



The National Water Resources Strategy – navigating a fork in the road

The South African water community is once again seized with a critical national conversation. The draft second National Water Resources Strategy (NWRS-2) has been gazetted for public comment. The discussions have been vibrant, informative and passionate in many forums, including parliament, where the parliamentary portfolio committee for water and the environment hosted four days of public hearings over the last two weeks of October.

Why is the conversation so important? Why have the levels of engagement already been so high? After all this isn't a law or a new policy – it's just a five-year strategy demanded as compliance requirement of the National Water Act after all – or is it?

In several ways for many this is, sixteen years later, the follow-up to the national dialogue led by former Water Affairs Minister, Kader Asmal,

that led to the promulgation of the National Water Act in 1998. The review that preceded the development of NWRS-2 is also timely. After eighteen years in this fledgling democracy characterised by continuous positive economic growth, concomitant population growth, tremendous extension of basic services to the previously marginalised majority, all of which has been very water intensive – we have stretched our resources. Of course, much of this has been done in a very carbon-intensive paradigm. Add to this mix the fact that some 200 years of poor mining and other industrial practices have finally come home to roost in the most dramatic way with the poisoning of our vital aquifers through acid mine drainage and related factors and the picture that emerges points in one direction. The burden on our water ecosystems has reached Gaia's

limits and the Earth Mother is expressing her displeasure.

We are at a fork in the road and the choices we make now will not only affect the next five years until NWRS-3, but the next 50 years as the knock-on effects will be profound. During the discourse thus far the notion of a South Africa in water crisis has been raised in many quarters and was, in fact, the lead question in a DWA sponsored *Mail and Guardian* Critical Thinkers Forum in October. Several countries that have lower natural water reserves and lower precipitation patterns when compared with us are not spoken about in the same terms – why? These countries and regions have been able to ensure their water security when many with much higher rainfall figures and much better storage options have not based on four factors.

Firstly, the water management in these more successful areas are informed by high levels of science, technology and innovation. The decision-making is highly informed and water is a critical upfront consideration in any development plan. The second is good, well maintained infrastructure. The third is the development and availability of large pools of skilled talent to plan, develop, operate and maintain the water management system at all levels. The fourth, and in many cases, differentiating factor in most systems is water use behaviours across the spectrum from large industry and agriculture to the individual at household level. Like electricity usage individual behaviour changes have an accumulative and almost immediate impact on the system both in positive and negative directions. What is different about water from electricity are the reuse possibilities.



That single litre of water can be used several times with the proper system design.

The WRC and the South African water research community has over the past forty years developed a knowledge repository that ensure that the NWRS-2 and its successors have a natural R&D partner as

illustrated in the figure on p. 4. The WRC believes strongly that a NWRS-2 that is developed further and implemented with strong scientific support, good social dynamics analysis and innovative technological and systems solutions is the pathway to ensure a wetter South Africa with much more comfortable

levels of water security than the current trajectories extrapolate. This will also create the virtuous cycle of R&D informing and ensuring good water management decisions and practice which in turn organises for the further development of water research and the growth of the water research community

through higher R&D investment and partnership in South Africa. The attainment of the goals that matter – equity of access, and water as an enabler of growth and sustainable development depends on us achieving this with a strong partnership between science and the economy.

WRC research that informs and supports the NWRS-2

Governance and regulation

The WRC has played a critical role in advising and supporting government in its national water policies and laws, from studies in the areas of environmental flows and water services delivery to integrated catchment management and transboundary water governance. Following the promulgation of the National Water Act (NWA) in 1998, the research focus has shifted to implementation and improvement of South Africa's groundbreaking water laws and policies.

The marked shift from central management of resources to a more localised scale is critical to the main founding concepts of integrated water resource management (IWRM) as set out in the NWA. The defined management boundary based on watershed boundaries is another fundamental provision in IWRM as a concept. The WRC supports research on tools and methodologies for IWRM decision support, which aims to provide strategic intervention for new policy development and to improve the understanding regarding the effective functioning of institutional structures for implementing IWRM through institutional governance and reforms; compliance and enforcement; pricing and financing of IWRM, transboundary water resources and future scenarios.

Water resource assessment & planning

WRC research in this area is focused on developing a scientific understanding of the hydrological cycle (and inter-linkages) to promote systematic water assessment and planning. This includes the development of practical tools for a better understanding of the variability of the quantity and quality of water available for use and development in South Africa. The latest Water Resources Study (WR2012) is the sixth comprehensive national water resources assessment being undertaken in South Africa. WR2012 will assist decision makers at all levels of government to make informed choices about all policies concerning South Africa's water resources. In related projects, the WRC has funded the development of an approach to integrate water resources and water services management tools, as well as a generic integrated framework, which can incorporate relevant and appropriate water management tools that are used in both water resources and water services. Another WRC-funded study developed a framework for uncertainty assessments in water resources availability analyses in South Africa, its main objective being to contribute to the incorporation of uncertainty assessments in water resource decision making in South Africa.

Water resources protection

Reliable supply of good quality water is required for the health, environmental, social and economic wellbeing of the country. Much of WRC-funded research focuses on protecting the country's water resources by reducing the quantity of

harmful materials reaching the water resources, within a broader framework for all uses. Broadly, research in this area focuses on the generation of knowledge and understanding of the catchment processes and land use activities that influence the quality and quantity, negatively or positively, of the water resources. Another main research thrust of research for the WRC addresses the management of ecosystems for sustainable utilisation for the provision of ecosystem benefits that people depend on. Central to this is the need to manage the social and economic requirements of society from ecosystems and the implementation of policy and legislation.

Climate change

As a result of its naturally variable climate and scarce water resources, South Africa is particularly vulnerable to the potential effects of climate change. The WRC plays an important role in national as well as global efforts to resolve challenges associated with the impact of climate change of water resources. The organisation first recognised the potential impacts of climate change on the water resources of South Africa in the mid-1980s. Adaptation that reduces South Africa's vulnerability to climate change is critical. Accordingly, the WRC focuses on developing understanding of global climate change and hydro-climatic variability impacts, crafting methodologies for vulnerability assessments and development of appropriate adaptation options and solutions at various scales. WRC research also includes developing appropriate quantitative understanding, tools and strategies for managing the impacts of climate variability and change as well as human interventions on the hydrological cycle and related water resources.

Equitable water use

The issues of gender and equity are key elements of the required change in the way we manage water. WRC-funded research focuses on ensuring that historically marginalised water users can actively participate on catchment management decisions while gaining sustainable access to at least basic water services. Among others, the WRC has funded studies aimed at investigating practical steps that have been taken by the government to create an enabling environment for women's participation in the management committees of water user associations. In addition, a study aimed at deriving principles that would enhance the impact of gender mainstreaming in the water services sector has been completed. Another recent study has focused on the achievement of redress of race and gender inequities as water allocation reform is implemented. It aimed to derive lessons from international experience and also from initial implementation of various processes and to make this information available for improving immediate interventions.



American bird takes first trip ever to Africa

Local bird enthusiasts flocked to the Rietvlei section of Cape Town's Table Bay Nature Reserve in October for the rare sighting of a black skimmer (*Rynchops niger*), the first to be spotted in Africa.

According to the City of Cape Town, the bird was first thought to be an African skimmer when it was first sighted on 4 October. Later bird expert, Trevor Hardaker, together with Reserve Manager Cliff Dorse, confirmed it to be a black skimmer.

Since it was first seen, many other birders have come out to see it. The gate staff extended the operating hours from sunrise to sunset to accommodate birders

from as far as Gauteng who wanted to come and see the bird. According to Koos Retief, Area Manager: Milnerton Area, this is arguably by far the rarest sighting ever recorded at Rietvlei.

The black skimmer is a tern-like seabird that is native to the Americas. It breeds in North and South America. Northern populations usually winter in the warmer waters of the Caribbean and the Pacific coasts, while the South American populations make only shorter movements in response to annual floods. The bird is known for "skimming" the water surface in low flight as it searches for food.

Calling all young water professionals

Young water professionals (YWP) still have time to submit papers to the Third Southern African Regional Biennial YWP Conference, to take place in Stellenbosch from 16 to 18 July, 2013.

The conference theme is 'Water, Africa, Youth'. Participation is open to all post-graduate students and young professionals (under the age of 35 who gained their qualifications less than five years ago) working in the water and wastewater sector in Africa. Around 500 delegates from all over Africa are expected to attend.

It is widely recognised that capacity building and sustainable knowledge transfer are critical concerns for several sectors in South Africa, and the water sector is no different. The loss of intellectual assets is a major threat to effective water management, particularly in water-scarce countries such as South Africa where the onus has always been on the scientific community to find technological

solutions for sectoral challenges.

The repercussions for the sector include high staff turnover as well as the loss of skills and institutional memory. YWPs in South Africa are therefore faced with the threefold challenge of developing their skills; finding mentors to help them do so; as well as grappling with the added responsibility of re-learning knowledge that could have been retained through sustainable knowledge transfer policies and programmes.

The YWP Programme, established by the International Water Association plays an important role in the continuous development of a workforce which is adequate in size, capable in skills and strong in leadership. In South Africa, the initiative is led by the Water Institute of Southern Africa.

The deadline for the submission of papers is 1 December. For more information, Visit: www.sa-ywp.org.za

New task team to look at water data collection

The hydrological sciences community is setting up a task team under the leadership of the Water Research Commission (WRC) to investigate and come up with recommendations regarding current challenges related to the collection of water data.

This is one of the main outcomes following a workshop, hosted by the South African National Committee of the International Association of Hydrological Sciences (SANCIAHS) and the WRC in collaboration with the Department of Water Affairs (DWA), in Pretoria, to examine the current status of data collection and access in South Africa. Around 140 participants, including water researchers, practitioners, water resource managers and decision-makers participated in the workshop held on 1 October. With presentations from main data collection agencies, namely DWA, the South African Weather Service (SAWS) and the Agricultural Research Commission (ARC), workshop participants evaluated the state of present observation networks, storage and access to data, as well as investment in data collection.

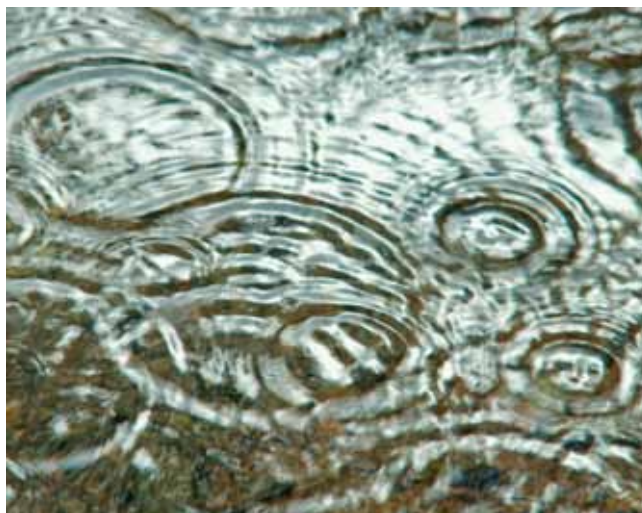
"Despite the availability of modern, high-power hydrological models, spatially representative, long-term consistent records of rainfall and streamflow data remain essential for achieving a high level of understanding about water resources," said SANCIAHS in a statement. "Of great

concern to the South African hydrological sciences community is that all data collection agencies are reporting a decline in their gauging networks as a result of budget cuts and staffing challenges. The fact that payment is now required to access some national data collection networks also affects hydrological science efforts."

Recent investigations revealed that the number of useful streamflow gauges in the country has decreased from a peak of 450 in the late 1980s to less than 350 in 2004. The number of weather stations has been reduced to around 1 800, with some water management areas now having less than half the number of stations open than was the case in 1920. Maintenance is reported as one of the main reasons for a declining in data networks.

Presentations from the data collection agencies confirmed that the perceived decline in data observation networks is real and that the situation is more critical than initially thought.

"This lack of investment in climate and water data collection is ironic in view of the country's water scarcity and high rainfall variability that will possibly be worsened by climate change realities," said SANCIAHS. "Additionally, it will be practically impossible to manage the country's water resources if there are no data collection efforts (of long-term, continuous datasets) to inform water resource management interventions."





Cloud control could tame hurricanes, study shows

They are one of the most destructive forces on Earth, but now environmental scientists are working to tame the hurricane.

In a paper, published in *Atmospheric Science Letters* earlier this year, researchers from the University of Leeds propose using cloud seeding to decrease sea surface temperatures where hurricanes form. Theoretically, the team claims the technique could reduce hurricane intensity by category.

The team focused on the relationship between sea surface temperature and the energy associated with the destructive potential of hurricanes. Rather than seeding storm clouds or hurricanes directly, the idea is to target marine stratocumulus clouds, which cover an estimated quarter of the world's oceans, to prevent hurricanes forming.

"Hurricanes derive their energy from the heat contained in the surface waters



of the ocean," explained Dr Alan Gadian from the School of Earth and Environment. "If we are able to increase the amount of sunlight reflected by clouds above the hurricane development region then there will be less energy to feed the hurricanes."

Using a technique known as Marine Cloud Brightening (MCB), the authors propose that unmanned vehicles could spray tiny seawater droplets, a good fraction of which would rise into the clouds above, increasing their droplet numbers and thereby the cloud reflectivity and duration. In this way, more sunlight is

bounced back into space, thereby reducing sea surface temperature.

"Data shows that over the last three decades hurricane intensity has increased in the North Atlantic, the Indian and South-West Pacific Oceans," noted Dr Gadian. "We simulated the impact of seeding on these three areas, with particular focus on the Atlantic hurricane months of August, September and October."

- To access the original article, Visit: <http://onlinelibrary.wiley.com/doi/10.1002/asl.402/abstract>

Biofuel algae may contain risk – US researchers

Algae – high on the genetic engineering agenda as a potential source for biofuel – should be subjected to independent studies of any environmental risks that could be linked to cultivating algae for this purpose.

So say scientists of Ohio State University, in the USA, writing in the August 2012 issue of the journal, *BioScience*. The researchers argue that ecology experts should be among scientists given independent authority and adequate funding to explore any potential unintended consequences of this technological pursuit.

A critical baseline concern is whether genetically engineered algae would be able to survive in the wild, said Allison Snow, professor of evolution, ecology and organismal biology at Ohio State University and lead author of the paper.

"If they are grown in big, open ponds, which are mainly what we are talking about, could the newer types of micro-algae get out into nature and mingle? We need to know if they can survive and whether they can hybridize or evolve to become more prolific when they get out of a controlled environment."

If they can survive, we also need to know whether some type of genetically engineered blue-green algae, for example, could produce toxins or harmful algal blooms – or both," Prof Snow continued. And became algae are so small and could be dispersed by rough weather or wildlife activity, biologists worry that any transgenes they contain to enhance their growth and strength could be transferred to other species in a way that could upset a fragile ecosystem.

The authors recommend, for starters, a comparative examination of genetically engineered algae strains intended for large-scale cultivation with their natural counterparts to determine the basic differences between the two. They also acknowledge that genetically engineered algae might be equipped with so-called 'suicide genes' that would make it impossible for the algae to survive a release into the wild.

"If such precautions are taken in lieu of thorough environmental assessments, more information should be required to ensure their long-term success and to prevent [genetically engineered] algae from evolving to silence or overcome biological traits that are designed to kill them," the authors note.

Source: Ohio State University

Water by numbers

0,007% – The percentage of the world's water that is readily accessible for direct human use. That is equal to a volume of about 90 000 km³ a year.

R670-billion – The approximate capital requirement for the entire water sector over the next ten years, according to the Department of Water Affairs (DWA).

5 000 – The estimated number of job opportunities created through the City of Cape Town's Transport, Roads and Stormwater Directorate in the 2011/12 financial year. These job opportunities are focused on verge maintenance, open stormwater and catchpit cleaning as well as invasive plant control.

R7-billion – The annual Municipal Infrastructure Grant allocation for water and sanitation. According to the findings of the Sanitation Task Team, appointed by Human Settlements Minister, Tokyo Sexwale, to investigate the state of sanitation services delivery, much of this allocation was being rerouted by local authorities to other priorities. As a result, municipalities are not adequately planning for the sanitation programme in their budgets.

28 – The number of municipalities out of 229 who have no engineering professionals in its employ, according to the Municipal Demarcation Board's *State of Municipal Capacity Assessment 2011/2012*. A further 24 municipalities were found to employ only one technician or technologist. The geographical distribution of engineers remains uneven, with higher concentrations of engineering capacity in metros and secondary cities.

780 million m³ – The total volume of water to be transferred from Lesotho to South Africa via the Lesotho Highlands Water Project (LHWP) during the 2012 calendar year. The infrastructure is currently undergoing routine maintenance to be completed before the end of the year.



Farmers must lead irrigation efforts to stem hunger in Africa

A new study finds that small-scale irrigation schemes can protect millions of farmers from food insecurity and climate risks in sub-Saharan Africa and South Asia.

The study, *Water for Wealth and Food Security: Supporting Farmer-driven Investments in Agricultural Water Management*, was published by the International Water Management Institute (IWMI) earlier this year.

According to the report, expanding the use of smallholder water management techniques could increase yields up to 300% in some cases, and add tens of billions of US dollars to household revenues across sub-Saharan Africa and Asia. "We've witnessed again and again what happens to the world's poor – the majority of whom depend on agriculture for their livelihoods and already suffer from water scarcity – when they are at the mercy of our fragile global food system," says Dr Colin Chartres, IWMI DG. "However, farmers across the developing world are increasingly relying on and benefiting from small-scale, locally-relevant water solutions."



The assessment quantified the potential reach and possible additional household revenue for a number of different on-farm and local community water solutions. The initiative unearthed for the first time the scale at which enterprising smallholder farmers themselves are driving this revolution by using their own resources innovatively rather than waiting for water to be delivered.

"We were amazed at the scale of what is going on," reported IWMI's

Meredith Giordano. "Despite constraints, such as high upfront costs and poorly developed supply chains, small-scale farmers across Africa and Asia have moved ahead using their own resources to finance and install irrigation technologies. It is clear that farmers themselves are driving this trend."

In Ghana, for instance, small private irrigation schemes already employ 45 times more individuals and cover 25 times more land than public irrigation schemes.

Research predicts Spanish trout will be extinct within a century

Climate change, pollution, the extraction of water for irrigation and overfishing all threaten the survival of the common trout in the Iberian Peninsula.

According to a study by the Complutense University of Madrid (UCM), the fish is expected to completely disappear from Iberian rivers by 2100 as a result of the depletion of its habitat. The study was published in the journal, *Global Change Biology*.

Lead author, Ana Almodóvar, explained that the study dealt with how variations in temperature affect trout population both now and in the future. "The fish has very narrow physiological margins in which it can live and is therefore a good indicator of the highest stretches of our rivers."

Among others, the scientists analysed the temperature records of Navarra between 1975 and 2007 and using a mathematical model they calculated the temperature of the region's rivers. "We saw a clear tendency of temperature increases, which was particularly marked around 1986," outlined Almodóvar. In addition, the team monitored the trout populations of 12 rivers in the Ebro basin and saw that an increase in temperature was associated with a decrease in trout populations.

"In the best of cases, which would involve just slight climate change, the situation for the trout is disastrous," noted Almodóvar. The study indicates that the temperature increases in Spanish rivers will cause the trout to lose half of its habitat by 2040 and become practically extinct by 2100.

According to the research team, these results can be extrapolated to other regions of the Iberian Peninsula and the Mediterranean, such as Italian, Balkan and Anatolian Peninsulas.

Students from Singapore win 2012 Stockholm Junior Water Prize

Three 18-year-old students from Singapore won the 2012 Stockholm Junior Water Prize for their research on how clay can be used to remove and recover pollutants from wastewater.

The compounds studied are so called non-ionic surfactants, soap-like additives which are used in industry and in household detergents and cosmetic products. They are common pollutants in wastewater and traditionally hard and expensive to remove.

The students, Luigi Marshall Cham, Jun Yong Nicholas Lim and Tian Ting Carrie-Ann Ng, seen in the photograph with HRH Crown Princess Victoria of Sweden, have developed a method where bentonite clay is used to remove

and recover the pollutants from the water without the generation of any waste products. The clay is able to absorb up to 100% of the non-ionic surfactants and can then be flushed clean with alcohol, allowing the compounds to be reused.

"This year's winning project shows the possibility of using a lower cost

method to decrease an important water environment problem, which is relevant all over the world. The study does not only present an efficient way to remove a toxicant, but also a novel way to recover and reuse materials which would otherwise be discarded as waste," said the International Jury in its citation.

The International Stockholm Junior Water Prize competition brings together the world's brightest young scientists to encourage their continued interest in water and the environment. This year, teams from 27 countries completed in the finals. The winners received US\$5 000 and a prize sculpture.



Solar-powered toilet shines in design challenge

The solar-powered toilet designed by the California Institute of Technology (Caltech) has won the Reinventing the Toilet Challenge issued by the Bill and Melinda Gates Foundation.

Caltech engineer, Michael Hoffman, and his colleagues were awarded US\$100 000 for their design, which they demonstrated at the Reinvent the Toilet Fair, a two-day event held in Seattle earlier this year.

The challenge is part of a US\$40-million programme initiated by the Gates Foundation to tackle the problems of water, sanitation and hygiene throughout the developing world. Hoffman's proposal – which won one of the eight grants given – was to build a toilet that uses the sun to power an electrochemical reactor. The reactor breaks down water and

human waste into fertilizer and hydrogen, which can be stored in hydrogen fuel cells as energy. The treated water can then be reused to flush the toilet or for irrigation.

The team built a prototype and after a year of designing and testing they were able to show off their creation. The Gates Foundation brought in 50 gallons of fake faeces made from soybeans and rice for the demonstration.

The US\$60 000 second-place prize went to Loughborough University in the UK, whose toilet produces biological charcoal, minerals and clean water, while the University of Toronto won third place with their design, which sanitizes faeces and urine and recovers resources and clean water.

Source: Caltech

'Wonder material' found to be toxic to aquatic animals

Carbon nanotubes (CNTs) are some of the strongest material on Earth and are used to strengthen composite materials, such as those used in high-performance tennis rackets.

However, while CNTs have potential uses in everything from medicine to electronics a joint study by the University of Missouri and the US Geological Survey found that they can be toxic to aquatic animals. The researchers urge that care be taken to prevent the release of CNTs into the environment as the materials enter mass production.

"The great promise of carbon nanotubes must be balanced with caution and preparation," noted Baolin Deng, professor and chair of chemical engineering at the University of Missouri. "We do not know enough about their effects on the environment and human health. The Environmental Protection Agency and other regulatory groups need more studies like ours to provide information on the safety of CNTs."

CNTs are microscopically thin cylinders of carbon atoms that can be hundreds

of millions of times longer than they are wide, but they are not pure carbon. Nickel, chromium and other metals used in the manufacturing process can remain as impurities. Deng and his colleagues found that these metals and the CNTs themselves can reduce the growth rates or even kill some species of aquatic organisms. The four species used in the experiment were mussels (*Villola iris*), small flies' larvae (*Chironomus dilutes*), worms (*Lumbriculus variegatus*) and crustaceans (*Hyalella azteca*).

"One of the greatest possibilities of contamination of the environment by CNTs comes during the manufacture of composite materials," said Hao Li, associate professor of mechanical and aerospace engineering at Missouri University. "Good waste management and handling procedures can minimise this risk. Also to control long-term risks, we need to understand what happens when these composite materials break down."

Source: University of Missouri

Reduce risks posed by use of chemicals now, UN calls



Governments must urgently act to reduce the health and environmental hazards posed by the increase in use of chemicals in industries worldwide.

This is according to a United Nations (UN) report released earlier this year, which stresses that more sustainable management policies are needed to address this growing risk.

Produced by the UN Environment Programme (UNEP), the *Global Chemicals Outlook* report argues that a shift in the production, use and disposal of chemical products from developed to developing countries has made it essential to establish better management policies to avoid diseases and pollution caused by weak regulations.

"Communities worldwide – particularly those in emerging and developing countries – are increasingly dependent on chemical products, from fertilizers and petrochemicals to electronics and plastics, for economic development and improving livelihoods," said UNEP Executive Director, Achim Steiner. "But the gains that chemicals can provide must not come at the expense of human health and the environment. Pollution and disease related to the unsustainable use, production and disposal of chemicals can, in fact, hinder progress towards key development targets by affecting water supplies, food security, well-being or work productivity."

The report highlights not only the damaging consequences to the environment and human health, but also the economic burden of treating chemical poisoning for

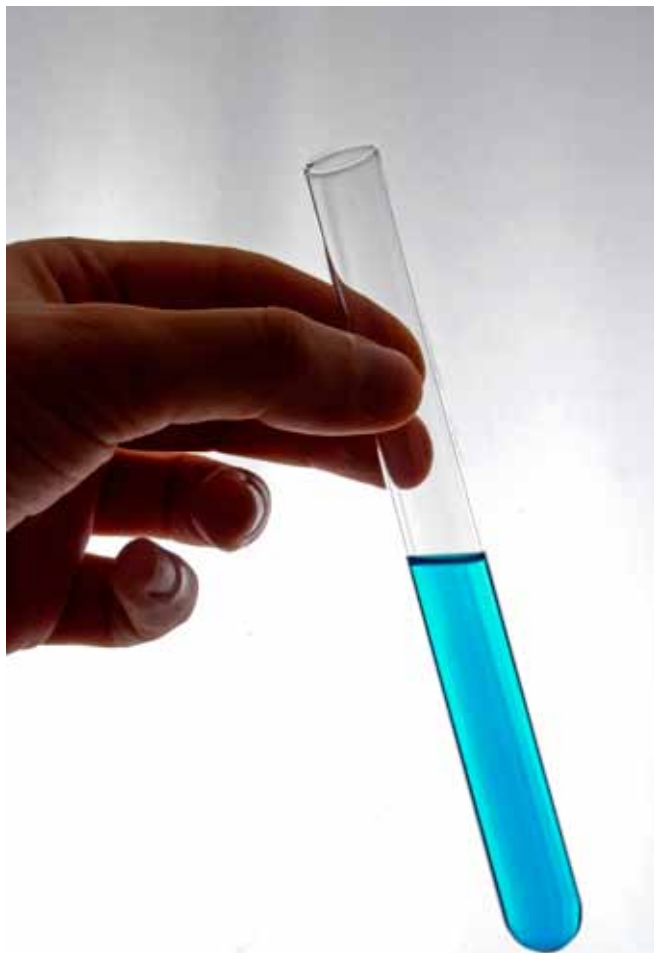
many countries. In sub-Saharan Africa, for example, the estimated cost of poisonings from pesticides now exceeds the total annual overseas development aid given to the region for basic health services, including HIV/AIDS.

From Sudan to Ecuador, to bigger economies such as China and the US, the costs of pesticide poisoning, water pollution and toxic waste, among other issues, are not being borne by manufacturers and industries, but by social welfare systems and individuals, the report notes. It calls for sustainable chemical management policies not just to combat these costs, but also to improve livelihoods and develop green technologies.

"The economic analysis presented in the *Global Chemicals Outlook* demonstrates that sound chemicals management is as valid an area as education, transport, infrastructure, direct health care services and other essential public services," said World Health Organisation Director for Public Health and Environment, Maria Neira. "This could foster the creation of many green, decent and healthy jobs and livelihoods for developed and developing countries."

Some of the recommendations put forward by the report include the integration of chemicals management into national social and economic plans, the development of policies focused on risk prevention and promotion of safer alternatives, and encouraging the private sector to play a more active role in development of safety policies in conjunction with governments.

Water research going up, up and up, study shows



Research into water resources and the critical water for food nexus is growing faster than the average 4% annual growth rate for all research disciplines.

This is according to a new report published by Elsevier in collaboration with the Stockholm International Water Institute. The report, *The Water and Food Nexus: Trends and Development of the Research Landscape*, takes the first look at the state of water and food research within the larger field of water resources research, examining the state of research literature on both fields through 2011.

It indicates that between 2007 and 2011, the compound annual growth rate (CAGR) for water resources research published articles as 9.2% a year, while food and water research articles grew at 4.7% a year. The reports shows that in

2011, water resources research articles surpassed 6 000 articles per year and water and food research topped 4 000 articles per year.

Output is still highest in the USA, however, China is increasingly seeing the fruits of its steadily increased investment in water research and is expected to surpass the USA in a few years where growth has been slower. Interestingly, Iran and Malaysia have seen mercurial growth in water resources research, while Iran, Malaysia and South Africa have undergone the same growth in water and food research.

Remarkably, the research with the most impact did not come either from the most productive countries or from those exhibiting the highest growth rate in publication output. The most influential

scientific papers originated from the Netherlands, Switzerland, Denmark and Belgium for water resources research, and Sweden, Switzerland, Great Britain, the Netherlands and Denmark for water and food research.

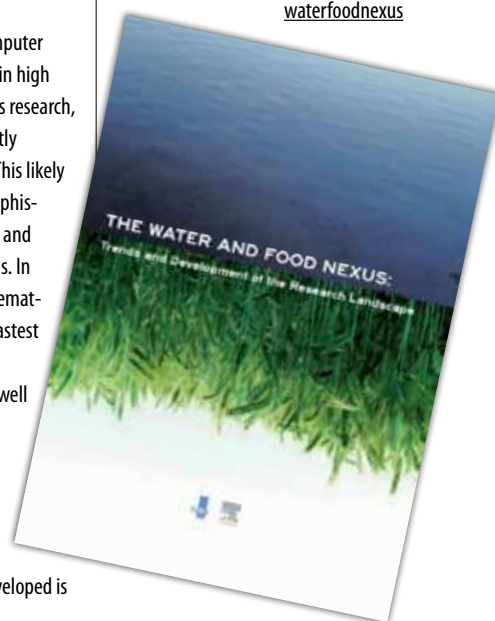
Since the flow of water respects no man-made boundaries, water problems are often international problems. And, as the water crisis touches nearly every corner of the globe, the search for solutions is a collaborative effort. Thus, more than half of all water resources and water and food research articles are produced by international collaboration among researchers.

According to the report, computer science and mathematics remain high growth fields in water resources research, while economics has significantly declined in the last two years. This likely reflects the growing use and sophistication of statistical modelling and quantitative measurement tools. In water and food research, mathematics and social sciences are the fastest growing fields. Agriculture and biological sciences account for well over half of all water and food research articles.

According to the report a critical challenge going forward is ensuring that this immense knowledge being developed is

translated into sustainable action. "Water research in itself will not help solve the world's water challenges – particularly how to produce more food with less water – unless this research is translated into informed leadership decisions and sustainable action. Building capacity for action can be supported by improved knowledge exchange of research findings and technologies best practices," the report concludes.

To access the report, *The Water and Food Nexus: Trends and Development of the Research Landscape*, Visit: <http://www.info.scival.com/resource-library/waterfoodnexus>



The number of papers published in the fields of water resources and water for food between 1980 and 2011.

New from the WRC

Report No. 2013/1/12

Development of analytical sensors for the identification and quantification of metals in environmental samples (V Somerset; C van der Horst; B Silwana; C Walters; E Iwuoha & S le Roux)

In this project the emphasis was mainly on assessing the aquatic environment around platinum group metals mining activities to determine which national water resources are in close proximity to these mines, and to determine whether the current analytical tools and techniques used to analyse heavy and precious metal containing effluent is adequate for the task at hand. The use of fast, reliable and continuous monitoring techniques for routine analysis of water quality and to quantify pollution events has become essential in order to manage the discharge of potentially harmful wastes to the environment.

Report No. 1856/1/11

Development of a revised desktop model for the determination of the ecological reserve for rivers (DA Hughes; D Louw; AY Desai; & AL Birkhead)

The main objective of the project was to create a new version of the Desktop Reserve model that more explicitly includes the links and relationships between hydrology, hydraulics and ecological response. The previous version of the Reserve Desktop model, that has been in use for a number of years, was largely based on hydrology and regional model parameters that attempted to implicitly include variations in ecological response and the flow requirements needed to maintain different levels of ecological functioning.

Report No. 1724/1/12

Sustainable agricultural use of municipal wastewater sludge: Matching nutrient supply and demand (EH Tesfamariam; JG Annandale; PC de Jager; I Mbakwe; P van der Merwe; L Nobela & M van der Laan)

Management of sludge from both industrial and domestic origins is an ever growing challenge. The beneficial

utilisation of sludge is a better long-term waste management strategy than disposal. Municipal sludge is a source of essential nutrients and it is believed that its agricultural use will play an ever increasing role in future strategies. The beneficial use of sludge in both an agricultural and environmental context was the main impetus behind this project. This report (one of two emanating from this project) details the quantification of responsible sludge application rates in an attempt to match nutrient supply from sludge to actual crop uptake for sustainable agricultural use.

Report No. 1448/1/12

Grouted lining systems for the renovation of old steel pipelines and the design of new pipelines (SJ van Vuuren)

In South Africa steel pipes have been installed as far back as 1930. Among others, steel pipes need to be protected against corrosion. This is normally achieved through the provision of an internal lining and external coating. Some of the liner systems that have been used in the past have to be replaced and, in the case of Rand Water, consideration is given to install grouted viscous-elastic liners to extend the pipes' useful life. The objective of this study was to investigate alternative lining systems applicable lining systems applicable for South African conditions.

Report No. 1568/1/12

Development of a generic model to assess the costs associated with eutrophication (M Graham; J Blignaut; L de Villiers; D Mostert; X Sibande; S Gebremedhin; W Harding; N Rossouw; S Freeze; S Ferrer

& Michelle Brown)

Eutrophication causes excessive growth of phytoplankton (free-floating algae) and rooted macrophytes. The presence of large numbers of phytoplankton in water bodies diminishes the quality of water resources for many users and costly treatment is often required to overcome its negative effects. The costs associated with eutrophication need to be estimated in order to consider and justify, often expensive, preventative and ameliorative measures. The overall objective of the project was to develop a generic model to assess the economic costs associated with eutrophication in South Africa and to apply it to the Vaal River system.

Report No. 1705/1/11

An approach to estuary-based economic empowerment with a particular focus on the Eastern Cape Wild Coast (R Bowd; C Breen; D Hay; D Kotze; M Mander)

This project is the concluding chapter of a long-term research and outreach programme focusing on supporting the management of estuaries in the Eastern Cape. Commencing in 1998 the Eastern Cape Estuaries Management Programme was informed, philosophically, by the identified need to develop local solutions to local problems and work upward and outward from there. Also, at a practical level, there was the recognition that estuaries are valuable ecological, social and economic assets and they require active management. During the programme it was observed that disadvantaged people living at or near estuaries were continually marginalised in the economic development process, leading to this research project. Among others, the research assessed the state of and opportunities for economic empowerment at Eastern Cape Wild Coast estuaries. A key finding was that, while there was evidence of economic empowerment in the public sector

through state employment, this had not translated into infrastructure delivery that might benefit 'private' economic employment. At the estuary landscape level the main drivers of economic empowerment were found to be resort hotels which provided employment and subsidiary business opportunities.

Report No. KV 282/11

Towards improving the assessment and implementation of the Reserve: Real-time assessment and implementation of the Ecological Reserve (S Pollard; S Mallory; E Riddell; T Sawunyama)

The aims of this study were to assess the state of compliance with the Ecological Reserve – as a benchmark for sustainability – in the rivers flowing through the Kruger National Park (e.g. Olifants, Sabie, Crocodile, Letaba, Luvuvhu and so on) and some of their tributaries. It also explored the problems associated with an assessment of compliance. In short, these include the lack of planning and integration of Ecological Reserve determination methods with operations and the difficulties associated with real-time predictions of Ecological Reserve requirements. These factors severely constrain planning, monitoring and the management action to mitigate non-compliance.

Report No. 1909/1/12

Reducing uncertainties of evapotranspiration and preferential flow in the estimation of groundwater recharge (N Jovanovic; RDH Bagan; S Israel; S Dzikiti; E Kapangaziwiri; D le Maitre; A Rozanov; M Stander; D Mikes; F May; C Jarman & C Everson)

The quantification of groundwater resources is of utmost importance for future water allocations and management. Groundwater is stored in aquifers that include a static zone (permeable portion of the aquifer below the zone of natural groundwater level fluctuation) with a dynamic zone (volume of groundwater available in the zone of natural groundwater level fluctuation, above the static zone). The key variable of the dynamic storage zone that determines



natural groundwater replenishment and water table fluctuations is groundwater recharge. This project aimed at addressing the knowledge gaps identified in previous research. Improved methodologies for the estimation of recharge were proposed, as well as the use of hydrological models verified with field data to predict the effects of weather, vegetation, soil and geology on groundwater recharge. Evapotranspiration of natural vegetation, in particular Sand Plain Fynbos and Sandstone Fynbos, was never measured before.

Report No. TT 528/12 (Volume I) and TT 529/12 (Volume II)

Investigation of unsteady flow conditions at dam bottom outlet works due to air entrainment during gate closure Volume I: Physical modelling and Volume II: Computational modelling (Eddie Bosman & Gerrit Basson (Editors))

The Berg River Dam is equipped with the first multi-level draw off environmental flood release outlet in South Africa and can release flows of up to 200 m³/s. The outlet is controlled by a radial gate and is protected by a vertical emergency gate. Commis-

sioning tests of the emergency gate in 2008 found that large volumes of air were expelled from the air supply shaft designed to reduce expected negative pressures in the conduit during emergency gate closure. In 2009, Stellenbosch University was first commissioned by the WRC to investigate this phenomenon. That study, comprising tests on a 1:40 scale physical model and a two-dimensional numerical computational fluid dynamics (CFD) analysis, was inconclusive on the cause of the large air releases. Volume I covers a subsequent study using

1:14-scale physical model. The accompanying Volume II report covers a study using three-dimensional CFD analyses.

Report No. 1766/1/12

Field investigations to study the fate and transport of light non-aqueous phase liquids (LNAPLs) in groundwater (G Steyl; M Gomo; K Vermaak; J Bothwell; GL van Tonder; K Surridge; S Lorentz; J Ngaleka; S Sikosana; M Dlamini; N Zondi & S Revil-Bourdard)

In this report the key features in characterising and evaluating a LNAPL contaminated site is presented. The characteristics which define LNAPLs are expanded on in this report, with special attention to the chemical and physical properties of these compounds. The influence that the local geology has on the distribution of these compounds has been discussed in regards to the type of aquifers present in South Africa. A review of geophysical methods was incorporated in this study to highlight the most effective methods available.

To conclude the review of LNAPL contamination at a site, the most important transport and remediation mechanisms are highlighted.

Report No. 1855/1/11

Water allocation reform in South Africa: History,

processes and prospects for future implementation (Ml Msibi; PZ Dlamini)

Following South Africa's democratisation, a number of programmes and policies have been launched to redress imbalances of the past. Among these is Water Allocation Reform (WAR) for which the National Water Act provides the legislative framework. WAR is aimed at promoting beneficial use of water in the public interest in a manner that supports fair and equitable allocation of water resources to all South Africans while promoting social stability and investor

confidence. A number of factors make water reform a necessity rather than an option, including the country's national water scarcity, the present and long-term effects of projected climate change, existing stressed and over-allocated water resources, and the persisting skewed distribution of water allocation. This WRC-commissioned study aimed to document available knowledge on WAR to facilitate its sharing and discussion with a view to informing policy.

Report No. 1908/1/11

The development of a hydrologically improved digital elevation model and derived products for South Africa based on the SRTM DEM (HL Wepener; HM van den Berg; M Metz & H Hamandawana)

Digital elevation models (DEMs) represent the topography in a landscape and are an important data source used in numerous hydrological and geo-hydrological studies/projects. There are several DEMs available for South Africa, but usually they require significant editing before they can be used for hydrological modelling, therefore this project is trying to provide a readily usable set of data products for hydrological modelling. The aim of this project was to prepare a hydrologically improved DEM for South Africa from the Shuttle Radar Topography Mission (SRTM) DEM.

Report No. KV 280/11

A stable isotope approach for the early detection and identification of N loading in aquatic ecosystems (JM Hill; S Kaehler; MP Hill & J Coetzee)

Global increases in urbanisation and anthropogenic activity within watersheds and catchment areas have resulted in excessive nitrogen loads in aquatic ecosystems. Increasing nitrogen loading can result in widespread aquatic ecosystem degradation, including harmful algal blooms, increased turbidity, hypoxia, loss of aquatic vegetation and habitat and fish kills. It is also one of the mechanisms driving aquatic weed invasions. Understanding the fate and processing of anthropogenic nutrients in natural systems is therefore critical for both preserving the well-being and biotic heritage for future generations as well

as providing a tremendous opportunity to improve the management driven by science. The objectives of this study were to evaluate the feasibility of mapping anthropogenic pollution through stable isotopes signatures of aquatic plants, to investigate the potential for identifying different pollution sources, concentrations and distributions in a freshwater environment and to determine the utility of these techniques in identifying early eutrophication.

Report No. 15701/12

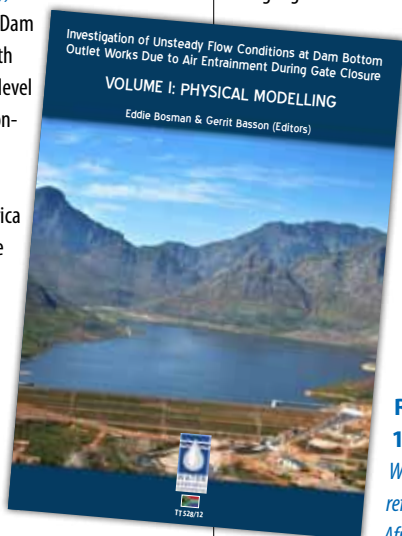
Econometric model to predict the effect that various water resource management scenarios would have on South Africa's economic development (Conningarth Economists)

The specific objective of this report was the development of an integrated macroeconometric model that considers the role of water as an input to the South African economy, and that can be used to predict and evaluate the likely effect of water management and policy interventions. This objective was directly linked to the WRC's research requirement for the development of an 'Appropriate and Scientifically Based Analytical Tool' that can be used for this particular purpose in the South African context. It is against this background that this project examined the available macro-econometric models that, inter alia, establish the functional relationships that exist between the various production sectors and the water sector.

Report No. KV 295/12

Faecal contamination source identification using a combination of chemical and microbial biomarkers (R Tandlich; CD Luyt; WJ Muller)

In South Africa, the probability of water supply interruptions was 47,6% in 2010 and there was a 61,8% increase in deaths from intestinal infectious diseases between 2001 and 2007, possibly partly due to intermittent water availability. Some households are forced to supplement their drinking water from water resources of inadequate microbial quality. Contamination of the water bodies occurs via surface runoff from sanitation infrastructure, defecation by livestock and



laundry activities in the vicinity of water bodies, or seepage from landfills and manure deposits. Enumeration of E.coli forms the basis of the National Microbial Monitoring Programme. The analyses are performed using the Colilert®18 system at prioritised sampling sites. However, only 70% of relevant water resources were covered by the National Microbial Monitoring Programme in 2009 due to lack of accredited laboratories and skilled personnel and given financial limitations. This project aimed at reviewing and sampling alternative methods for the detection of the presence or absence of faecal contamination.

Report No. 1974/1/12

Determining the socio-economic value of groundwater: Franschhoek case study (D Pearce; Y Xu; and E Makaudze)

The Western Cape is facing increased pressure to develop new supplies of freshwater to cater for the region's rapidly growing demand. Groundwater is being explored as a possible contributor to the freshwater supply. Development of the resources has been slow despite the existence of significant potential groundwater resources in the form of several shallow primary aquifer systems and an extensive secondary aquifer formation known as the Table Mountain Group (TMG) Aquifer. This slow development may be attributed primarily to a lack of awareness among key stakeholders and general ignorance in the water market with regards to the potential of this resource. The purpose of this study was to develop and apply a valuation model that can estimate the value of groundwater from a demand-sided approach so that the socio-economic factors that drive its value can be identified.

Report No. 1694/1/12

Towards a sampling and monitoring protocol of radioactive elements in fractured rock aquifers for groundwater resource security in Beaufort West (Y Xu; G Mahed; Y van Wyk; L Lin; X Sun; L Xiao & S Talma)

The WRC granted this project to a consortium of researchers led by the University of the Western Cape to develop a sampling and monitoring protocol for radioactive elements in fractured rock environments. This report forms part of a suite of deliverables from that project and deals with sampling and monitoring of radioactive elements in aquifers for groundwater security in Beaufort West where radioactive elements were first detected in the groundwater in 1964.

Report No. 1760/1/12

Measurement of the bulk flow and transport characteristics of selected fractured rock aquifer systems in South Africa (G Steyl; J Bothwell; GJ van Tonder; B Zhao & J Odiyo)

In this research report the need for an effective method for regional bulk flow properties is discussed. An estimation method for transmissivity values in South Africa is given in respect to fractured rock aquifers with dual porosity properties. The influence of bulk regional transmissivity values for dual porosity medium is discussed in regards to the differences between the largest transmissivity value and the smallest.

Report No. 1351/1/12

Effect of agroforestry and intercropping systems on fodder production in rural areas of South Africa (CS Everson; BE Mthembu & TM Everson)

The major agricultural enterprises for small-scale farmers in the Upper Thukela region are livestock (mainly cattle) and crops (mainly maize and dry beans). These enterprises (cattle and crops) are the sources of their income and staple diets respectively. However, one of the major constraints in rural farming systems of the Upper Thukela region is the shortage of adequate and good quality forage during the dry winter season. Supplementation of feed using commercial supplements is expensive for resource poor farmers and not easily available in remote areas. Provision of

alternative sources of fodder such as tree leaves and pods can increase production. Among others, this project sought to determine the effect of different agroforestry systems on increasing fodder production in rural farming systems; the effect of agroforestry practices on soil water availability to traditional crops; and to determine whether the inclusion of trees in traditional cropping systems can enhance the infiltration of rainfall and prevent soil loss.

Report No. 1773/1/12

The development of a performance management tool for the implementation of IWRM in South Africa (M Wade; C McKenzie & G de Jager)

The vision behind this project was to provide a tool that could facilitate with the management of a catchment and the implementation of IWRM. The performance management tool aims to draw attention to areas where management targets for a water management area and/or catchment are not being met, providing possible reasons for this as well as recommendations for the way forward. This will enable the catchment management agency to track and measure its functions, as well as make management decisions and to allocate necessary resources to appropriate areas and activities.

Report No. KV 288/11

Investigating water knowledge flow to communities (J Burt & R Berold)

People working in the water resource management sector have found that very few knowledge/research resources are accessible to most people. This happens because resources are not disseminated properly (or at all), or because they are inappropriately technicist, or because potential readers are hampered by low education. This consultancy is the beginning of an enquiry into

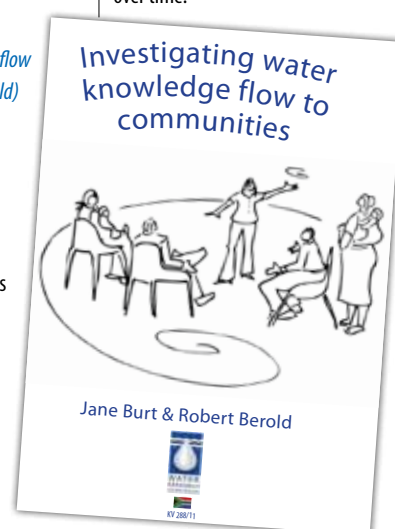
which resources work best and why.

Water communicators around the country were interviewed, followed by two focus groups meetings, which brought water communicators together.

Report No. 1724/1/12

Sustainable sludge land application and co-disposal strategies: The potential of sludge amended combustion coal ash residues as artificial plant growth media – A laboratory column study to assess the influence of weathering on the elemental release (PC de Jager; JG Annandale; I Mbakwe & BH Sukati)

Management of sludge both from industrial and domestic origins is an ever growing challenge. The beneficial utilisation of sludge is a better long-term waste management strategy than disposal. This report focuses on the potential use of a petrochemically derived sludge for reclamation of a coarse ash dump. It includes a laboratory column study in which weathering, elemental release and water holding characteristics of co-disposed industrial sludge, fine and gasification mixtures are investigated to assess chemical and physical suitability as potential growing media for plants. The report highlights the benefits and risks of mixing various waste streams in certain ratios, as well as the expected end products as these mixes weather over time.



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