where the copepods have subsequently been sampled are all ephemeral and undergo periods when they dry out completely. Adults produce eggs before the ponds dry and these eggs settle into the sediment, which dries out completely, sometimes for years at a time. The dormant eggs then hatch out when the dry ponds fill with water once again following good rains.

#### What is the importance of this find?

The fact that such a conspicuous crustacean could be overlooked in one of Africa's aquatic research hotspots highlights the nation's current lack of invertebrate taxonomic expertise.

The knowledge generated by taxonomic findings such as this can have far reaching implications. Taking stock of the biodiversity present in our water bodies is of the utmost importance, especially given the increase in habitat degradation

#### Upfront

associated with development, water abstraction and other pressures placed on our scarce water resources.

In addition, it is impossible to understand the ecology of a system when scientists do not know the identity of the key organisms present. Only when the ecology of an environment is understood can researchers begin to quantify their ecosystem services and benefits to humans.

Ephemeral ponds are particularly vulnerable aquatic habitats which are difficult to protect given their dynamic nature and sensitivity to degradation during dry periods. Little information is available on these habitats in Africa despite their importance for many invertebrates, amphibians and water birds. Ephemeral ponds are among the most difficult freshwater ecosystems to map or restore primarily because of their unique hydrological and ecological properties.

The taxonomic and ecological work on ephemeral ponds of the region is ongoing with the primary investigators including Drs Ryan Wasserman and Olaf Weyl from SAIAB as well as Dr Tatenda Dalu and Prof William Froneman from the Department of Zoology and Entomology at Rhodes University. Further collaborative work with Dr Suárez-Morales and numerous other researchers and institutes is underway.



Dr Tatenda Dalu collecting water from one of the ephemeral ponds found to contain Lovenula raynerae, the new species of copepod.

The Eastern Cape contains numerous ephemeral ponds, but these environments are, for the most part, not even mapped let alone surveyed. There is much research potential for further taxonomic and ecological work in these environments.

 The discovery has been published in the journal *Crustaceana* 88(3) in 2015. To access this article, Visit: http://booksandjournals.brillonline.com/content/ journals/10.1163/15685403-00003416

Source: SAIAB

## Sanitation Indaba

#### Need for a sanitation revolution in South Africa, indaba delegates hear



Deputy President, Cyril Ramaphosa, delivering the opening address.

Nothing short of a sanitation revolution will lead to the provision of basic services to all South Africans.

These were the closing remarks of Minister of Water and Sanitation, Nomvula Mokonyane at the 2015 National Sanitation Indaba, held in Durban earlier this year. "To us the sanitation revolution should become a vehicle through which the objectives of the National Development Programme can be achieved in a more organic and integrated manner to realise a people-centric, radical strategic socio-economic transformation," she told delegates.

It is estimated that around 74% of households currently have access to safe sanitation in South Africa.

At the centre of this approach, according to Mokonyane, was the introduction of innovative and technologically advanced sanitation innovations that did not place additional stress on the country's scarce water resources, but rather brought about benefits at every step of the sanitation value chain.

## Upfront

The aim of the indaba, which attracted close to 500 delegates, was to showcase the practical demonstration of appropriate sanitation technologies suitable for implementation in South Africa; provide an engagement space for communities on the feasibility of technology implementation as it pertains to their contexts; pool ideas and experience to accelerate the adoption of sanitation technologies; and develop a roadmap for scaling-up of sanitation solutions in South Africa.

In his opening address, Deputy President, Cyril Ramaphosa, said that the restoration of people's dignity could not be achieved merely through budgetary allocations. "It cannot be achieved through a model of service provision in which the people who use the services remain passive recipients. It requires a deep sense of human solidarity and the full commitment and involvement of all social partners."

#### He added that

"To succeed, we must ensure that the solutions we pursue take into account local dynamics, our history, culture, geography and aspirations. All stakeholders must demonstrate a willingness to explore new sanitation delivery models. This must be done with careful planning and engagement with our communities."

The Deputy President commended the Department of Water and Sanitation for hosting the sanitation indaba. "It will go a long way in generating awareness, stimulating innovation and promoting greater usage. It will help challenge conventional motions about sanitation and dispel concerns about the efficacy and reliability of new technology," he said.

The indaba also included a site visit, led by minister Mokonyane, to several sanitation technology demonstration sites in and around eThekwini Municipality. Invited guests were encouraged to participate in a dialogue with community representatives on the feasibility of the technologies demonstrated and their scaling-up potential.



Executive Mayor of eThekwini Municipality, James Nxumalo, Minister of Water and Sanitation, Nomvula Mokonyane, Deputy President, Cyril Ramaphosa, and KwaZulu-Natal Premier, Edward Senzo Mchunu.



Delegates at the opening plenary of the Sanitation Indaba.



WRC Executive Manager, Jay Bhagwan, provided the framing presentation on sanitation technology assessment and evaluation.

## Global News

#### Misperceptions about math don't add up

A misperception – the belief that the ability to do difficult mathematics is something that you either have or don't – currently prevents many girls from opting for studies in physics, engineering, mathematics, or computer science (PEMC), suggests a new study.

What is positive is that schools, families and policy makers can help students to shift their (mis-)perceptions.

"Our results indicate the potential for more women to move into PEMC if they perceive their mathematics ability as strong, and open to growth," noted Lara Perez-Felkner, Assistant Professor of Higher Education and Sociology at Florida State University and co-author of the study.

Together with doctoral students Samantha Nix and Kirby Thomas, Perez-Felkner set out to determine how the choice of college major is influenced by gender and perceptions about ability. They focused on a group of 4 450 students from 750 high schools across the USA, following them over the period 2002-2012. The results were revealing.

Someone's self-perceived ability in mathematics, particular in difficult and challenging tasks, matters. While boys in high school tend to overrate their abilities in mathematics, girls tend to underrate them. But girls in 12th grade who reported being convinced that they could do the most difficult and challenging mathematics were an estimated 3.3 times more likely to take a PEMC major. This held true even after correcting for other factors, for example the science courses they took in high school, ethnicity, college entrance exam scores, and the selectivity of the college.

"Most people believe they can do some mathematics, such as splitting a dinner bill with friends, but fewer believe they can do mathematics they perceive as 'difficult'. Here we show that this belief



can influence the decision to specialise in mathematics-intensive fields, for both women and men," said Nix.

These findings have direct implications for policy. They suggest that interventions that foster a growth mindset of mathematical ability could be effective in raising the number of women that pursue a career in PEMC fields. This gender gap is bad news for everyone: science and society lose talent, while women miss out on potential careers with higher-than-average income and job stability.

The research, which was funded by a National Science Foundation grant, is published in the open-access journal *Frontiers in Psychology*.

## Handwashing slashes prevalence of intestinal worms - study

Encouraging handwashing can slash the prevalence of worm infections in children, a study in Ethiopia has found.

The six-month trial, published in *PLOS Medicine*, found that regularly cleaning the hands with soap reduced new infections by intestinal parasites by 68%. Weekly nail clipping reduced such infections by 49%. The researchers also found that handwashing lowered children's rates of anaemia.

Mahmud Abdulkader Mahmud, a researcher at Mekelle University in Ethiopia and the lead author of the study, says the results are important because of the prevalence of worm infections in the country. Intestinal worms are common in areas with poor sanitation and are thought to affect more than a billion people worldwide, causing diarrhoea, anaemia, stunted growth, malnutrition and learning problems. To read the full study, Visit: http://journals.plos.org/ plosmedicine/article?id=10.1371/journal.pmed.1001837



#### Wasting food? Prepare less to begin with



Food wasted means money (and water) wasted, which can be an expensive problem.

A new study from the Cornell Food and Brand Lab and the Getulio Vargas Foundation showed that the top causes of food waste include buying too much, preparing in abundance, unwillingness to consume leftovers, and improper food storage. "Fortunately, most of the factors that lead to food waste can easily be remedied by simple changes in food buying, preparing and storing," said lead author Gustavo Porpino.

For the study, in-home interviews were conducted with mothers of 20 lowermiddle class families from two suburbs of Sao Paulo, Brazil, to collect information about each family's shopping, cooking and disposal practices. Each family was also observed and photographed preparing, eating and disposing of food.

Based on interviews and in-home observation, Porpino and co-authors Dr Juracy Gomes Parente and Dr Brian Wansink determined that the practice that resulted in the most food waste was simply buying too much food, followed by preparing food in abundance. Leaving foods on dishes after meals or not saving leftovers, and decaying of prepared foods after long or inappropriate storage were also significant factors that resulted in disposal of foods.

Furthermore, the researchers found that strategies that are intended to save money, such as buying in bulk and shopping monthly (rather than more frequently), and cooking from scratch, actually contributed to the generation of food waste and ultimately did not result in savings.

"Teaching home cooks efficient meal and shopping planning strategies and proper food storage techniques can have a significant impact on reducing food waste and saving money," noted Porpino. The researchers suggest that food assistance programmes should take these findings into account and incorporate buying, cooking, and storage techniques in the nutrition education curriculum.

#### No more fish? Blame estuary pollution

A comprehensive study of a major Californian estuary has documented the links between nutrient runoff from coastal land use, the health of the estuary as a nursery for young fish, and the abundance of fish in an offshore commercial fishery.

The study, published in *Proceedings of the National Academy of Sciences*, focused on Elkhorn Slough and Monterey Bay on California's central coast.

Lead author, Brent Hughes, now a postdoctoral research fellow at the University of California, Santa Cruz (UCSC), began studying water quality in Elkhorn Slough as a UCSC graduate student. His earlier research showed that virtually every portion of the estuary is adversely affected by high nutrient levels, which stimulate the growth of algae, leading to low oxygen levels when the algae die and decompose.

The new study, based on data collected over the past 40 years, shows how low levels of oxygen (or hypoxia) affects fish populations in the estuary and beyond. "We found that declines in dissolved oxygen levels were consistently associated with declines in the diversity and abundance of fish in Elkhorn Slough," reported Hughes. "In particular, we saw a drop in certain species of fish that we know use the estuary as a nursery ground for juveniles."

English sole is one of the fish species that uses Elkhorn Slough as a nursery, and the study found that low oxygen was associated not only with fewer juveniles in the estuary, but also with later declines in the numbers of English sole caught in the commercial fishery and scientific fish surveys in Monterey Bay.

"From a conservation perspective, these findings suggest that improvements in land management and reductions in nutrient runoff could directly benefit estuaries and indirectly benefit offshore fisheries due to the important role of estuaries as nurseries for some species," said co-author Mary Gleason, lead marine scientist for The Nature Conservancy in California. She added that there are many opportunities for improving coastal land management practices. "This study demonstrates the important connections between land management and the health of our estuaries and oceans. We need to have better dialogue between land managers and ocean managers – between farmers and fishermen – to ensure that land use practices are being improved to reduce adverse effects of nutrients on coastal and marine ecosystems."





## New from the WRC





## Report No. TT 620/14 and TT 621/14

Self-regulation of the package plant/ small wastewater treatment works industry (PN Gaydon)

Small wastewater treatment works and package plants are a common form of service utility in sewage treatment for smaller communities, and are needed where sewage reticulation is absent due to inadequate space, difficult terrain, remoteness of areas in need and where standards set are higher than the effluent quality obtained from simple septic tank systems. This WRC project aimed to, among others, develop a framework of standards for small wastewater treatment technologies, which is practical for South Africa; assess and recommend how the framework of standards will work within the sector; develop a conceptual model with key criteria for an independent testing facility of the different technologies; and develop an accreditation system

for technologies by the various suppliers. The study resulted in the compilation of two reports. Volume 1 is titled *Development* of a proposed framework of standards, a conceptual model for a test facility and an accreditation system for each 'new' technology provided by suppliers. Volume 2 is titled *Development* of a 'green droplet' accreditation system.



#### Report No. TT 623/14

Integrated water quality management: A mindset change (L Boyd, O Malete, M Strydom and B Hart)

In 2008 the WRC initiated a project on integrated water quality management (IWQM); the aim of the project being to develop a conceptual model for aligning the management of the quality of water resources with that of drinking water quality in order to support the effective

management of water use in the interest of all water users. The management model was tested and subsequently refined in several management units in the Breede River catchment of the Western Cape. This report describes the IWQM model and the proposed way of rolling out the product to help water users and the Department of Water and Sanitation manage the implementation of the water use authorisations. The final report also includes a CD containing the system that can be used by water users.

#### Report No. 2383/1/14

#### Long-term forecasts of water usage for electricity generation: South Africa 2030 (A Pouris & GA Thopil)

South Africa's energy sector is currently in a state of flux as a result social, economic and environmental pressures. The need for more energy while sustaining the society, economy end environment simultaneously calls for more efficient management of resources. Water is a vital component in electricity generation. This study aimed to forecast water usage patterns associated with coal-based electricity generation. Forecasting of water consumption factors and total water consumption was done. Secondly, the project assessed scenarios of water usage patterns based on cooling technology and power plant type. Lastly, the project proposed projected water saving measures within distressed water management areas.







#### TT 616/14 (Volume I), TT 617/14 (Volume II) and TT 618/14 (Volume III)

Water industry footprints for industry in South Africa (Traci Reddy, Mao Amis, Hannah Baleta & Guy Pegram)

The WRC commissioned this project to explore the applicability of water footprints in South Africa. The purpose of the project was to understand how water footprints may contribute to sustainable development of water in South Africa primarily in the industrial sector, and to explore linkages between water and energy and the concept of water offsetting. Three volumes have been published as the final end-products of the project. Volume I (Literature Review) explores the international experience with water footprints and linkages to carbon footprints and offsetting. Volume II (Policy and Regulation) places the water footprinting tool in context with various other water resource management strategies, policies and tools. Volume III (Key Insights from South Africa Case Studies) summarises the key learnings from South African case studies and makes recommendations for the applicability of water footprinting in the corporate sector.

#### Report No. 1879/1/14

Investigation of smallholder food value chains: Evidence from Eastern Cape and KwaZulu-Natal provinces (B Muchara; B Letty; J McCosh; S Arowolo & AJ Adeyemo)

The purpose of this research project was to develop a better understanding of the environment in which emerging farmers operate, and their goals and aspirations for entering food value chains, as well as to ascertain the value chain in which they currently participate, or could potentially participate. The research project also aimed to analyse a number of irrigated and rainfed food value chains, with specific attention to water use, in order to identify mechanisms allowing subsistence and emerging farmers to participate in the mainstream economy, and to understand the current lack of participation. Lastly, the study was expected to generate knowledge on the role of water in rural communities and how it could be better managed and shared.



#### Report No. TT 608/14 (Volume I) and TT 609/14 (Volume II)

Review of available methods for the assessment of the ecological condition of wetlands in South Africa (DJ Ollis, HL Malan, JA Day, JL Ewart-Smith and NM Job)

The overall objective of this project was to conduct a gap analysis in wetland integrity assessment methods used in South Africa, and to develop a consolidated approach supported by a decision-

support system applicable in all types of wetlands. Volume I provides a review of available methods for the assessment of the ecological condition of wetlands in South Africa, while Volume II describes the development of a decision-support framework for wetlands assessment in South Africa, and a decision-support protocol for the rapid assessment of wetland ecological condition.



#### Report No. TT 614/14

Supporting better decisionmaking around coal mining in the Mpumalanga Highveld through the development of mapping tools and refinement of spatial data on wetlands (N Mbona, N Job, J Smith, J Nel, S Holness, S Memani & J Dini)

The Mpumalanga Highveld contains one of the highest concentrations of freshwater priority areas in the country. Opencast mining methods used to extract this coal frequently

have significant negative impacts on overlying water-related ecosystems and their constituent biodiversity. Among others, this project set out to ground-truth and refine the current data layers on the extent, distribution, condition and type of freshwater ecosystems in the Mpumalanga Highveld coal belt, in order to support informed and consistent decision-making by regulators in relation to the water-biodiversity-energy nexus. The revised layers were then incorporated into the atlas of highrisk freshwater ecosystems and guidelines for wetland offsets being developed by SANBI.

#### Report No. 2216/1/14

#### Pressure drop prediction for efficient sludge pipeline design (R Haldenwang; V Fester & R Kotzé)

Head loss data for wastewater treatment sludge is not available in standard design tables and is therefore mostly estimated. The more highly concentrated the sludge becomes, the more non-Newtonian the flow behaviour is and the higher the pressure drop or energy required to transport the sludge. There is still no widely accepted design correlation of sludge viscous properties as a function of solids content, causing frustration to design engineers who, in the absence of obtaining costly rheological data, have to make estimates which could compromise efficient design of pump and pipe systems. Among others, the main aims of this project were to expand the existing sludge database obtained from tube viscometer measurements to validate and improve the pressure drop-flow rate predictions developed and published previously and to test the application of an in-house UVP viscometer over a range of sludge concentrations.

#### Report No. 2061/1/14

#### Development of defensible regional climate change projections for adaptation and policy (B Hewitson; C Jack; L Coop; P Wolski; R Blamey and A Steynor)

This report addresses issues underlying the critical question: 'How do I assess the regional climate change information for my sector/location/decision/policy?'This is a nuanced issue, and within this context this report explores the multiplicity of approaches for developing robust regional understanding of climate change. In many respects this is a problem of ethics; the challenges only exist because of the choices humankind has made, and our future depends on the choices we will make – choices that are now, in part, predicated on projected climate change.



## New 'survival guide' for water research novices

The Water Research Commission (WRC) has launched a new 'survival guide' (**Report No. SP 81/15**) to assist post-graduate students working on WRC research projects to find their way in the academic landscape. The guide is the outcome of a research project that investigated the

experiences of students on Commission-funded projects. Research conducted in the education sphere has shown that the way in which students adapt and manage the 'transition phases' of their career is a determining factor in their success. Each transition comes with a new set of personal and professional requirements and expectations, which in turn require a new set of skills and mindsets by the students. Anecdotal evidence in the water research sector suggests that students often find these transitions difficult. They are deeply influential in a student's performance and integration into research project teams and institutions. This document aims to be an easy-to-use companion in a student's journey on a WRC project. It will help them identify where they are in the academic journey and the transitions they are encountering; what types of characters and personas they may encounter; and the expectations that will be placed on them as a project team member. The guide will also provide them with pointers for success provided by WRC-funded students who have previously participated in research. The guide includes stories about their experiences and key learnings from their journeys.

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## **Inland Fisheries**

## Making space for inland fishers



From late 1800 to mid-1900, inland fisheries received ample attention and support. Our country's first freshwater fisheries legislation was promulgated, and state hatcheries were created. Mostly, these stocked alien fish species for recreational purposes. The booming dam building era of the 1960s and 1970s saw large promotion of inland fisheries for commercial and livelihood purposes as part of the then-'homelands' development policy, but proved to be mostly non-viable due to the low prices of freshwater fish and the problematic concept of so-called development projects in former homelands.

Cut to over four decades later, in the post-1994 era, and inland fishery

management is largely at the beck and call of biodiversity conservation, and mostly falls under the mandate of provincial environmental management agencies. Since the original legislation has been drawn up, little attention has been given to the social and economic aspects of inland fisheries, and the livelihoods and rights of those dependent on it. This lack of policy to steer the allocation of rights is a problem that is causing underlying tensions between a growing small-scale subsistence or artisanal fisher group and the lucrative recreational fishing sector.

"Inland fisheries have been overlooked in legislation," says Prof Peter Britz of the Department of Ichthyology and All photographs courtesy Rhodes University

Fisheries at Rhodes University. Prof Britz was the project leader of a four-year, Water Research Commission (WRC) initiated project that aims to support the development of policy and institutional arrangements for inland fishery governance. The two-volume project report, called the Baseline and scoping study on the development and sustainable utilisation of storage dams for inland fisheries and their contribution to rural livelihoods (WRC Report nr. TT 615/1/14 and TT 615/2/14) was published earlier this year, and sets down the knowledge base that will inform new policy to address the problem. Prof Britz himself is advising on the policy process with the Department of Agriculture, Forestry and Fisheries (DAFF).

The project was executed by a trans-disciplinary team of researchers with fisheries and social science backgrounds from Rhodes University's Department of Ichthyology and Fisheries Science; the University of the Western Cape's Institute for Poverty, Land and Agrarian Studies (PLAAS) and the South African Institute for Aquatic Biodiversity (SAIAB).

#### Who are we talking about?

Small-scale fishing in rural communities is largely an informal activity with no established system for stakeholder representation or data gathering. Yet, on 77% of waterbodies surveyed, small-scale fishing for livelihood purposes was present. The activity is not rooted in indigenous fishing traditions, but rather an adaptive livelihood strategy to modern socio-economic circumstances. Most small-scale fishers were poor, but the role of fishing in their livelihood strategies was diverse, ranging from a part-time subsistence activity to a full-time artisanal occupation. Value chains for freshwater fish were short, with little evidence of value adding. The fish were generally sold fresh and informally, or consumed by the family. In certain localities a significant daily income could be generated to cover family living costs. Rural community members also practised recreational fishing, but fish caught was usually consumed.

Conflicts were present on some of the water bodies due to a lack of recognition of customary common pool rights, and the lack of capacity of communities to participate meaningfully in existing governance institutions. Community narratives around inland fishery use often reflected unrestituted legacies of dispossession and marginalisation from customary resource access arising from apartheid and colonial era dam building, forced removals and land dispossession. Formal statutory and customary or informal resource governance systems existed side by side on many water bodies with varying degrees of cooperation. While small-scale fishing was often tolerated by the authorities, and in some instances actively supported, the fishers remained vulnerable to prosecution, and their activities were often marginalised by other resource users and stakeholders. Artisanal gill netting by outsiders with vehicles and boats was seen by local communities as inequitable and unsustainable. Gill netting by local community members was tolerated on most water bodies, although some concerns were expressed about the sustainability of the method.

In comparison, the recreational angling sector has a substantial participation rate (estimated to be of the order of 1.5 million participants) and a significant economic impact associated with the tourism sector and angling services and supply value chains. This activity was recorded on 69% of dams surveyed during the study.

This popular activity on state dams is supported by the Department of Water Affairs (DWA) policy of promoting recreational activities on these dams. Yet, despite its economic impact and ability to create rural livelihoods and decent jobs, recreational angling is not recognised or represented as a fishery sub-sector by the DAFF.

To some degree, the challenges to creating a viable commercial market for inland fisheries have not changed since the 1960s and 1970s. "There has never been a big commercial market for freshwater fish, and there is still not a big economy attached to it," says Prof Britz.

In essence, the productivity of inland water is deemed too low to support large-scale commercial fisheries. Most formal commercial fisheries attempted on inland waters in recent years have proved non-viable due to the low yields and the low prices for the fish. According to Prof Britz, "the value of inland fisheries lies more in their value as a food security safety-net as well as the add-on services from recreational fishing."



A fisherman's catch at Lake Fundudzi, in Venda.



Fishermen at Zeekoevlei, in Cape Town, take a moment to smile for the camera.





Above: A recreational fisherman shows off his latest catch. About 1.5 million people participate in the South African recreational angling sector.

Left: Subsistence fishermen at the Pongolapoort Dam wall.

The researchers concluded that recreational, as well as smallscale subsistence and artisanal fishing for livelihoods purposes are the optimal forms of inland fishery utilisation for maximal socio-economic benefit.

#### What is the current situation?

Resource management plans for dams are predominantly designed for recreational fisheries, notes Prof Britz, "but, what about the social economic objectives?" Rural communities have been excluded from dams, and new policy and legislation should rectify this.

Such legislation should aim towards meeting two objectives, he says. The first is recognition of the right to fish for a livelihood. "Current policy is silent on that, and as a result, many are using recreational rules to fish, or fish illegally." The second is empowering people to improve their livelihood.

"Basically, it's all about rights," Prof Britz explains. There are people that are dependent on fishing from dams and rivers for their livelihood, and have been for generations, but they are often prevented from legally benefiting from the resource, while recreational fishers are allowed to reap benefits.

Mitigation of the current situation is marred with challenges and obstacles. Researchers found that any existing inland fisheries governance institutions are fragmented and incomplete. This is in stark contrast to South Africa's marine fisheries, which are governed by the Marine Living Resources Act. While the National Environmental Management Act (NEMA) provides for sustainable development and equity through access to natural resources, a policy specifically dealing with inland fisheries is lacking. Rather, fishing on inland waters is primarily governed as a recreational activity based on biodiversity considerations, while fishing for one's livelihood are not provided for at all. This is despite constitutional recognition of customary practices and the need for equity of access to natural resources.

According to the WRC report, the management mandate for inland fishery resources is currently delegated to the provincial environmental and nature conservation authorities, while the DWS and various authorities regulate activities on dams. The only specific legislative provisions governing the use of inland fish resources are rudimentary fishing 'effort control' rules prescribed in the provincial environmental acts and ordinances, which have their origin in pre-democratic era policies.

While small-scale fishers from local communities are generally regarded as having a legitimate claim to fish, in the absence of a supporting rights-based governance framework, their activities are usually illegal, unmanaged and often unsustainable. This has led to growing conflicts between water users on a number of impoundments.

According to the study report, the equitable and sustainable use of South Africa's inland fish resources requires fundamental reform of the very rudimentary existing inland fishery governance arrangements. The researchers further concluded that the governance reform process should be led by the DAFF, due to its primary resource sector development mandate which now includes inland fisheries.

Following the start of the WRC study in question and the emphasising of the plight of inland fishers, the DAFF announced in 2012 that it would create an inland fisheries policy and programme.

#### The way forward

The policy will be drafted in alignment with the constitution, as well as best-practice international principles for sustainable fishing, such as those set up by the Food and Agricultural Organisation of the United Nations, notes Prof Britz.

Stakeholders from all sectors involved will then be called upon to participate in the process before a policy is synthesised. Issues such as inequity, capacity building and training and even public-private partnerships will have to be taken into consideration. After this, actual interventions such as legislation, licensing and management plans will have to be put in place.

"You have to design governance arrangements for each dam and bring the stakeholders into the management plan. We need to think how to design it to be fair and achieve the goals, and get the buy-in from the recreational users."

Issues that have been raised at stakeholder meeting include concerns around any damage to the recreational fishing industry should fishing for livelihoods be formalised. Yet, Prof Britz is at pains to point out that there will be participation from all stakeholders allowed before any policy is drafted. Furthermore, he is mindful to point out that such legislation should not be in lieu of recreational anglers, but that access to that value chain could rather help create decent jobs and food security in rural areas.

Food security is understood to be 'means of access to a secure supply of nutritional food' so this can either be producing or harvesting food oneself or a secure job which provides the means. Thus decent jobs in recreational angling or small scale fishing value chains can provide food security. The policy would need to look at the best way to achieve this, he says. "The huge economy attached to recreational fishing cannot be compromised."

The DAFF is planning to have a policy gazetted by this time next year.



To obtain a copy of the final reports, Scoping study on the development and sustainable utilisation of inland fisheries in South Africa, Volume 1: Research Report (**Report No. TT 615/1/14**) and/or Volume 2: Case Studies of Small-Scale Inland Fisheries (**Report No. TT 615/2/14**) contact Publications at Tel: +27 (0) 12 330-0340; Fax: +27 (0) 12 331-2565, Email: orders@wrc.org.za or Visit: www.wrc.org.za to download an electronic copy.

## Conclusions and recommendations of the WRC inland fisheries project:

- 1. DAFF is the lead agent for inland fisheries. The DAFF should promote cooperative governance arrangements with other departments and public sector agencies with mandates relevant to inland fisheries governance.
- 2. Policy and legislation. Policy and legislation to implement the DAFF inland fishery mandate should be developed, and be aligned with DAFF policies such as the Growth and Development Plan 2011- 2030, Zero Hunger, and Marine Small-scale Fisheries Policy.
- 3. Non-industrial fishery. Inland fisheries are non-industrial and the sector is made up of mainly recreational, subsistence and small-scale commercial fishing activity. This user profile will shape management and governance approaches.
- 4. Developmental Approach. Due to the context of rural poverty, inland fishery governance requires development interventions to address issues of equity and capacity in order for communities to realise livelihood opportunities based on inland fisheries.
- 5. Equity and Rural livelihoods. Legal recognition of the use of inland fisheries for socio-economic benefit and the support of rural livelihoods is required. Inland fishery policy must take into account the historical inequity in access to inland fisheries and promote development interventions that empower disadvantaged rural communities.
- 6. Co-management. Each dam is unique in terms of land and water rights, economic opportunities, production potential and stakeholder composition, so specific local management arrangements are required. Cooperative governance arrangements and institutions for co-management are thus essential to inland fishery development and management.
- 7. Precautionary approach. A constraint to promoting inland fisheries on most South African water bodies is the lack of knowledge about the productivity and sustainability of the resource, and the potential impact on indigenous species biodiversity. A precautionary approach to resource exploitation should be adopted. Research surveys and stock assessments will be required to address resource information gaps and develop fishery management plans.
- 8. Training needs. Government managers require training in inland fishery management and should be provided with a "toolbox" of management resources and skills to address the situation on specific water bodies.
- 9. Value chain approach. Inland fishery policy needs to be based on a value chain approach in order to maximize the socio-economic benefits. The recreational fishing value chain is the most economically valuable component of inland fisheries, and subsistence fishing plays a vital food security role. Public sector interventions that enhance the value of fish to local communities should thus be promoted; for example, equity of access to fishery resources for rural communities and capacity building to participate in all levels of the associated value chains.

## Indigenous knowledge systems

### What can we learn from Karoo farmers about coping with drought?



Drought is an ever-present threat to the agricultural sector, and is likely to increase in some areas due to high climatic variability and change. What coping strategies can be gleaned from Karoo farmers, who are accustomed to dealing with dry conditions? A Water Research Commission (WRC) project set out to document their knowledge. Article by Sue Matthews.

The 2009 to 2011 drought in the Central Karoo and Southern Cape caused such severe water shortages in some towns that emergency measures had to be implemented. More than 70 new boreholes were drilled, four desalination plants constructed, and innovative solutions for water reclamation put into effect (see the Water Wheel, May/June 2015). In Beaufort West, water 'loadshedding' was introduced as a rationing measure, at least five million litres of tanker water were trucked in, and a nationally broadcast publicity campaign brought donations of bottled water pouring in.

More than R570-million was made available for disaster response, and R495-million of this was used to improve urban water supply infrastructure. But what about the vast areas beyond the towns, where people earn their living from the land? Less than 13.5% of the funding was allocated for drought aid to the agricultural sector, mainly in the form of fodder relief, and that didn't start until February 2011.

Farmers were forced to cope with the situation as best they could, and many of them had prior experience of drought to

draw upon in finding ways to limit their losses. Their knowledge could surely help others in similar situations, and is particularly pertinent in light of the predicted increase in droughts in some areas due to high climatic variability and change.

A recently completed WRC project by researchers from the Cape Peninsula University of Technology (CPUT) sought to identify and capture Karoo farmers' coping practices that might inform future drought adaptation and risk management strategies. The project focused on the municipalities of Beaufort West and Prince Albert in the Central Karoo District, and Oudtshoorn in the Eden District. It involved consultation with 101 farmers and seven extension and Landcare officers, who helped identify farmers from the subsistence, smallholder and commercial groupings.

People cultivating small patches of land behind buildings were considered to be subsistence farmers, but those involved in the project were all teachers or community members who had planted vegetable gardens to benefit others. For example, a nurse began planting vegetables 20 years ago to provide supplementary nutrition for mothers of premature babies, but over the years the project had grown into a crèche, and the vegetables are now used to feed the children as well as vulnerable members of the community.

Three types of smallholder farmers were identified. While typical smallholders own about two hectares of land and may lease additional land, in the Zoar community seven farmers practice small livestock farming as a group. Each farmer owns up to 80 goats but land, water and three permanently employed herders are shared between them. Then there are the emerging farmers who have benefitted from the government land reform programme. The eight who took part in the WRC project were granted 3 700 hectares of land, on which they rear 200 Angora goats for mohair and 300 sheep for mutton on a communal basis. Having only started farming in 2010, they could certainly learn from other farmers' experience, although they have received some training and technical assistance.

The commercial farmers were successors of family farms that had been in existence since the 1800s. Most were producing fruit such as olives, apricots and prunes for export, or meat for the local market. Due to the decline in ostrich production following the avian influenza outbreak, livestock farmers had become more reliant on sheep and goats in recent times.

In days gone by, many Karoo farmers owned another farm in a wetter area, such as the Free State, and moved their livestock between them on a seasonal basis. This provided some resilience against drought – in fact, the government gave farmers train subsidies to move livestock to unaffected areas during the Karoo's long drought in the 1960s. Those who couldn't afford other farms or transport costs destocked their land instead. This was designed as part of the coping strategies during uncertainty periods.

Nowadays, some farmers still resort to early marketing of livestock to reduce the herd size, while maintaining a breeding

stock until drought conditions abate. The first course of action, though, is to conserve grazing land by rotating livestock between fenced camps. In addition, most commercial farmers routinely grow lucerne as dry-season fodder, and store enough as hay or silage to see them through a few years of drought. If all else fails, they may purchase fodder from neighbours or from further afield, or even buy pellets specifically formulated as drought feed.

During the 2009-2011 drought, the provincial Department of Agriculture approved fodder relief vouchers for more than 2 400 farms, primarily in the Eden District. Interestingly, most Karoo farmers interviewed for the project did not consider it a drought because their farming systems were not seriously affected. These farmers did not consider it as drought but perceived it as part of the normal dry spell or cycle that they experienced throughout the year.

"The Karoo is a naturally dry area, so drought for them is something that occurs over a longer time period – three or four years," explains Principal Researcher of the project, Dr Bongani Ncube. "The Eden District is a wetter area, where the farmers are less able to cope with dry periods."

This is mainly because Karoo farmers at all levels have adapted over the long term to dry conditions. They have focussed on drought-resistant species, such as Angora goats, ostrich or springbok, and some resort to hardy saltbush, prickly pear, agave or mesquite as fodder. They depend on boreholes to tap groundwater, but have also become adept at harvesting rainwater from mountain slopes.

Farmers from the Oudtshoorn area of the Eden District typically have some livestock, but crop production is comparatively more important. Many commercial farmers have adopted modern technology such as soil-water probes, irrigation scheduling software and drip-irrigation systems, although sprinkler systems are still widely used.



Many farmers routinely grow lucerne as dry-season fodder, and store enough as hay or silage to see them through a few years of drought.



Hardy livestock species, such as Angora goats, are a common sight in the Karoo.

# *"Karoo farmers at all levels have adapted over the long term to dry conditions."*

Subsistence farmers who cannot afford such expensive technology use perforated tin cans or plastic bottles to supply water to root systems, and compost with manure or kitchen waste to improve soil fertility. Of course, farmers at all levels understand the importance of retaining water in the soil by mulching, and using shade-netting where practical. During droughts, they would rely more heavily on boreholes, focus on one crop, or plant and irrigate smaller areas. Fruit farmers might supply just enough water to keep their trees alive but not producing fruit, and concentrate on livestock instead.

Towards the end of the project, a workshop was held to present the findings to the provincial Department of Agriculture and its extension, Landcare and disaster risk management officers. When asked for their opinion on which strategies research should focus upon in order to improve the adaptive capacity of farmers against drought, they identified the following as priorities:

- Planting more drought-resistant fodder plant species
- Research on drought-resistant crops
- Conservation Agriculture
- Long-term early warning and accurate weather/climate forecasts.

The first two are self-explanatory, but Conservation Agriculture is essentially an approach that discourages ploughing, and would therefore be applicable primarily to crop farmers. It advocates minimising soil disturbance, ensuring permanent organic soil cover, and mixing and rotating crops.

Soil tillage, or ploughing, leads to a reduction over the long term of organic matter, which not only provides nutrients for the crop but is also vital for stabilising soil structure. Without ploughing, crop residues remain on the soil surface and provide a protective layer of mulch that reduces erosion and evaporation. Surface runoff decreases while soil porosity increases thanks to the burrowing activity of earthworms and other soil biota, both of which enhance infiltration. Another means of increasing infiltration is basin tillage, a Conservation Agriculture practice promoted to subsistence and smallholder farmers, in which crops are planted in shallow basins dug with hand-held hoes.



Principal Researcher of the WRC project, Dr Bongani Ncube, is both a lecturer within Cape Peninsula University of Technology's Department of Agriculture, and a researcher in CPUT's Centre for Water and Sanitation Research.

With regard to the last bullet, there are already a number of seasonal forecasts available for the region, and their accuracy will no doubt improve as knowledge of ocean-atmosphere interactions increase and predictive models are fine-tuned. Of course, effective dissemination and communication of early warnings is a challenge, but of more concern perhaps is uptake of the information. It takes a leap of faith for farmers to adjust their plans months in advance and risk economic hardship on the basis of a less than convincing probability for drought.

The South African Weather Service (SAWS) distributes the official Seasonal Climate Watch, which incorporates long-range forecasts by SAWS, the CSIR and the International Research Institute for Climate and Society. The early warning unit within the Department of Agriculture, Forestry and Fisheries' climate change and disaster management directorate uses this information for the National Agro-meteorological Committee (NAC) Advisory. This is relevant for the following five months and includes suggested strategies for rainfed crop production, irrigation farming, stock farming and grazing. The provincial Department of Agriculture then summarises information relevant to the Western Cape in a monthly Agri-Outlook.

Taking a more proactive approach, the Western Cape's agricultural and environmental authorities are also engaged in a collaborative endeavour with UCT's African Climate and Development Initiative, called the Smart Agriculture for Climate Resilience (SmartAgri) project, which aims to increase the agricultural sector's ability to cope with shifts in weather patterns due to climate change. It is underpinned by the concept of climate-smart agriculture introduced by the FAO in 2010, which promotes environmentally and socially sustainable ways of increasing agricultural productivity in order to meet food security and development goals, while also adapting to climate change and contributing to mitigation by reducing greenhouse gas emissions.

Furthermore, the disaster risk management section within the provincial Department of Agriculture is in the process of compiling a new Drought Plan for the Western Cape, and the research team for the WRC project is part of the group of stakeholders that will provide input on the plan. Dr Ncube reports that they have forged close working relationships within the Department of Agriculture, from the Chief Director: Farmer Support and Development, to district managers and extension officers, and the project findings were very well received at feedback sessions. She was subsequently invited to give a presentation to a group of farmers in the Central Karoo District at Beaufort West in early June 2015.

"Feedback sessions were a fantastic opportunity, because when we presented the project findings to the extension officers they kept saying that the farmers could really use this information, particularly the new farmers who don't really know how to cope with the dry environment of the Karoo," she says. "The farmers at the Beaufort West presentation were indeed very receptive, and said they wanted more of this type of information."

"We certainly intend to do some follow-up studies, and will explore the possibilities of doing a research project in conjunction with the disaster risk management officials".

The CPUT team, together with the WRC and the Western Cape Provincial Department of Agriculture are planning to have two information sessions at different study sites before the end of September as part of information sharing and knowledge exchange with government officials and farmers.

To access the report, *Insights into indigenous coping strategies to drought for adaptation in Agriculture: A Karoo scenario* (**WRC Report No. 2084/1/15**) contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; Email: orders@wrc.org.za or Visit: www.wrc.org.za to download an electronic copy.



All Karoo farmers understand the importance of retaining moisture in the soil by mulching, and using shadenetting where practical.





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## Water and the consumer

## Changing our behaviour – How to get the most from your water bill



Even where there is a clear economic incentive through the tariff to reduce water consumption, if the consumer remains unaware of what is reasonable consumption, it will not result in the necessary behaviour change in being proactive about fixing leaks, reducing excessive garden watering and getting teenagers to take shorter showers. Paying for water and not using it effectively is the same as putting it on the braai and cooking it without any meat, argues Richard Holden.



Even where consumers receive regular, accurate monthly bills, this holds true, which means where there is inaccurate or nonexistent billing and credit control from a municipality (sadly a common occurrence) there is no hope of trying to change consumer behaviour.

Using the City of Johannesburg as an example, the current tariff for domestic use, on a monthly read meter, is depicted in Table 1. This results in an increasing cost of water as shown in Table 2.

## Table 1: The current water tariff for domestic use in Johannesburg, on a monthly read meter

Tariff	Per kilolitre, per erf, per month (excl VAT)
First 6 kl	R0.00
In excess of 6 kl up to 10 kl	R6.18
In excess of 10 kl up to 15 kl	R9.97
In excess of 15 kl up to 20 kl	R14.06
In excess of 20 kl up to 30 kl	R18.46
In excess of 30 kl up to 40 kl	R19.67
In excess of 40 kl	R24.21

#### Table 2: Cost of water

Cost of water	Excl VAT
6 kl	R0.00
10 kl	R24.72
15 kl	R74.57
20 kl	R215.17
30 kl	R399.77
40 kl	R596.47
50 kl	R838.57

From the author's own experience it could be argued that in a house of four people, a consumption of between 10–15 kilolitres per month is not unreasonable.

While it might be argued that an amount of R30.73 plus VAT is unreasonably low and not cost-reflective, when the sanitation charge is taken into account, which is a fixed monthly charge, the amount appears reasonable for the package of services provided. In fact, the structure of the tariffs is such that if all other things are equal, there is a clear incentive to opt for a sanitation solution that can be managed on site by the household. The question that needs to be asked is why, when there is such a clear financial incentive to conserve water, is it so common to come across households using in excess of 50 kl per month, and why do they not take action to find the cause and rectify the problem? Since often this is water that the consumer is paying for, but not using in any effective manner, it is the equivalent of putting R6 000 of your money annually on the braai, burning it and not even having cooked meat to enjoy afterwards.

This situation is due to a combination of bad practice at households, municipalities and within the plumbing profession. The key to unlocking this problem is empowerment at household level to get consumers to proactively manage their water consumption.

#### Five cases in point

Although the general principle is that any leak before the water meter is for the municipal account and anything after is for your account, Lunghisa's experience shows that this is not always the case.

Lunghisa's water bill suddenly tripled, but she swore that there were no leaks in the house. She went to the municipality to complain, but they simply sent her away saying that it was her meter reading. After another month of high water bills Lunghisa then noticed that water was appearing on the surface next to her drive, which was a sure sign that there was a leak in the pipe. The problem, however, was a leak in the meter box between the meter dial and the stop cock. So, although the water had passed the dial, it was still in the municipality's property. Armed with that information Lunghisa was then able to go back to the municipality, and get them to come out and replace the meter.

This can be contrasted with another colleague who also received a high water bill and swore that it could not be his as the meter was covered and had not been read. He had already lodged a complaint with the municipality before requesting assistance from the author. The first check, which involved uncovering the meter and checking the reading against the bill, showed that it was, in fact, his bill.

A quick check also revealed that the outside toilet was overflowing, and then he remembered leaving the hose on overnight, an act which can easily result in 10 kl flowing through the meter. Now put yourself in the municipality's position of trying to distinguish between legitimate queries and where basic checks have not been done.

Toilets overflowing is a very common problem, and in a third colleague's house it was found that all three toilets were overflowing. In fact, one could clearly hear the toilets when entering the house, but the colleague was oblivious to what the sound meant.

A fourth colleague was more aware and realised that his water consumption was too high, so he called out a plumber to try

#### Looking for leaks

#### Step 1: Basic steps

- 1. In an average home with no excessive garden watering or big pool to top up, consumption (including teenagers who stand in the shower for hours) should be between 3-4 m3 per person per month (divide total consumption on your bill by the number of people in the house).
- 2. Open the meter and check that the meter reading corresponds, or almost corresponds, to that on your bill. If it is widely out then there is probably a billing problem. If they almost correspond then it is a problem after the dial.
- 3. Check that the meter number (if you can see it) is the same as that on your bill. If it doesn't correspond, then there is a problem at the municipality.
- 4. If you have a new meter where the shutoff valve is incorporated in the meter box, turn it off. If the meter still runs then the leak is in the meter box and the municipality must replace the meter and refund above the average consumption.

#### Step 2: Checking for leaks

- Go through the house and check that taps are not dripping or toilets overflowing (very common). On old toilets it is easy to see if the rubber seal is old and hard. With modern mechanisms, lift the ball valve (or equivalent) and if the toilet still fills, the seal needs replacing – this will cost R5 assuming you know how to do it.
- 2. If not leaking taps or toilets, then it is leaking pipes, or behaviour (that you don't know about). Do the following checks:
- a. Look for any damp patches on the walls, particularly where you know there are pipes going to taps, toilets etc.
- b. Put your ear to the pipes where they come out of the ground/walls etc., and listen for any sounds (make sure dripping taps and toilets are fixed first). If you can hear sounds then you probably have a leak. The louder the sound the closer you are to the leak, where at least you can direct your efforts to this general area.
- c. If still nothing, then the leak is probably between the meter and the house, or it is behaviour. Leave the shutoff valve at the meter open and close the valve (if you have one) where it goes into the house. If the meter still runs then it is somewhere along the pipe. If the pipe is easily accessible (i.e. not buried under paving etc.) then by opening up every few metres you will eventually find the leak. If the pipe is inaccessible at that point it is often cheaper to lay a completely new pipe than trying to find a leak.
- d. If you close off and the meter does not run, then it is probably behavioural. Monitor the meter every day at the same time, and if there is a spike in the daily reading, investigate. A hosepipe left on all day has been known to cause a 10 m<sup>3</sup> jump in readings.

and find the leak. The recommendation from the plumber was to replace the entire pipe from the meter to the house – a distance of over 40 m. The cost was so high that he balked at this.

However, when the author was at the house he noticed what appeared to be an overflow pipe continually running; according to this colleague, the plumber was unable to trace where it was coming from. It took five seconds to work out it was the overflow from an old-fashioned toilet, and fix it. Thus armed with the knowledge to trace leaks the colleague was also able to pinpoint a second leak outside the kitchen door. In the end the result was a much reduced water bill without the need to replace the entire pipe.

The fifth example is a complex comprising 60 units in Montgomery Park, Johannesburg. The author was approached after the monthly bill in the complex went from R33 000 per month (R550 per household) to R96 000 per month (R1 600 per household). Here it was clear that the reticulation was rotten, as the unmetered fire reticulation (nonrevenue water to Johannesburg Water) had already required extensive repairs.

One year later neither Johannesburg Water nor the complex had taken any action, resulting in major losses for both of them. Given the demographics in the complex, a monthly bill of R5 000 per month would have been reasonable, meaning that the complex over the past 12 months had paid out over R1 million for water that had passed through its meter, but that had not been used for any constructive purpose whatsoever.

#### Lessons drawn

A number of lessons can be drawn from this last example.

Firstly, if the households in the complex were happy to pay R550 per month, then increasing tariffs to reflect the true cost of supplying water should not be difficult if it is matched with a reduced consumption (i.e. the monthly bill remains the same). Once consumers understand what a reasonable consumption is and how they can trace leaks themselves, it will empower them in their dealings with the municipality and plumbers. From the municipality's point of view, empowered consumers will assist them in providing an efficient and effective service.

Secondly, in order to reduce abstraction from the resource, both non-revenue (the fire reticulation) and revenue water (the domestic reticulation) need to be targeted. In the case of the Vaal River System a 15% reduction is the target and it can be concluded, from all the above examples, that this can easily be achieved.

Thirdly, a more proactive approach needs to be taken by the water service providers in helping consumers fix the leaks. The problem in the complex was that the rules governing the Body Corporate did not allow them to borrow the money to fix the problem. However, if a special tariff could be introduced by Johannesburg Water for the period it takes to pay back the cost of fixing the problem (in the above case combining both the fire and domestic reticulation into a single reticulation with individual household metering) then everyone would gain.

However, all the other examples show that, at a household level, once the household was aware of how to resolve the problem it was relatively easy to fix, either themselves or with their municipality. The primary driver in all cases was money. So, for behaviour change to happen, municipalities must accurately bill their consumers on a monthly basis, enforce credit control and, if possible, notify the consumer when consumption patterns change.

How many more R6 000 braais must South Africans have before they can enjoy the meat?

This article first appeared in the April 2015 edition of *Civil Engineering*, as one of a series of articles on the economic pricing of services. Thanks to the South African Institution of Civil Engineering for permission to republish the article.



Water consumption in an average home should be between 3-4 m<sup>3</sup> per person per month.



A hosepipe left on all day can cause a 10 m<sup>3</sup> jump in water meter readings.

# WATERWHEEL

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The Water Wheel

## **Riparian vegetation**

## Shedding light on Mapungubwe's disappearing riverine forest

A team of scientists are working to uncover the mysteries of Mapungubwe's disappearing riverine forest. Article by Petro Kotzé.



Riparian vegetation is roughly described as the vegetation that hugs waterways such as rivers. Because rivers flow through a variety of landscapes the vegetation itself varies greatly, but in general, the different types are unified by the fact that they are in the way of waterthirsty developments such as agriculture, and suffer the consequences once water is abstracted upstream.

As a result, already scarce riparian vegetation has become endangered. Most of the Orange River's riparian vegetation, for example, has been classified as critically endangered because it has been lost due to irrigation farming along the river, reduced flow by dams that have been constructed in the river's upper reaches and the impact of alien plants and livestock.

This 'green' part of the river ecosystem fulfils various essential functions. It helps to regulate the river flow by absorbing water into its root systems and physically blocking water to moderate the impact of flooding on the surrounding areas. It has been reported that it filters pollutants from the surrounding land to prevent it from entering the river. It's also an important habitat for many plants and animals.

The Limpopo is another river of which huge swaths of riparian vegetation have

been lost and that which remains in the rich alluvial deposits along the river is of prime conservation importance. Of particular interest is a stretch of vegetation close to where the Limpopo meets the Shashe River and the point where South Africa, Botswana and Zimbabwe meet. Referred to as the Greefswald riparian forest, it is protected by the Mapungubwe National Park and World Heritage Site.

Greefswald was once a true, closedcanopy forest, dominated by giant Fever trees, Ana trees, Leadwoods, Sycamore Figs and Nyala trees. It is still considered to be Lowveld Riverine Forest and is one of the few remaining examples of this rare vegetation type to be found in South Africa.

The forest was also included on the National List of Threatened Ecosystems produced by the South African National Biodiversity Institute in 2011. Yet, the past two decades or so have been a tumultuous time for this piece of forest. From 428 trees tagged for measurement in 1990 in a 40 ha area, a quarter were lost 15 years later. As a consequence, the forest has been transformed to open woodland. The trees are still declining steadily, with little signs of regeneration, says Dr Tony Swemmer, manager of the Ndlovu Node of the South African **Environmental Observation Network** (SAEON).

Various factors are thought to be responsible for the decline of the forest, but the relative importance of each of these, in the past and currently, is not clear.

## What has happened to the forest?

Colin Eversor

In 1990, 428 canopy trees in a 40 ha area of the Greefswald canopy forest were mapped and tagged, and measured for their size, degree of creeper infestation, and canopy volume by Prof Tim O'Connor (currently the Observation Science Specialist for SAEON). That was done to monitor any impact of water abstraction for the Venetia mine, which commenced the following year.

The De Beers Venetia Mine is an opencast kimberlite operation, located approximately 80 km west of Musina and some 500 km north of Johannesburg, and is South Africa's largest producer of diamonds. The mine abstracts the majority of its water from a wellfield in highly porous alluvial deposit located on Greefswald (which was once a farm). Water is also abstracted from another alluvial aquifer downstream (the Schroda wellfield) when necessary.

During the 1991/2 season, the country experienced one of the worst droughts on record, during which flow of the Limpopo River ceased completely during the summer – something that had never been recorded before. Then, the February 2000 flood took place – one of the largest on historical record. After that, the Mapungubwe National Park was created, and elephants returned to the southern banks of the Limpopo. Prof O'Connor returned 15 years later to find that "the individual and cumulative impact of different agents on canopy trees was quite dramatic". He used various lines of evidence to ascribe mortality of an individual tree to a set of mortality agents, which included drought, water abstraction, flood, wind-throw, salinisation, elephant use, lightning, creepers, and ring-barking by porcupine.

In 2005, no trees had been killed through ring barking by elephants, although about half the trees had been debarked to a degree. Drought accounted for 76% of trees lost, and the 2000 flood for an additional 21%. Creepers were implicated in the drought-related death of nearly half of the trees which succumbed to drought. It could not be determined directly whether a tree had succumbed to natural drought or deprivation of water supply by abstraction, but tree mortality within the area of abstraction was approximately one-and-a-half times that of what it was without.

Sycamore figs had lined the banks of much of the 4.4 km river front that was sampled, but a large proportion of these were lost downstream when the

#### What it While the forest h a smalle Berry, is An unex stable is Swemm reason to forest sp on river Forest F suppler someth

Launched in March under the auspices of SAEON, a Cosmic Ray Probe was installed to monitor the soil moisture and the amount of water inside the canopy of trees at Greefswald.

What is the fever berry up to?

While the largest trees in the Greefswald forest have declined by over 25%, a smaller species, the Forest Fever Berry, is doing uncomfortably well. An unexpected by-product of the stable isotope research by Nippert and Swemmer has revealed a potential reason for this - while the rest of the forest species show primary reliance on river water or groundwater, the Forest Fever Berry appears to be supplementing its water needs with something quite distinct - dew. Research on the drivers of the forest community change in Mapungubwe continues, with an emphasis on seasonal and among-year dynamics of source water use as well as elaborating on the potentially unique characteristics of fever berry in this system.

2000 flood eroded up to 60 m of bank for a distance of at least 1.6 km. Prof O'Connor found no evidence in support of mortality by ingress of saline water, porcupine, or wind-throw, although the latter had reduced the size of a number of trees.

By 2007 the first deaths resulting from elephant ring-barking had started to occur, and more were likely to follow as the overall extent of debarking had increased. The species most targeted were Maroelas, Fever trees, and Sycamore figs. By 2014, Swemmer found that over 97% of all large trees in the forest had suffered some form of elephant damage. Elephants, however, had also severed many of the creeper connections with infested trees, thereby reducing this stress on remaining canopy plants.

Each of the main canopy species experienced a different degree of impact from the different agents of mortality. Species such as Apple-leaf, Weeping Boerbean, and Nyala trees had been less affected by most agents, such that woodland composition was now becoming dominated by these seemingly more drought-tolerant species.

Prof O'Connor found that initial concern about the impact of water abstraction on riparian forest was ultimately dwarfed by the impacts of severe drought in combination with climber infestation, a mega-flood, and elephants.

Yet, since that time, the trees' decline has continued, even though the dramatic flood and drought events were not repeated (the January 2013 flooding of the Limpopo River had little impact). "We have returned to monitor the status of the tall trees, and tree recruitment, every year for the last four years and found that the loss of tall trees is continuing," says Swemmer. In addition to ongoing mortality of large, adult trees, there is little or no recruitment of juvenile trees of the forest species.

To work out why, new research has been initiated by SAEON in the forest. This includes comparing mortality rates with other patches of forest where there is no water abstraction (in collaboration with SANParks), a stable isotope study to identify sources of water used by the forest trees (in collaboration with Kansas State University) and the deployment of a state-of-the-art sensor to monitor soil water content.

A similar number of forest trees were tagged in another part of Mapungubwe National Park by scientists from South African National Parks (SANParks), and together with SAEON these are now monitored annually in the same way the Greefswald trees are. These data reveal similarly high levels of mortality in recent years for one species, but not for others (see figure).

This reiterates the complexity of the situation, indicating different causes of mortality for different species. While the elephant impacts are likely to be the cause of the very high rates of mortality of Fever trees, it is appears that other factor, such as water stress, are contributing to higher rates of mortality in Greefswald relative to areas upstream, notes Swemmer.

He adds that impact of elephants has probably become unnaturally high in recent years. This is due to the combination of the effects of numerous waterholes in game reserves in nearby Botswana, and a channelling effect of the extensive agriculture found either side of the park, which forces a large population to utilize a relatively narrow stretch of forest during the dry season.

In order to better understand the role of water stress in driving mortality, Swemmer collaborated with Dr Jesse Nippert (from Kansas State University, USA) to identify exactly where the remaining forest trees are getting their water from. Dr Nippert is a specialist in the use of stable isotopes to study plant water use, and by analysing water in the stems of trees of each of the dominant species, was able to determine whether



Elephants are likely to be the cause of the very high rates of mortality of Fever trees, but not the only one.



The last number of years has been a tumultuous time for riverine plants next to the Limpopo River.

trees were using primarily water derived from the river (via the alluvial aquifer) or from rain (via shallow soil water).

Final results from this study are still pending, but preliminary indications are that the trees use a combination of sources, and that those currently showing the highest mortality (Fever Trees and Ana Trees) do make use of the alluvial aquifer during the dry season. Whether water abstraction by Venetia is causing a shortage of water for these trees cannot yet be confirmed.

## Old questions, new technology

Launched in March under the auspices of SAEON, a Cosmic Ray Probe was installed to monitor the soil moisture and the amount of water inside the canopy of trees at Greefswald. In addition, "heat pulse velocity" probes inserted into the trunks of few selected trees are being used monitor the rate at which water moves up these trees, from the roots to the canopies. Reduced rates of flow indicate water stress, and together with the soil moisture data from the Cosmic Ray Probe, these data be used to design an early warning system for detecting tree water stress.

The project is progressing "very well" and they already have data available to be viewed, says SAEON hydrometeorologist, Prof Colin Everson. It is a collaborative effort supported by grants from USAID-National Science Foundation (PEER), and National Research Foundation (NRF-RISP) while the physiological and ecological work is supported by De Beers, WWF and SANParks. Prof Everson, together with Trenton Franz from the University of Nebraska-Lincoln, are now in the process of testing the technology, originally developed for agriculture.

The device sends data in real time to the Cosmic-ray Soil Moisture Observing System (COSMOS) server (http://cosmos. hwr.arizona.edu/), which makes use of a novel, non-contact technique capable of measuring average soil water content over a footprint of 34 hectares (a circle with a radius of 330 m) and depths up to 50cm. The aim of the project is to fill a serious handicap that currently exists in soil moisture measurements, namely the mismatch between limited point measurements using contact methods and remote sensing estimates over large areas (100 km<sup>2</sup> - 2500 km<sup>2</sup>) without thick vegetation cover.

The method involves measuring lowenergy cosmic-ray neutrons above the ground, whose intensity is conversely correlated with soil water content and with water in any form above the ground level (the contributions of subsurface ad surface waters are distinguishable). The data is freely available in near real-time over the internet, and includes neutron counts in two energy bands, soil water content, snow pack water equivalent (and possible also vegetation water equivalent), temperature, pressure and relative humidity.

"The benefit of the new method is that the process of gathering data is automated," explains Prof Everson. Currently, there is a monthly gap in between *in situ* measurements of plant water stress and people have to travel from Pretoria to do it.

The team are combining this data with in-field monitoring of the vegetation to determine if and when the forest is being affected by water stress caused by ground water pumping for the De Beers Venetia mine. This is particularly important as the mine will be applying for a new water license to meet its water needs.

The project is set to continue until November, so the researchers will only have a data set from one season. Still, if deemed successful, it might continue to run and be expanded to other areas in South Africa. While it is yet to be confirmed, riparian vegetation of the Orange River might be a suitable target.

#### The future of the forest

"We are not sure exactly when and how the Greefswald forest formed," says Swemmer. He explains that it could well have been a result of the rise of Mapungubwe civilisation in the area between 1000 and 1300AD – perhaps soldiers and farmers kept elephants out of the riverine areas, and together with the higher rainfall of that time, this may have enabled the current trees to establish.

As such, it is not clear what the natural ecological state of the area is. While research findings will help to elucidate the ecological processes causing the recent decline of the forest, SANParks (the current custodians of the area) will have to decide whether to attempt to restore the forest, in order to preserve the significant biodiversity it contains, or allow contemporary ecological processes to operate freely, even if that means a complete absence of tall riparian trees.



Heat pulse velocity probes inserted into the trunks of trees are being used monitor the rate at which water moves up these trees.



A rich and advanced civilisation lived in Mapungubwe between 1000 and 1300AD. Remnants are now on display at the Mapungubwe Interpretive Centre.

## Irrigation and food safety

## Ensuring the safety of our food from farm to market

In the last few years a number of outbreaks of foodborne diseases worldwide have highlighted the *importance of increased* awareness around the *importance of food safety* in the supply chain. A new study, funded by the Water **Research** Commission (WRC) and led by the University of Pretoria, has examined food safety in the South African food value chain. Article by Dr Erika du Plessis and Prof Lise Korsten.

There are various pathogens associated with foodborne disease outbreaks, including *E.coli, Salmonella* spp., Hepatitis A and protozoa (Giardia and Cryptosporidium), among others. The contamination of fresh produce with these pathogens can happen at any stage in the food value chain, from pre-harvest production to post-harvest packaging and processing.

Potential sources of contamination at the pre-harvest level are soil, faeces, irrigation water, reconstituted fungicides and insecticides, dust, insects and manure. At the post-harvest level the produce could be contaminated by contact with asymptomatic human carriers, harvesting equipment, transport containers, surfaces in processing factories and polluted process water.

Many farmers in South Africa rely on surface water sources to irrigate their produce. Unfortunately, the quality of some of these water resources has been compromised due to factors such as the proximity of growing informal settlements without adequate sanitation and stormwater services, ill-functioning wastewater treatment plants and intensified urbanisation.

The pollution of irrigation water resources not only poses a risk for the consumers of fresh produce, but also to farmers, especially those supplying the burgeoning export market. In 2013 (the latest figure available from the Department of Agriculture, Forestry and Fisheries or DAFF), around 2.6 million tons of vegetables were produced in South Africa (excluding potatoes), 4% of which was exported. Outbreaks of foodborne disease in recent years highlight the potential economic impact on farmers. In May 2011, for example, there was an outbreak of *E.coli* in the European Union. The outbreak was initially pinned on cucumbers and tomatoes produced in Spain, but was later linked to a German sprout producer.

The resultant misdiagnosis caused €225-million losses per week for Spanish vegetable producers. This incident highlights the potential economic impact of such outbreaks on an industry. Therefore, ensuring microbiological safety of both local and exported fresh produce is essential in ensuring public health, and keeping the fresh produce industry vibrant through adequate food safety assurance systems based on scientific data.

To investigate the extent of this problem, a solicited research project was funded by the WRC and co-funded by DAFF. The resultant reports, *Quantitative Investigation into the Link between Irrigation Water Quality and Food Safety: Volumes I-IV* (**WRC Report No. 1773/1-4/12**), are available from the WRC. (To read more about this project, read the article, 'There's something in the water - Research highlights dangers of pollution to irrigation' in the *Water Wheel* January-February 2014)

The conclusion from this study was that microorganisms on fresh produce surfaces were present as a result of transfer from contaminated irrigation water. Subsequently, the WRC initiated a follow-up project (**project no. K5/1875/4**) to investigate the potential link between irrigation water and fresh produce (fruit and vegetables) at as well as after harvest from the farming to the processing stages of production up to the point of purchase. The study is led by the departments of Plant Science and Food Sciences at the University of Pretoria, with inputs from the Department of Microbiology at the University of KwaZulu-Natal. Baseline microbiological information (bacteria, fungi, yeasts and/ or viruses) was obtained for irrigation and processing water and fresh produce sampled from farms, processing factories, fresh produce markets, street vendors and retailers. In addition, the prevalence of human pathogenic microorganisms was determined using a combination of optimised basic and molecular methods.

Produce samples were collected from five provinces in South Africa i.e. Gauteng, North West, Limpopo, Kwa-Zulu Natal and the Western Cape. Since the presence of pathogens on different crops has been reported and its prevalence has been linked to the surface characteristics (hairy, smooth, etc.), a broad range of fresh produce including vegetables, frozen vegetables, whole fruit and minimally processed fruit were analysed.

#### Main findings of the study

Microbial analysis confirmed the results of the previous study, with *E.coli* levels in irrigation water sources often exceeding the maximum allowable levels of 1 000 cfu/100 ml as stipulated by the World Health Organisation and the Department of Water and Sanitation. Further, genotyping of Hepatitis A virus and Sapovirus strains isolated from irrigation water samples showed that they were of human origin. This indicates that human faeces was the most likely source of the contamination. This poses a clear health risk to consumers.

Although agricultural chemicals can be used in the supply chain to reduce foodborne-pathogen-associated hazards, it is important to be aware of the fact that some of the chemicals can support pathogen growth. This should be taken into consideration in a risk assessment study for each crop and spray programme.

The researchers next investigated the extent of microbial contamination on irrigation raw fresh produce up to harvest, at harvest as well as after harvest. The microbial levels on crop



#### Relative importance of major vegetables types, based on gross value of production 2012/2013

"It is now a scientific fact that waterborne pathogens can enter plants through growth cracks, roots and stomata and internalise in plants similar to plant pathogens."



Generally the percentage of pathogens present on vegetable products was found to be higher when compared to fruit samples.

surfaces were found to often exceed the microbiological specification guidelines of the Department of Health (DoH) for ready-to-eat fresh fruit and vegetables. However, levels were generally found to be lower further down the supply chain.

It is important to note that the DoH guidelines provide specifications only for ready-to-eat fresh produce and these values should therefore not be directly used in production or even processing systems. One of the objectives of the current project is to develop realistic specifications for harvested and packed produce.

The microorganism levels on plant surfaces depended on the type of crop planted and growth stage. *Staphylococcus aureus, Listeria* spp., *Salmonella* spp., *E. coli*, viruses and protozoa were isolated from fresh produce at certain stages along the supply chain, but not from the beginning to the end of the chain. It was evident that the fresh produce with the highest microbial contamination was leafy vegetables (lettuce and spinach). The study also for the first time in South Africa reported the presence of norovirus of swine origin on fruit – in this case strawberries.

Researchers found a strong correlation between irrigation water sources and pathogen presence on the fresh produce. In addition, the *E.coli* isolates from irrigation water sources were often found to be resistant to multiple antibiotics (up to 42%).

Generally the percentage of pathogens present on vegetable products was higher when compared to fruit samples. This is an important finding since it confirms the previous reports that fruit in general is by its very nature and production system a lower risk product than vegetables which are mostly grown in closer proximity to the ground.

Environmental conditions, such as exposure to high temperatures, UV and minimal processing (chlorine washing, hydrogen peroxide treatment, cooking, blanching, microwaving and freezing) steps contribute to a reduction in microorganism numbers including human pathogenic bacteria tested for. It was concluded that the effectivity of minimal processing steps to reduce microbiological surface contamination levels is crop dependant due to the surface characteristics i.e. smooth versus hairy and/or rough. A combination of minimal processing methods led to the greatest reduction of pathogen numbers.

In this study the effect of irrigation methods (drip, sprinkler and flood) on the surface contamination of fresh produce was determined to be crop dependant and results showed that drip irrigation had the lowest risk of microbiological contamination for both tomatoes and lettuce. This is in agreement with previous reports in the literature that irrigation methods that do not allow for direct contact of the contaminated water with the edible regions of the plant facilitate a lower potential risk of contamination.

#### Special issues investigated

Biofilms have been reported to form rapidly in irrigation water storage facilities, irrigation pipes and wash-bath water in the packhouse or processing factory. Waterborne pathogens may be incorporated in these biofilms and shed over time during irrigation which constitutes a constant source of inoculum. This study highlighted the importance of implementing effective biofilm management systems in all water contact surfaces.

Internalisation studies confirmed the ability of pathogens to attach, survive, internalise and increase in plant tissue. It is now a scientific fact that waterborne pathogens can enter plants through growth cracks, roots and stomata and internalise in plants similar to plant pathogens. The ability of a pathogen to attach, colonise and survive on plant surfaces differ depending on the specific cultivar. However, it should be noted that in our and other studies pathogen concentrations higher than natural pathogen concentrations in the field were used. Although this situation in nature seldom applies, it shows the potential for contamination under extreme conditions such as flooding with highly contaminated water. Once internalised the pathogens are protected against the effect of minimal processing steps employed to promote food safety in the supply chain.

In the current study it was concluded that the accuracy of results can be correlated with sample size and test methods used. Sample size must be adequate to obtain a statistically validated result as far as pathogen presence/ absence is concerned. Incidence studies further provide a snapshot of contamination potential at a specific study site and on a specific crop at a particular time during the year. Therefore, caution should be exercised when drawing conclusions from any result based on biased sampling and sample size.

This study confirmed previous research results on the presence of human pathogenic bacteria in irrigation water, the potential transfer to fresh produce and importance of food safety management systems to limit foodborne pathogen presence in the fresh produce supply chain.

The study will be published later this year.



The study confirmed the results of an earlier WRC study, namely that there is a strong link between irrigation water quality and pathogens found on fresh food produce.



This study investigated pathogen levels on food produce throughout the supply chain.

## **Biodiversity protection**

## Partnering for fish protection in the Oorlogskloof River



Article by Peter Ramollo and Mandy Schumann.

The Oorlogskloof River originates in the Roggeveld Mountains in Calvinia, passes through the Oorlogskloof Nature Reserve and joins the Koebee River. The Koebee River flows into the Doring River, a tributary of the Olifants River.

The Oorlogskloof Nature Reserve section of the Oorlogskloof River is an important area for fish conservation. The Oorlogskloof River is one of the last sanctuaries for the endangered Clanwilliam Sandfish (*Labeo seeberi*), endangered Clanwilliam Sawfin (*Barbus serra*) and the vulnerable Clanwilliam yellowfish (*Labeobarbus capensis*) as well as genetically distinct Chubbyhead minnow (*Barbus anoplus*). The river serves as a biodiversity corridor linking the Oorlogskloof Nature Reserve to conservation areas in the Cederberg. The upstream activities of the Oorlogsklfoof River include commercial farming, mostly sheep and goats. The most significant alien tree invading the Oorlogskloof River above the reserve is the mesquite (*Prosopis spp*), followed by blue gum (*Eucalyptus spp*) and black wattle (*Acacia mearnsii*) trees.

To date, the only alien fish species recorded in the Oorlogskloof Nature Reserve section of the river is the banded tilapia (*Tilapia sparmannii*). These fish were introduced to the river via the upstream Nieuwoudtville municipal dam, which overflows into the Groen River, a tributary of the Oorlogskloof River. Downstream of the reserve, a natural barrier, consisting of large boulders, protects the reserve from invasion of bass, blue gill and other alien fish. In order to promote the conservation of the Fynbos regions freshwater rivers and endangered fish species, The Northern Cape Department of Environment and Nature Conservation has partnered with the Endangered Wildlife Trust and Cape Nature through the Cape Critical Rivers Project. The annual fish survey was conducted as part of the Cape Critical Rivers Project, which is assisting to implement the actions of the endangered Sandfish Biodiversity Species Management Plan.

The fish were sampled by using a seine net and some of the water variables were recorded including pH, total dissolved solids, salinity, temperature and electrical conductivity using a Prc water testing meter. The pool habitats sampled varied in size, depth and substrate. Dominance of the fish species at each site therefore varied as a result. Further analysis is needed to determine if there is a species preference for the different pool habitats.

Sawfin, Sandfish and banded tilapia were recorded throughout the sampled sites, until the natural barrier. Below the natural barrier, only banded tilapia, blue gill and bass were recorded. Clanwilliam yellowfish were only recorded at two of the 36 sites, however, they are difficult to catch with a seine net, so may be under represented. Although banded tilapia compete with indigenous fish for space and food, they have not been recorded eating indigenous fish. It is unknown at this stage what the competitive effect of the tilapia on the indigenous fish will be. It is feared that during particularly long dry years the reduced pool sizes and increase in the tilapias competitive affect could negatively effect the indigenous fish and make them more susceptible to parasites and diseases.

> "It is feared that during particularly long dry years the reduced pool sizes and increase in the tilapias competitive effect could negatively affect the indigenous fish and make them more susceptible to parasites and diseases."

The Oorlogskloof River is protected by a steep gorge, so accessing it is a hard work. Participants in the survey need to be physical fit in order to hike in and out daily carrying drinking water, food and sampling equipment. Roughly 8 km is hiked daily along the river banks to locate the monitoring points. The survey takes five days and is conducted in March, so ambient temperatures are quite high.

Fortunately the pools offer cool relief and if one sits still for long enough, you are rewarded by schools of inquisitive indigenous fish which will nibble along exposed legs and feet. It is this lack of fear that has contributed to the indigenous fish being so vulnerable to the verocious predatory alien fish, introduced years ago for angling, and which have now invaded almost all the Fynbos rivers.

Through the annual monitoring of the critically important Oorlogskloof Nature Reserve fish population and improving awareness of the threats of alien fish, including moving any fish species between river systems, the first steps are being taken to reverse the threat of extinction for the indigenous fish species found here. The annual monitoring takes place at first week of March every year.



Sandfish were among the fish sampled.



The Oorlogskloof River offers a challenging working environment.



The Oorlogskloof River is protected by a steep gorge.

## Skills development

FETWater – Building the bridge between capacity building and sector sustainability

When developing capacity building and training programmes, aligning these programmes with sector occupational and professional requirements is key to sustainable skills development. Article by Dr John Zvimba,

Programme Manager for FETWater.

The lack of coordination of capacity building and training initiatives in the South African water sector has resulted in poor knowledge management, ineffective planning, duplication of effort and low return on investment. In addition, uncertainty over the link between qualifications and available career paths in the sector limits the uptake and thus the sustainability of capacity building initiatives.

The relevance and quality of capacity building and training programmes therefore remain questionable as the water sector has yet to develop appropriate mechanisms for standardisation and quality assurance. Currently there is a plethora of education and training programmes which lack currency and portability, with qualifications and certificates obtained often receiving no recognition with regard to career progression or skills enhancement.

One of the significant efforts in dealing with capacity building challenges in the South African water sector has been the introduction of the framework programme for research, education and training in the water sector (FETWater). The programme was originally developed as a response to a 1998 study by the then Department of Water Affairs & Forestry, UNESCO and the World Meteorological Organisation which revealed a marked lack of human resources and competencies in the local water sector.

This deficiency not only jeopardises the implementation of the National Water Act, but also potentially hampers the country's ability to conform with, and take advantage of, global trends in integrated water resource management. FETWater Phase I ran from 2002 to 2005, followed by FETWater Phase II which ran from 2007 to 2010, with more than a thousand professionals receiving training during Phase II of the programme. FETWater Phase III, which is running from 2014 to 2018, currently focuses on six thematic areas, with the major objective of achieving sustainability beyond 2018.

Although the previous FETWater training initiatives covered essential elements of capacity building for the sector, uptake has been limited. This is because the FETWater courses were not linked to sector skills planning and delivery systems for professional and career development.

In order to improve currency and sustainability of FETWater offerings in the capacity building environment, an occupationally-directed focus, aligned with professional body and Quality

# FET

Framework Programme for Research, Education and Training in the Water Sector

> Council for Trades and Occupations (QCTO) requirements, is imperative for course planning and registration. On this basis, presentations, discussions and deliberations at the FETWater Phase III National Planning Workshop held from 22-23 January 2015 called for closer links with Sector Education and Training Authority (SETA) and sector skills planning initiatives, highlighting the need for improved curriculum development and quality assurance protocols to ensure currency for occupational and professional development.

The National Planning Workshop therefore resolved that support be provided to each of the six networks for qualification development within the SETA and QCTO frameworks to ensure currency and sustainability of FETWater training initiatives. It was resolved that network capacity be developed to participate in, align and implement FETWater initiatives within the Water Institute of Southern Africa (WISA), QCTO and SETA environments, providing a foundation for network sustainability through ensuring that:

 Networks have qualification development facilitators that understand the QCTO process and are able to facilitate the development of occupational qualifications and continuing professional development

#### One of the significant efforts in dealing with capacity building challenges in the South African water sector has been the introduction of the framework programme for research, education and training in the water sector (FETWater).

(CPD) courses in areas of critical and scarce skills with a community of expert practitioners;

- Expert practitioners in networks work with WISA to ensure standards are maintained by participating in the Assurance Quality Partner (AQP) processes and professionalisation processes; and
- Networks participate in skills planning with the Water and Sanitation Sector Leadership Group (WSSLG) and SETA to ensure uptake and funding of FETWater initiatives as part of the National Water Resources Strategy 2.

In order to consolidate the alignment requirements for FETWater Phase III network activities, a follow-up workshop, the FETWater Phase III Network Coordinators – WSSLG Partnership Workshop, was held on 14 April 2015, further reiterating and resolving that:

 Networks identify occupational clusters which are endorsed by WISA, SETA and QCTO for Development Quality Partner support;

- Network activities be properly aligned to WSSLG and QCTO processes with regard to milestones and scheduling;
- Network learner Qualification Development Facilitator and expert practitioners develop and register qualifications;
- Networks develop learning material, participate in AQP processes and implement qualification in accordance with the QCTO delivery system; and
- Networks market offerings and receive funding from SETA mandatory and discretionary grants to sustain capacity building and training initiatives and continue working with WISA on professional development and quality assurance mandates.

As a way of supporting the FETWater Phase III networks to achieve the above requirements for their CB&T moving forward, a series of workshops on network capacity development and linkages will be facilitated. These workshops will include, inter alia:

- Workshop on critical and scarce skills

   SETA Skills Planning process & DQP status;
- Learner QDF induction workshop SETA QDF meets networks to plan the development of occupational qualifications;
- WISA workshop on AQP roles and implementation process – WISA outlines AQP business plan and CEP roles in accreditation and certification;
- Upscaling and sustainability workshop – confirming network training delivery mechanisms, targets, accreditation and certification; and
- WISA conference workshop and roadshow regarding targets and grants with regions – grant applications to SETAs.

It is hoped that such a partnership framework for FETWater Phase III with SETAs, WISA and WSSLG will significantly leverage funding, expertise and activities for the benefit of FETWater, thereby providing the necessary foundation for programme sustainability beyond 2018.



Students during a FETWater field visit.



Delegates at a FETWater workshop earlier this year.

#### Water Kidz





Estuaries can sometimes be cut off from the sea in drier years.

As the world celebrated World Oceans Day on 8 June, we take a look at those nurseries of the seas, our estuaries.



The United Nations celebrates the world's oceans every year with a special day. This year, the theme for World Oceans Day was 'Healthy oceans, healthy planet'. Few people realise that estuaries are an important component of ocean health, as they serve as nurseries and refuge areas for many oceanic species.

The Knysna estuary is one of the largest estuarine systems of its kind in South Africa.

#### What is an estuary?

An estuary is a partially enclosed body of water along the coast where freshwater from rivers and streams meets and mixes with salt water from the ocean. Estuaries and the lands surrounding them are places of transition from land to sea and freshwater to salt water. Although influenced by the tides, they are protected from the full force of ocean waves, winds, and storms by such land forms as barrier islands or peninsulas.

Estuarine environments are among the most productive on earth, creating more organic matter each year than comparably-sized areas of forest, grassland, or agricultural land. The tidal, sheltered waters of estuaries also support unique communities of plants and animals especially adapted for life at the margin of the sea.

Many different habitat types are found in and around estuaries, including shallow open waters, freshwater and salt marshes, swamps, sandy beaches, mud and sand flats, rocky shores, oyster reefs, mangrove forests, river deltas, tidal pools, and seagrasses.

#### **Helpful websites**

www.worldoceansday.org

https://www.capetown.gov.za/en/CSRM/Documents/Taking\_care\_of\_our\_estuaries.pdf http://sacoast.ioisa.org.za/docs/media/brochure%20estuaries&lagoons.pdf



Many South African estuaries are used for recreational and subsistence fishing.

#### The importance of estuaries

Estuaries provide us with a suite of resources, benefits, and services. Estuaries provide places for recreational activities, scientific study, and aesthetic enjoyment. Estuaries are an irreplaceable natural resource that must be managed carefully for the mutual benefit of all who enjoy and depend on them.

Thousands of species of birds, mammals, fish, and other wildlife depend on estuarine habitats as places to live, feed, and reproduce. And many marine organisms, including most commercially-important species of fish, depend on estuaries at some point during their development. Because they are biologically productive, estuaries provide ideal areas for migratory birds to rest and re-fuel during their long journeys.

Because many species of fish and wildlife rely on the sheltered waters of estuaries as protected spawning places, estuaries are known as the nurseries of the sea. At least two-thirds of all the fish consumed worldwide are dependent on estuaries, which provide spawning, nursery and feeding grounds.

Estuaries have important commercial value and their resources provide economic benefits for tourism, fisheries, and recreational activities. The protected coastal waters of estuaries also support important public infrastructure, serving as harbours and ports vital for shipping and transportation. Estuaries also perform other valuable services. Water draining from uplands carries sediments, nutrients, and other pollutants to estuaries. As the water flows through wetlands such as swamps and salt marshes, much of the sediments and pollutants are filtered out. This filtration process creates cleaner and clearer water, which benefits both people and marine life.

Estuaries and their surrounding wetlands are also buffer zones. Coastal wetlands, such as coral reefs, mangroves, tidal flats, deltas and estuaries like ours, can limit the damaging effects of storm surges and tidal waves by acting as a physical barrier that reduces the water's height and speed. Wetland vegetation such as saltmarshes can literally bind the shoreline together and reduce erosion from storms and freak tides.



*Estuaries are home to many species of birds and plants.* 

#### **Estuaries in South Africa**

There are about 250 estuaries along the South African coastline. These can be categorised into five different types. These five types include estuarine bays (making up 1% of estuaries in South Africa), permanently open systems (18%), river mouths (5%), estuarine lakes (3%) and temporarily closed systems (73%).

As many as 100 species of fish are completely or partially dependent on South African estuaries, while up to 400 species frequent estuaries at some time of their lives. Common estuarine fish species include the mullet, spotted grunter, steenbras, stumpnose and kob. Other smaller species are the sand goby, glassies, needlefish and pipefish.

Unfortunately as with other water bodies, humans also threaten estuaries with their activities. As estuaries are where sea and river meet, they are also the place where various different natural forces interact and are therefore particularly vulnerable to harm through man's actions.

Furthermore, compared to many other countries South Africa's estuaries are small in size and few in number, and many of these have already been extensively impacted on. A major threat to our estuaries is the deterioration of their catchment areas through, for example, the damming of rivers and removal of water, which results in a reduced input of freshwater as well as altered river flow patterns. This results in flood events (which are vital to the health of our estuaries) becoming smaller and less frequent, which in turn reduces the scouring of sediment from the estuary, so that it is not flushed out properly and could start to silt up. Over time the estuaries, starved of water, become shallower and more saline.

Properties alongside estuaries are very popular development sites with high property values. However, development here means that the important shallow waters on the estuary margins are often lost when filled in with rubble and soil, or converted into marinas. Estuary mouths then have to be breached prematurely to prevent flooding of buildings situated too close to the water. This dramatically affects the dynamic nature of the estuary.

Other negative impacts arise from agricultural practices that may lead to soil erosion; roads or railways which intrude into floodplains; the 'fixing' of mouths with retaining walls; various forms of pollution from land or sea; and dredging to remove excess sediment build-up.

## A special South African estuarine creature – the Knysna seahorse

The Knysna seahorse is unique in that it is the only seahorse species in the world to be found only in estuaries. It is also an endangered species. To stop itself from being washed away by tidal currents, the seahorse coils its tail around aquatic plants like eelgras.

Apart from the seahorse, the Knysna estuary, being the largest estuarine system in the warm temperate region of South Africa, supports the largest number of birds of any estuarine system between Cape Agulhas and Durban Bay. Apart from the resident waterbird population, the Knysna Estuary also plays host to Curlew Sandpipers, which travel 15 000 km from Siberia seasonally. These birds arrive in South Africa on their annual migration around September, and generally return to Siberia in April.

The answer to the many threats that face our estuaries lies in finding a balance between the often conflicting interests of developers and conservationists. With the growth of human populations and the increase in urbanisation and industrial activities, the development of certain estuarine areas is both inevitable and necessary for the economic well-being of our country. Protection of these areas is also essential if the natural resources provided by estuaries, and the quality of human life near them, is to be maintained.

# Science minister launches sanitation technology in the Eastern Cape

Minister of Science and Technology, Naledi Pandor, has officially launched a low-flush sanitation system at St Marks Primary School at Cofimvaba, in the Eastern Cape.

The alternative sanitation technology, developed through funding from the Water Research Commission (WRC), uses significantly less water than conventional flush toilets. In addition, there is no complex sewerage and wastewater treatment network required, making this technology cheaper to install, operate and maintain. The technology has been successfully tested in home and school settings in KwaZulu-Natal and the Western Cape.

"People do not accept ventilated improved pit toilets as an adequate [sanitation] solution," notes Jay Bhagwan, WRC Executive Manager for Water Use and Waste Management.

"Most people aspire to full flush toilets, however, we are a water-stressed country and waterborne sanitation will not serve our water security in the future. We need to continue to be innovative."



Hlengiwe Cele from the WRC (in red) explaining the low-flush sanitation technology to Minister of Science and Technology, Naledi Pandor, while Stuart Woolley (WRC) and Imraan Patel (Department of Science and Technology) look on.



The minister and her entourage taking a closer look at the technology.



The children were encouraged to decorate their new toilets.

## 4<sup>th</sup> YWP-ZA Biennial and 1<sup>st</sup> African YWP Conference

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The Water Reasearch 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.

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