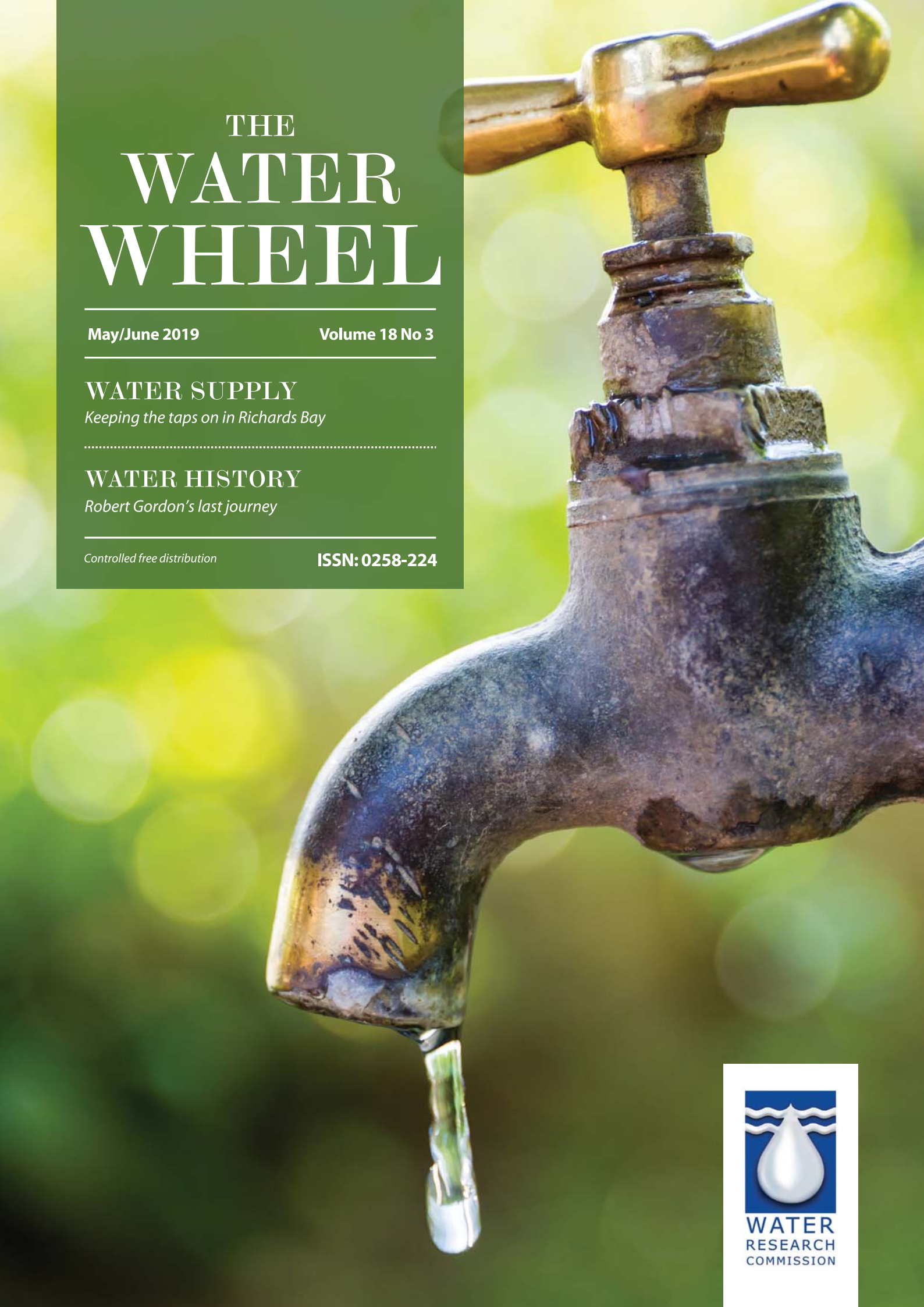

THE WATER WHEEL

May/June 2019 Volume 18 No 3

WATER SUPPLY

Keeping the taps on in Richards Bay

WATER HISTORY

Robert Gordon's last journey

Controlled free distribution

ISSN: 0258-224

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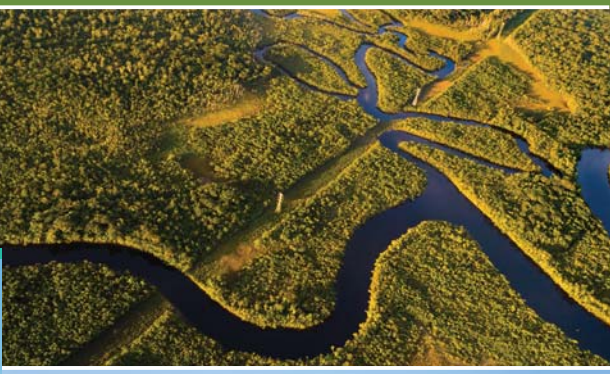
WATER RESEARCH COMMISSION



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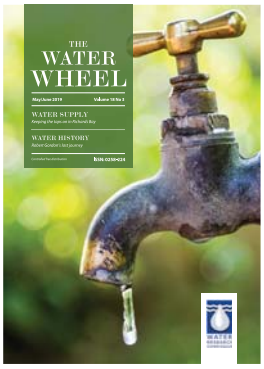
Contents



Water strapped Richards Bay is considering various augmentation options. Article on page 12.

FLUID THOUGHTS

WRC CEO, Dhesigen Naidoo

Sanitation innovation – a key to Africa's development strategy

The demographic dividend, new production revolution, shifting wealth patterns, accelerated urban transition and climate change and the green economy are the megatrends that will influence this continent's future claims the latest analysis in a report named ***'Africa's development dynamics – growth, jobs and inequalities'*** compiled by the African Union Commission in partnership with the OECD.

By 2063, Africa will constitute 30% of the global population with 3 billion inhabitants, more than doubling the current population of 1.25 billion. More than that it will be that region of the world with the most youthful population. What we do now will determine whether this computes into a demographic dividend or a demographic burden.

For an already underserviced continent with respect to basic needs of water, sanitation, energy, health and nutritional security; the prospect of a doubling of the population in the next half century is daunting. We are rapidly reaching, and in some cases exceeding the Planetary boundary conditions on the one hand and have the objective of ensuring universal access to these basic services and facilitating economic growth on the other.

But as Pliny the Elder remarked ***'Ex Africa semper aliquid novi'*** – "there's always something new coming out of Africa." Africa can pioneer global sustainable development, not despite, but precisely because of its current low industrialisation levels. This means while the global North has to invest in high cost retrofitting in order to switch from the current high carbon, water intensive, waste producing economic model; Africa can leapfrog directly into the sustainable development paradigm. She already has a wonderful example of this leapfrogging with mobile telephony which has provided proliferated access to hundreds of millions of Africans while saving most of connected Africa from the eyesore of millions kilometres of high maintenance and aesthetically challenging overhead telephone wire networks.

Another of those critical domains that has this possibility is sanitation. The current African backlog which is primarily in Sub-Saharan Africa is estimated at 570 million people who don't yet have access to improved sanitation, and if we are to achieve the Sustainable Development Goal for sanitation, this situation has to reversed by 2030. This is in an environment of increased water scarcity and although the International Monetary Fund (IMF) in its Regional Economic Outlook report pegs a continued recovery, it is still a low growth rates forecast of 3.5% in 2019. In addition, this is a region with low energy access and security. The International Energy Agency (IEA) in its Energy Access Outlook 2017 concluded that 95% of the 1.1 billion people without access to electricity were in Sub-Saharan African countries. These are difficult boundary conditions. It will take high levels of innovation, creativity and ingenuity to meet both the SDGs and lay the foundations of sustainable development within this framework.

Fortunately, we have already achieved some important starting points. One of these is in sanitation. The Water Research Commission together with its local and international partners, many working under the banner of the Gates Foundation Reinvent the Toilet programme, have developed a suite of cutting-edge innovative technologies and solutions that has the potential to revolutionise sanitation. These state-of-the-art technologies share the following characteristics – firstly, they are designed to use less than a litre of water per flush with some using no water at all. Secondly, the engineering genius at the back end means on-site or decentralised safe and hygienic treatment of the waste. This means financial savings in construction costs as the kilometres of massive sewerage pipelines as well as large wastewater treatment plants are no longer needed.

> *"The WRC has, together with its local and international partners, developed a suite of cutting-edge innovation technologies."*

This goes along with the saving of the vast quantities of water that conveys the human waste vast distances to the treatment works as required by the current model. Add to this the huge energy savings in the treatment works themselves and you have already an amazing trinity of efficiencies – in water, power and money - precisely in the areas of greatest scarcity on the continent.

BACK TO TOP

The boon does not stop there. Add to this the beneficiating of the waste on site. This ranges from using the waste in basic ways like fertilizers and first level energy source through biochar, to more sophisticated value addition through biogas capture, protein and lipid extraction and you have the beginnings of an innovative 21st century industrial value chain. Together with this comes the promise of greater economic growth, enterprise development and job creation. This will facilitate our ability as a continent to meet our SDG goals and creating the mechanisms for our partners in Asia, Latin America and other parts of the Global South to be able do the same.

If we manage to achieve this, we will be introducing a model for low cost, high beneficiation, low water, low energy and of course concomitantly low carbon sanitation. If we go further than the SDGs to making this a pivot point to revolutionise sanitation provision with large-scale adoption, meaning the conversion in the Global North as well, then we have the bedrock of true sustainable development.

Africa will indeed have brought forth something new - better phrased as former President Mbeki reminds us as ***"Semper aliquid novi Africa affert".*** Let us in this Africa Month 2019 re-engage the possibility of the African Century where this continent leads in the shaping of a better Africa and a better world.

WATER DIARY

Water engineering
21-24 May 2019
Stellenbosch University is offering a four-day course on the sustainable design, construction, operation and maintenance of large, hydraulic structures. The course has been structured to give state-of-the-art theory and practice on dam site and dam type selection, geotechnical and structural dam design aspects, and hydraulic design.
Email: civilcourse@sun.ac.za

Wastewater treatment
23-27 June
The 16th IWA World Conference on Anaerobic Digestion will be held in Delft (The Netherlands).
Visit: https://www.ad16conference.com

Young water professionals
23-27 June
The International Young Water Professional (YWP) Conference will take place in Toronto, Canada. This conference is one of the vehicles in which the IWA supports YWPs to develop themselves to be at the forefront of decision-making. For more information,
Visit: iwa-youngwaterprofessionals.org

Environmental history
22-26 July
The Third World Congress of Environmental History will be held in Brazil.
Visit: https://www.3wceh2019.floripa.br

World water
25-30 August
Hosted by the Stockholm International Water Institute, World Water Week will be held in Stockholm, Sweden, with the theme 'Water for society – including all'. For more information,
Visit: www.worldwaterweek.org

Research and development
11-13 September
The Water Research Commission will be hosting its fourth biennial Symposium at the Sandton Convention Centre. For more information,
Visit: www.wrc.org.za

Municipal engineering
2-4 October
The 83rd annual conference of the Institute of Municipal Engineering of South Africa (IMESA) is taking place at the Durban International Conference Centre with the theme 'Conquering municipal challenges'.
Visit: https://conference.imesa.org.za/

Eco-health
10-11 October
The 10th Annual Eco-health and Well-being Research Conference will be held at UNISA (Florida Campus) with the theme 'Community challenges: Multidisciplinary and interinstitutional interventions as vehicles to solutions in the developing of South Africa'.
Enquiries: Yolandi Jordaan,
Email: openbookdesign@gmail.com,
Tel: 082 553 6463.

Young water professionals
20-23 October
The 6th South African Young Water Professionals Biennial Conference will be held in KwaZulu-Natal.
Visit: https://ywpzaconference2019.co.za

Groundwater
20-23 October
The 16th Groundwater Division Conference and Exhibition will be held in Port Elizabeth under the theme 'Conservation, demand and surety'. For more information,
Visit: www.gwd.org.za

Emerging contaminants
4-8 November
The second African Conference on Health Effects of Endocrine Disruptors will be hosted by the University of Pretoria at its Future Africa Campus. For more information,
Visit: www.up.ac.za

BACK TO TOP

NEWS

Landmark study launched on SA research publishing

Improving and protecting South African research publishing is at the core of a consensus study published by the Academy of Science of South Africa (ASSAf).

Addressing new possibilities and challenges which have arisen and were exacerbated with the advent of open science, the study, ***Twelve years later: Second ASSAf report on research publishing in and from South Africa (2018***) highlights the main issues and unresolved problems still remaining in the system despite progress.

The domain of scholarly publishing in and from South Africa is key to the maintenance and expansion of the country's developmental potential and future prosperity which is currently in a state of technological and commercial flux, internationally and nationally. Policy and practice must be adapted at all levels to address this new environment. The study seeks to provide a firm evidential basis for informed, inclusive and comprehensive debate, and wise policymaking for the future.

The results of this study have consequences at the systemic, institutional and individual levels. It warns that predatory publishing poses a significant threat to science in South Africa. "If it continues at the rate of growth of the past five years, predatory publishing may well become the norm in some disciplines and at some universities. Not only will this affect the very fabric of the science system (our confidence in the peer review system) but it will also undermine the trust and confidence of the general public in science and its products."

The report describes at least three publication practices which should be regarded as questionable (if not unethical) and provides case studies suggesting these. These are:

- Unacceptable levels of publication intensity by the editor or a member of the editorial board (in their journal).
- Unacceptable publication intensity by an individual in the journal (for example, publication of an excessively large number of papers in the same journal).
- 'Publication cartels' where two or more individuals (sometimes also members of the editorial board) co-author repeatedly in the same journal.

The study concludes with eight headline recommendations for the most urgent and important steps that need to be taken to improve and protect research publishing in, and from, South Africa.

To download the report, Visit: http://research.assaf.org.za/handle/20.500.11911/114

CSIR Chair gets presidential award

CSIR Chairperson, Prof Thokozani Majozi, has been awarded the National Order of Mapungubwe.

Awarded by the President of South Africa, the award recognises South Africans who have accomplished excellence and exceptional achievement in international research areas that have benefited the country.

Prof Majozi received the bronze award for his outstanding contribution to science, particularly the development of a novel mathematical technique for near-zero-effluent batch chemical facilities that enables the reuse of wastewater.
"Being honoured with an award of this magnitude is one of the most humbling experiences. As scientists, our daily effort merely stems from our predilection for new knowledge, and not necessarily from pursuit of any recognition. Consequently, to be recognised for the work we do should only be a blessing and affirmation that our work has positively impacted others. As a nation, we need to continue coming up with fundamental and innovative solutions to challenges facing our people," commented Prof Majozi.

Prof Majozi, who is a professor at the School of Chemical and Metallurgical Engineering at the University of the Witwatersrand, has been Chairperson of the CSIR Board since 2015.

BACK TO TOP

New publication calls on increased support for women in research

The Gender Working Group of the Global Research Council launched a new publication on gender equality in research earlier this year.

The case study booklet, ***Supporting Women in Research***, comprises 53 actions and case studies from 28 countries including contributions from the National Research Foundation. The booklet showcases action various GRC participants are taking to further the equality and status of women in research.

Continued global diversity in research excellence requires that all citizens have opportunities to participate in and contribute to achieving the full potential of research and innovation activities. Participants in the GRC consider that supporting gender equality is a key component of harnessing this diversity of talent, while recognising that the equality and status of women in research should be considered together with broader equality and diversity issues.

According to the GRC, to address the equality and the status of women in research, two aspects need to be considered:

- The participation and promotion of women in research workforce. This includes the longstanding dominance of certain demographics in academic culture and historical obstacles to their participation within particular disciplines and fields of research.
- The integration of the gender dimension in research design and in the analysis of research outcomes.

As part of its Research Capacity Development Strategy, The South African Government is committed to addressing equality in science through targeted interventions; including targeting women and black people for research support.

South Africa appears to be well on its way in terms of achieving gender equality in research – thanks to laws and policies, in 2017 out of a total of 3 057 doctoral graduates, 65% were black and 43% were women.

To access the booklet,
Visit: www.globalresearchcouncil.org

BACK TO TOP

GLOBAL

Only a third of large global rivers still free flowing

The physical signs and socio-economic impacts of climate change are accelerating as record greenhouse gas concentrations drive global temperatures towards increasingly dangerous levels. This is according to a new report from the World Meteorological Organisation (WMO).

The WMO Statement on the State of the Global Climate in 2018, its 25th anniversary edition, highlights record sea level rise, as well as exceptionally high land and ocean temperatures over the past four years. This warming trend has lasted since the start of this century and is expected to continue.

"Since the Statement was first published, climate science has achieved an unprecedented degree of robustness, providing authoritative evidence of global temperature increase and associated features such as accelerating sea level rise, shrinking sea ice, glacier retreat and extreme events such as heat waves," noted WMO Secretary-General Petteri Taalas.

These key climate change indicators are becoming more pronounced. Carbon dioxide levels, which were at 357.0 parts per million when the statement was first published in 1994, keep rising – to 405.5 parts per million in 2017. For 2018 and 2019, greenhouse gas concentrations are expected to increase further.

The WMO climate statement includes input from national meteorological and hydrological services, an extensive community of scientific experts, and United Nations agencies. It details climate related risks and impacts on human health and welfare, migration and displacement, food security, the environment and ocean and land-based ecosystems. It also catalogues extreme weather around the world.

"Extreme weather has continued in early 2019, most recently with Tropical Cyclone Idai, which caused devastating floods and tragic loss of life in Mozambique, Zimbabwe and Malawi. It may turn out to be one of the deadliest weather-related disasters to hit the Southern Hemisphere," said Taalas.

"Idai made landfall over the city of Beira: a rapidly growing, low-lying city on a coastline vulnerable to storm surges and already facing the consequences of sea level rise. Idai's victims personify why we need the global agenda on sustainable development, climate change adaptation and disaster risk reduction."

The start of this year has also seen warm record daily winter temperatures in Europe, unusual cold in North America and searing heatwaves in Australia. Arctic and Antarctica ice extent is yet again well below average.

To access the Statement on the State of the Global Climate, Visit: https://bit.ly/2XWqHJ9

BACK TO TOP

Only a third of large global rivers still free flowing

Just over one-third (37%) of the world's 246 longest rivers remain free-flowing, according to a new study published in the scientific journal, ***Nature***. Dams and reservoirs are drastically reducing the diverse benefits that healthy rivers provide to people and nature across the globe.

A team of 34 international researchers from McGill University, World Wildlife Fund (WWF), and other institutions assessed the connectivity status of 12 million kilometres of rivers worldwide, providing the first ever global assessment of the location and extent of the planet's free-flowing rivers. Among other findings, the researchers determined only 21% of the world's 91 rivers longer than 1 000 km that originally flowed to the ocean still retain a direct connection from source to sea. The planet's remaining free-flowing rivers are largely restricted to remote regions of the Arctic, the Amazon Basin and the Congo Basin.

"The world's rivers form an intricate network with vital links to land, groundwater and the atmosphere," noted lead author Günther Grill of McGill's Department of Geography. "Free-flowing rivers are important for humans and the environment alike, yet economic development around the world is making them increasingly rare. Using satellite imagery and other data, our study examines the extent of these rivers in more detail than ever before."

Dams and reservoirs are the leading contributors to connectivity loss in global rivers. The study estimates there are around 60 000 large dams worldwide, and more than 3 700 hydropower dams are currently planned or under construction. They are often planned and built at individual project level, making it difficult to assess their real impacts across an entire basin or region.

"Rivers are the lifeblood of our planet," noted Michele Thieme, lead freshwater scientist at WWF and global leader at WWF's free-flowing rivers initiative. "They provide diverse benefits that are often overlooked and undervalued. The first-ever map of the world's free-flowing rivers will help decision-makers prioritise and protect the full value rivers give to people and nature."

Healthy rivers support freshwater fish stocks that improve food security for hundreds of millions of people, deliver sediment that keeps deltas above rising seas, mitigate the impact of extreme floods and droughts, prevent loss of infrastructure and fields to erosion, and support a wealth of biodiversity. Disrupting rivers' connectivity often diminishes or even eliminates these critical ecosystem services.

To read the study, Visit: https://www.nature.com/articles/s41586-019-1111-9

Acute hunger still affecting 100 million people – global report

Around 113 million people in 53 countries experienced acute food insecurity in 2018. So reports the Food and Agriculture Organisation of the United Nations (FAO) in a report compiled with the UN World Food Programme.

The report, released in April, found that nearly two-thirds of those facing acute hunger are in just eight countries: Afghanistan, the Democratic Republic of Congo, Ethiopia, Nigeria, South Sudan, Syria and Yemen. In 17 countries, acute hunger either remained the same or increased.

Climate and natural disasters pushed another 29 million people into acute food insecurity in 2018. And 13 countries – including North Korea and Venezuela – are not in the analyses because of data gaps.

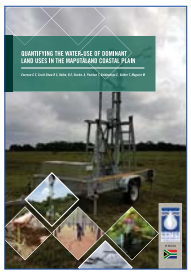
"It is clear from the Global Report that despite a slight drop in 2018 in the number of people experiencing acute food insecurity – the most extreme form of hunger – the figure is still far too high. We must act at scale across the humanitarian-development-peace nexus to build the resilience of affected and vulnerable populations. To save lives, we also have to save livelihoods," said FAO Director-General, José Graziano da Silva.

"To truly end hunger, we must attack the root causes: conflict, instability, the impact of climate shocks. Boys and girls need to be well-nourished and educated, women need to be truly empowered, rural infrastructure must be strengthened in order to meet that Zero Hunger goal. Programmes that make a communities resilient and more stable will also reduce the number of hungry people," noted WFP Executive Director, David Beasly.

To access the report, Visit: http://www.fsinplatform.org/global-report-food-crises-2019

BACK TO TOP

NEW WRC REPORTS



Quantifying the water use of dominant land uses in the Maputaland Coastal Plain

While forestry is an important contributor to the South African economy, the expansion of commercial forestry using fast growing alien tree species may have negative hydrological consequences. Commercial forestry is practiced along the Maputaland Coastal Plain. The aim of this WRC study was to understand and quantify the water use of different agricultural and ecological land use components of the Maputaland Coastal Plain. These could potentially be developed into an integrated, multiple-use agroforestry system(s), as an alternative to commercial plantation forestry in water stressed catchments.

Report No. TT 781/18

Exploring current and emerging irrigation and drainage management to reduce the impact of extreme events and mitigate droughts and floods

The Berg River Catchment is an important component of the Berg River water management area which supports seven municipalities in the Western Cape, including the City of Cape Town. This study took a participatory research approach to identify the opportunities and barriers in the Berg River Catchment, regarding innovation in irrigation and drainage practices aimed towards informing integrated management of the catchment. Different engagement tools were employed to ensure the incorporation of varied perspectives and knowledge of the social-ecological system.

Report No. 2861/1/18

Palmiet wetland sustainability: A hydrological and geomorphological perspective on system functioning

Prioium serratum (palmiet) is a robust plant that is endemic to the nutrient-poor Table Mountain Group (TMG) sandstones and the Natal Group sandstones. The plant grows in dense stands that impede river flow, forming wetlands. Palmiet is thus known as an ecosystem engineer. This study aimed to reduce uncertainty around palmiet systems by improving the understanding of the hydrological and geomorphological functioning of these wetlands. The study site was located in the upper catchment of the Kromme River.

Report No. 2548/1/18

Land tenure, tenancy and water services delivery in South Africa

This project sought to identify key questions that will help to develop policy tools to enable key stakeholders to deal with water and sanitation service delivery challenges emerging from the scenario of rapid urbanisation and de-agrarianisation of the post-1994 South African landscape. These tools may help to address the challenges presented by differing formal and informal land tenure and tenancy arrangements. The study builds on the findings of a previous WRC study on social protest and water services delivery in South Africa (**Report No. TT 631/15**).

Report No. 2358/1/18

Rotenone policy support and capacity development

Fish invasions are a major threat to imperilled South African fishes and other aquatic fauna. In some areas, particularly those of high conservation priority, the removal of non-native fish is necessary to restore natural processes. From a river rehabilitation perspective, eradicating non-native fish using piscicides such as Rotenone, allows for the rehabilitation of several kilometres of river. The primary objectives of this research project were to provide data on ecosystem responses of one river and two dams following Rotenone treatment to guide national policy on the use of piscicide for non-native fish removals; monitor rates of recovery of fish communities in the Rondegat River; and assess the recruitment and recovery rates of invertebrate communities to the removal of alien fishes.

Report No. TT 780/1/18 (Part 1) and TT 780/2/18 (Part 2)

Improving the uptake and impact of research-based knowledge in the digital age – A case study on water measuring and metering in commercial irrigated agriculture

The global demand for food and freshwater is increasing due to various factors. In South Africa, agriculture is the largest user of freshwater resources (about 60%). Irrigated agriculture is therefore increasingly under pressure to produce more food with less water. This goal can only be achieved if research on crop water use and advances in irrigation technology are applied appropriately in irrigation systems. The accurate monitoring and measuring of water use are integral to this process. Research organisations such as the Water Research Commission are one of the roleplayers in the agricultural system that produce the required research and development. However, local and international studies show that uptake of research-based knowledge/innovation in agriculture are generally disappointing. This study explored the journey from research to uptake through a case study in water measuring and metering in irrigated agriculture with the aim to address the challenge that local and international research organisations face: How do you ensure that your research products are adopted by the target audience?

Report No. TT 783/18

BACK TO TOP

Responding to new national and international water supply and sanitation monitoring and evaluation obligations

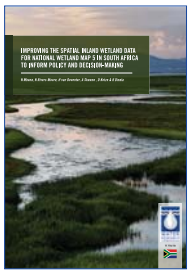
The world has moved into a new era of monitoring and reporting of developmental efforts. After 20 years of focusing on monitoring and reporting developmental interventions through the Millennium Development Goals, the globe has shifted to the monitoring of the sustainability of their development imperatives. The Sustainable Development Goals (SDGs) require that countries recognise the integration and balance required of the developmental initiatives to ensure the balance of the three dimensions of sustainable development: the economic, social and the environment. The aim of this research project was to link water and sanitation sector monitoring and reporting requirements in South Africa to better respond to future national and international needs; municipal reporting requirements and the SDGs. Recommendations are provided to guide local and national government on how to best align their water monitoring and reporting function to be able to provide a holistic and expedient picture of the status of the water sector.

Report No. 2588/1/18 (Main report); 2588/2/18 (Vol 2); 2588/3/18 (Vol 3) and 2588/4/18 (Vol 4)

Assessing the affordability of water services for residential consumers in South African municipalities

Households connected to municipal water systems in South Africa are likely to see rising water bills over the years to come due to rising costs of raw water supply and an increase in municipal water tariffs. In a country where more than half of the population is classified as poor, this raises concerns about the affordability of water. This study presents a more nuanced measure of water affordability for residential customers in four municipal case studies. The study focused on the ability to pay aspect of water affordability and calculated both the affordability ration and residual income.

Report no. 2584/1/18



Improving the spatial inland wetland data for National Wetland Map 5 in South Africa to inform policy and decision-making

It is widely agreed that it is a high priority to achieve an accurate map of South Africa's wetlands. Such a map will provide a critical baseline into the future, where, over time, the extent to which different forms of land use impinge into wetland extents can be mapped, and inferences can be drawn in terms of wetland condition and functioning. The latest National Wetland Map (NWM 4) was created in 2011. This project set out to assess the accuracy of the current map and improve the quality of spatial data on wetland extent as well as to investigate the impacts of scale and regional environmental patterns on predictor variables informing probabilistic models of wetland occurrence, type and condition.

Report No. TT 778/18

Validation and calibration of sap flux density measurements in citrus

The citrus industry is the largest exporter of fresh produce in South Africa in terms of volume and one of the highest earners of foreign exchange. Citrus is a perennial crop that requires a constant supply of water in order not to limit yields and returns on investment. Due to climate change, established production areas are likely to become drier, which will place increasing pressure on water resources and irrigation management to maintain productivity. A previous WRC research project used a sap flow technique to quantify water use of mature citrus, deciduous fruit and nut tree cultivars under best management practices. Findings from this project indicate results that were contrary to expectations, especially for citrus. This study presents information on the validation and calibration of sap flux density (SFD) techniques that were used to measure citrus water use. The most appropriate SFD technique to quantify transpiration in *Citrus sinensis* was identified and then used to gather information on citrus water use. A unique set of data on citrus water use was compiled.

Report No. TT 772/1/18 (Volume 1) and TT 772/2/18 (Volume 2)

To download a free copy of these reports
Visit: www.wrc.org.za.

BACK TO TOP

WATER SUPPLY

Keeping the taps on: Richards Bay at the water crossroads

Growing demand in the water-intensive Richards Bay industrial hub has raised concern about future supplies. Article by Tony Carnie.

Fiona Mackay

Sediment, sand and nutrients from the Thukela River gush into the Indian Ocean near Mandeni, nourishing marine life on the Thukela Banks. Three major industrial centres (Gauteng, Richards Bay and Durban) have also staked claims to the diminishing water resources of the Thukela.

It seems hard to imagine that the sprawling KwaZulu-Natal industrial hub of Richards Bay was little more than a fishing village just 50 years ago. Located at the mouth of the Mhlathuze River, the current harbour was once an expansive lagoon populated by a multitude of fish, hippos, crocodiles and other wildlife.

Portuguese mariners knew it as Rio-dos-Peixes (river of many fish) and way back in the 1820s, early British settlers pondered the possibility of turning it into a trading harbour. But it was not until 1879 that it gained its current name (from naval commodore Sir Frederick Richards, who landed near here to support British forces after the Battle of Isandlwana).

When the bells of the Second Anglo-Boer War rang out two decades later, the idea of a port was mooted once more, as Richards Bay offered one of the shortest routes from the coast to the former Transvaal.

Again, nothing really happened, and the quiet life resumed until April 1965 when former Transport minister, Ben Schoeman, announced firm plans to build a new deep-water harbour at Richards Bay. According to historian, A de V Minnaar, Richards Bay was pretty much a one-horse town at that time, comprising 49 cottages, a hotel, a one-room post office, a small general store, a bait station, a camping site and about 100 permanent inhabitants.

BACK TO TOP

That all changed once the first commercial ship entered the new deep-water harbour in 1975 and a massive underground fuel pipeline was installed to link the area to the industrial heartland of Gauteng.

Now, five decades later, the city and surrounding area is home to nearly half a million people and a multitude of heavy industries such as Mondi, Sappi, Richards Bay Minerals, Foskor, Tronox, South 32, Tongaat Hulett and the Richards Bay Coal Terminal.

Driving through the city today, some of the streets still pay homage to the former abundance of wildlife, with names such as Grunter Gulley, Anglers Rod or Fish Eagle Flight – but the real action is found in places like Alumina Allee, Bullion Boulevard, Dollar Drive or Krugerrand Grove.

Inevitably, rapid industrial development comes with a price tag. Richards Bay has emerged as a major user of the region's water resources – and potentially, national water resources such as the Thukela River.

The reality of future shortages was highlighted during the recent drought, when the level of the Goedertrouw Dam dropped to below 17% during 2016, compelling government to pump water from the Thukela River to ensure an emergency lifeline for Richards Bay. A year later, with river and dam levels still critical, a new 10 Ml/day desalination plant was established here to avert a water crisis.

But even before the drought took hold, the warning bells were sounded in 2015 in a report by the Aurecon consultancy group, commissioned by the Department of Water and Sanitation. This led to the publication of a new water reconciliation strategy for Richards Bay and surrounding towns for the period up to 2040, along with an interventions report.

The report found that while there was still enough water to cater for existing requirements, the region's water supply could come under significant stress in future – especially if rapid industrial growth materialised with the establishment of the Richards Bay Industrial Development Zone (RBIDZ).

The report looked at five scenarios (ranging from low growth to high growth over the next 25 years) and found that, even with low growth, Richards Bay was facing a potential water shortfall of over 30 million m^3/year by 2040. Under a high growth scenario, the city and surrounding towns faced a massive 142 million m^3/year shortfall.

Unless significant bulk industrial water saving and efficiency measures could be realised quickly, at least one new bulk water scheme would be needed by 2033 – while similar interventions would be needed as early as 2020 under the high growth scenario.

Should high-growth materialise in the long term, the Aurecon scenario evaluation demonstrated that several bulk water-supply schemes would be needed and some would have to be fast-tracked because of the long lead-times for the approval and construction of major infrastructure projects.

In the short term, water supplies could be augmented by raising the height of the Goedertrouw Dam by 2.8 m and by curtailing current water use through new conservation and water demand management strategies.

Bruce Mann

Richards Bay Minerals, which extracts titanium, ilmenite and other heavy minerals from coastal sand dunes along the Zululand coast, is one of the single-largest bulk water users in the Richards Bay region. Large volumes of water are lost daily from evaporation and seepage from its dredger ponds.

BACK TO TOP

Tony Carnie

Umgeni Water planning services manager, Kevin Meier, watches millions of litres of water pouring over the R1.6 billion weir which form part of the Lower Thukela Bulk Water Supply Scheme near the mouth of the Thukela River. Water from this scheme is used to supply growing industrial and residential development in the Mandeni and KwaDukuza area, north of Durban.

The report pointed to the need to plug leaking municipal pipes and reduce the volume of water used by sugar farmers and local industries. "The largest four industrial water users, namely Mondi, Richards Bay Minerals, Tronox and Foskor, use 96% of the total bulk industrial use."

To place this in perspective, Aurecon noted that these four companies alone appeared to be using nearly 60% of the total water used in the Richards Bay area. Based on 2013 data, Mondi's pulp and linerboard mill was using 75 Ml of potable water a day – of which about 65 Ml a day was discharged to sea as treated effluent.

Richards Bay Minerals was using a very similar volume of raw water from the Mfolozi River, Lake Nhlabane and Lake Nsezi (with about 55% of this used in the sand mining process and the remainder at its smelter plant). An astonishing 50 Ml of this was used daily in the mining process (about five times as much water produced currently by the city's new desalination plant).

Based on 2008 consumption figures, the Tronox KZN Sands operation was using 22 Ml of water daily (with at least 6 Ml of this lost daily due evaporation or underground seepage from its mining ponds).

Aurecon suggested that many of the large industrial users had achieved significant water savings since 2008 and recommended that the municipality should consider raising potable water tariffs for residential use as Richards Bay tariffs were considerably lower than those in Durban and Cape Town. The report also recommended that a new dam on the Nseleni River was likely to be a very cost-effective option, but could only deliver about 6 million m^3 of extra water per year.

Because Richards Bay is one of the country's strategic economic hubs, much larger bulk water augmentation is required for future industrial growth.

Future large-scale options could include a major new off-channel dam and transfer scheme from the Mfolozi River; two major schemes to transfer water from the middle and lower reaches of the Thukela River; and desalination of seawater.

Mfolozi dams option

The report notes that sections of the Mfolozi are already heavily utilised by upstream users (including the towns of Vryheid and Ulundi and irrigation farmers upstream of Mtubatuba). There is also a need to maintain the ecological reserve of this major river system that drains into the Lake St Lucia estuary in the iSimangaliso Wetlands Park and World Heritage Site.

While there are two potential dam sites inside the Hluhluwe-Imfolozi Park, any proposals to flood land inside this game park would be strongly opposed by Ezemvelo KZN Wildlife. There are also two potential dam sites on the Mfolozi which are outside the park, below the confluence of the White and Black Mfolozi Rivers.

If either of these dams were to go ahead, they should be built to avoid water back-flooding into the game reserve, as well as to reduce the number of rural homesteads that would have to be relocated.

As an alternative to building a large dam with significant environmental and social costs, a more feasible option could involve building an off-channel dam on the Mfolozi to store and pump water to Richards Bay.

Thukela River transfer scheme option

Following the 1994 drought, an emergency water transfer scheme was built to transfer up to 37 million m^3/year to the Mhlathuze River catchment, but the scheme was not intended to be permanent.

In future, one option would be to transfer much larger volumes of water from the Thukela from the Middledrift area or from the Lower Thukela near Mandeni.

However, abstracting more water from the Thukela would also have national implications because of competing demand for the same water to supply growing industrial and residential demand in both Gauteng and northern Durban.

"The strategic importance of the future allocation of water from the Thukela River must be considered in a broader, national strategic perspective," Aurecon cautioned, also noting that three large dams (Mielietuin, Jana and Smithfield) had also been proposed higher in the catchment to augment the Vaal River system. "It is not exactly clear how much water is available from the Thukela River, and this will need to be clarified."

Seawater desalination option

The report suggests that seawater desalination could in theory provide unlimited volumes of water at almost 100% assurance of supply and would not be affected by climate change or drought. However, a significant drawback is the extremely high electricity costs to desalinate seawater using reverse osmosis technology. It would also be necessary to ensure a back-up supply of electricity from generators in case of Eskom power failures.

BACK TO TOP

While desalination could yield almost limitless volumes of treated water, modelling suggested that a 60 Ml/day desalination plant could cost up to R1.8 billion, with annual operating costs of around R50 million per year if the plant relied on a marine intake.

If the water intake was located inside the harbour area, the capital and operating costs would be slightly lower, but further studies would be needed to measure the potential negative impacts of brine discharges.

"The high capital and operating cost would likely lead to increased water tariffs, depending on the extent to which the capital costs are subsidised. The very high operational cost would likely also lead to an operational practice where the desalination plant is utilised for less than 5% of the time i.e a significantly underused, yet strategically important asset," Aurecon cautioned.

Since the Aurecon augmentation report was published, a smaller 10 Ml/m^3 desalination plant was commissioned in January 2017 at a reported cost of R300 million. According to the 2017-2022 spatial development framework, published by the uMhlathuze municipality, Richards Bay is implementing a new five-year strategic management plan for water conservation and water demand management.

The municipal framework plan suggests that it may be possible to reuse significant quantities of water from a variety of sources, including wastewater currently discharged to sea and through the indirect use of water from municipal wastewater treatment plant.

But it also notes that there are other significant expansion plans in the pipeline – including new mining ventures, several new investments associated with the RBIDZ and a potential three-fold increase in the surface area of the city's deep-water harbour.

According to the RBIDZ strategic plan, there are nearly 12 new investment proposals in the pipeline with a total value of more than R10 billion.

It is understood that these proposals include a new liquified natural gas power plant, a solar panel manufacturing plant, a chemical plant, a palm oil refinery, a kraft paper mill and a titanium dioxide pigment plant.

In a recent case study thesis on water conservation and demand management in Richards Bay, University of Cape Town Masters student, Nkosinathi Mthethwa, noted that these new investment proposals would significantly increase the city's growing demand for water.

"If the demand for water continues to grow, with no steps taken to reduce the demand, water shortages could become the order of the day," he cautioned.

Tony Carnie

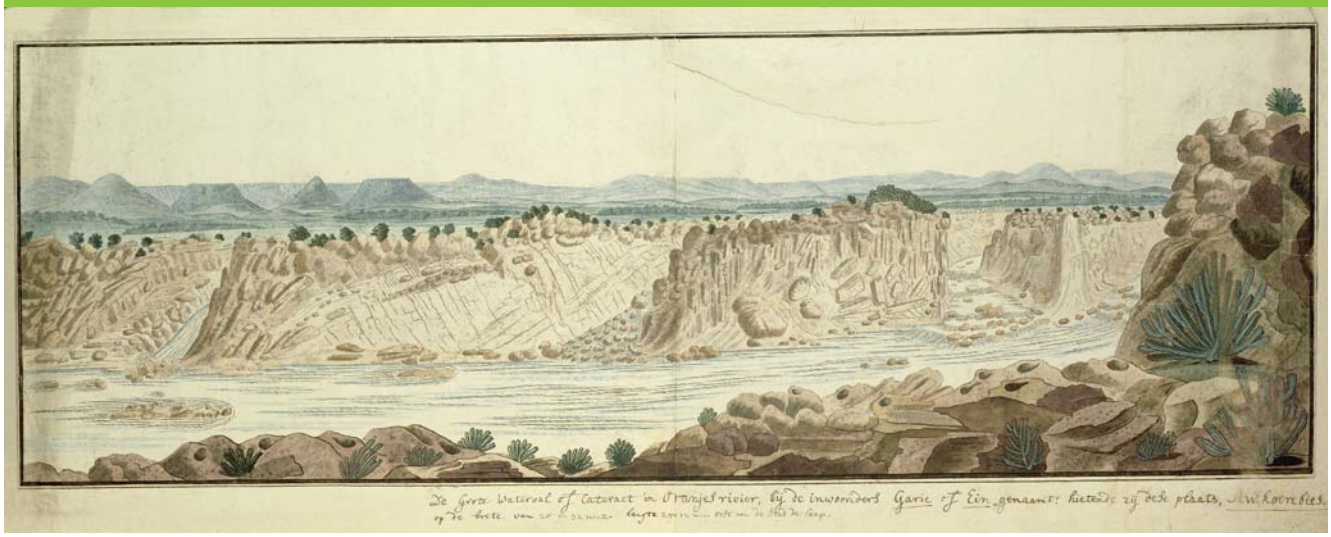
Eskom pylons convey electricity to the water-intensive industrial hub of Richards Bay. Further large volumes of water are also required to cool the coal-fired power stations which generate electricity for industry in Richards Bay.

BACK TO TOP

WATER HISTORY

Travels of Robert Jacob Gordon – Part 4

The final part of the Water Wheel's Robert Jacob Gordon series traces his journey along the Orange River, which he had named in 1777 after the Dutch Republic's Prince of Orange. Article by Sue Matthews.



All images attributed to Robert Jacob Gordon courtesy of the Rijksmuseum

Gordon visited the Augrabies Falls in October 1779, when the river level was very low.

After visiting the Orange River mouth and realising the terrain upstream was too rough for the ox-wagons, Gordon returned with the wagons to the vicinity of present-day Kamieskroon, before departing on 18 September 1779 and heading north into the Koperberg Kloof near present-day Springbok. The group passed the abandoned mine shafts sunk by Simon van der Stel and his team in 1685 to test the copper resource, and then headed north-east across the barren Bushmanland plains.

On 26 September they arrived at the cattle post owned by Gordon's travelling companion, Pieter Pienaar, who had taken the more direct route along the Orange River from the estuary. Pienaar reported that the trip had taken him 21 days – somewhat longer than Gordon's estimate of "twenty-four hours, travelling in a straight line" when they had parted company a month before. They were now just a few kilometres from the river, which lay behind a mountain range. During his stay at the cattle post, Gordon befriended some local people which he identifies in his journal as being 'Bushmen' and 'Einiquas', who decided to accompany him when he headed off after a few days' rest, leaving his boat here because he predicted that the wagons might have to be left at some point upstream.

After two days' travel, Gordon's group "outspanned at a brack spring called Commas, a little less than an hour from the river". This was the oasis later known as Cammas Fonteyn, and renamed Pella in 1812 by the resident minister of the London Missionary Society, after he and his flock relocated here following an attack on the Warmbad Mission on the northern side of the Orange River. Gordon noted that this was the "last farm", but the owner was absent and had left his cattle under the care of a servant.

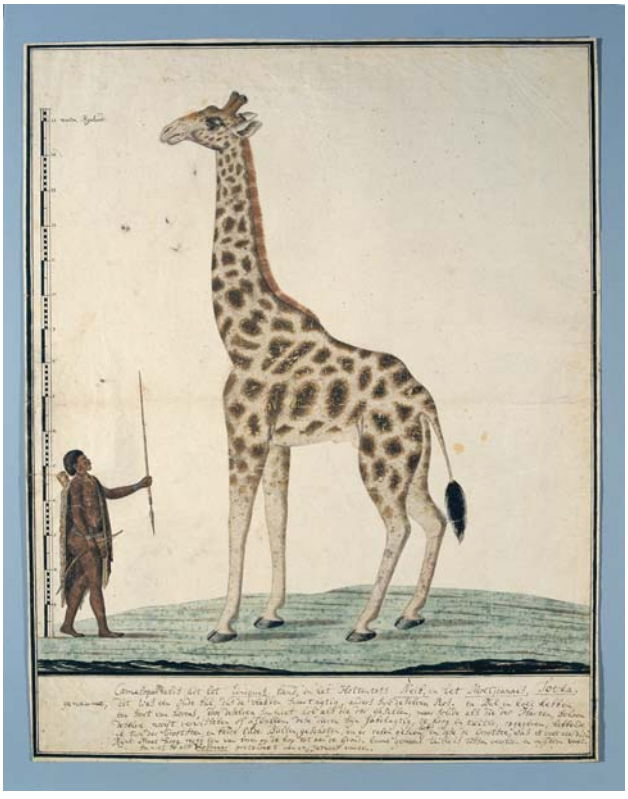
Their path blocked by a mountain, the group made a detour towards present-day Pofadder, and then approached the river in the vicinity of what is today the village of Onseepkans. Gordon noted that the river level was very low, and the bed so full of large stone slabs that one hardly saw any water at first glance. "That this river only becomes full in the thundery season or Cape summer, and is more often low than full, is shown by the

BACK TO TOP

many willows and sorts of mimosa trees that grow vigorously everywhere beside and within the river (apart from a small area in the middle) as well as on the banks and on a type of small island," he wrote. "When the river is completely full there must be a great flooding over the stone slabs."

For the next few days they had to travel some distance away from the river because of the mountainous terrain. At an underground waterhole they met up with Pienaar and his men, who would again be travelling with Gordon. The size of the party continued to grow though, because every day they were joined by more Bushmen, who shared in the spoils of the hunts. After Pienaar shot a giraffe, Gordon spent an entire day measuring and examining the "beautiful and extraordinary animal, one of the most loveliest that nature has formed". He recorded all these measurements in his journal with detailed descriptions, cutting up the corpse for further study and then burying the bones so that he could collect them upon his return. His accurate drawing of the giraffe made a great impression on his new travelling companions.

"Nothing could equal the surprise of the Bushmen and Einiquas on seeing the drawing. They said that we were amazing people and that they now saw that I could 'coeroe' everything (this means imitating and writing) and that they now saw why it was I had walked so far, backwards and forwards, looking, because at first they could make no sense of this."



Gordon's caption on this depiction of a giraffe hunt near Augrabies Falls can be translated as: "Here I had the most beautiful and most singular sight in all my journeys, seeing in one glance of the eye in a semi-circle, 12 giraffes, around 50 elephants, 5 rhinoceroses, a flock of 20 ostriches, a herd of 13 kudus, and a great herd of zebras, seeing also the hippopotamuses swimming and playing with each other in the river below."

On the 15 October the group made camp half-an-hour from the Augrabies Falls, which Gordon noted was called ***Aukoerebis*** or ***Holleplaats*** by the Einiqua. "Went to the river to look at the waterfall which I could not yet either hear or see, although when the river is in flood, one sees the spray a day's journey away and hears it from further," he wrote. "I saw that the water was at its lowest, otherwise I could not have reached the islands and thus the deepest crevice. (Although I missed the fine view of spray and the rainbow.)"

Of course, given that the Orange River is now a regulated system with scheduled dam releases for irrigation and hydropower, the 'low flows' of today are considerably higher than they were in Gordon's time.

"Surprised by the dusk, I returned by moonlight and found Pienaar who had gone off alone up the river. They had shot a hippopotamus and some of them nearly had an accident with a rhinoceros that they had managed to wound. They discovered two Bushmen kraals beside the river, who first fled before them but later came to get hippopotamus meat from them. They also had wicker traps and caught many fish, mostly mud-mullets. Each kraal was about fifty strong. One had a young woman whom they could not suffer, and she was as thin as a skeleton from hunger. She was frightened that they would take the hippopotamus meat that Pienaar had given her. When we come back again, I shall ask her to accompany us.

"I am astonished at the Bushmen: though everything lies within reach, they will touch nothing with the intention of taking it away. Although we are so vulnerable in this distant, savage country, full of wild animals, yet we are quite at ease, though keeping an eye out, as if in the middle of Cape Town. When one compares the descriptions of people who, even in the vicinity of Cape Town, find all kinds of danger, one can see how little real danger there is because it is only in the minds of men."

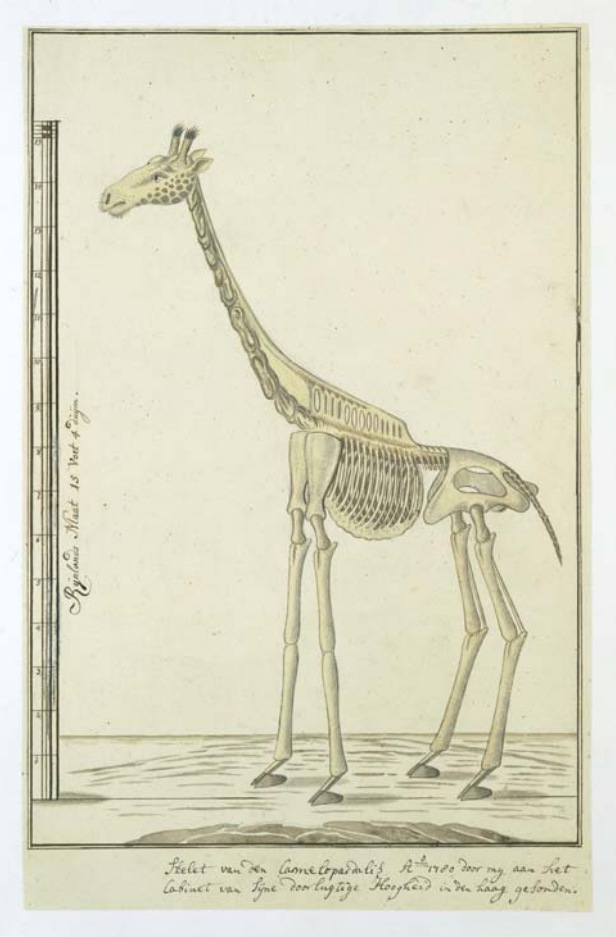
Gordon stayed here for a few days, exploring the falls and interacting with the local people, who he noted were of the Einiqua tribe. They survived in this inhospitable terrain by catching fish and digging pits on the side of the river to catch hippo, rhino and elephants.

"A little old Bushman or rather Einiqua from the Anoe kraal, showed me the way and everything else. In the late afternoon he brought me to the fourth stream over small stony islands where he showed me the place where the river makes the most noise when it is full, there being two such places a good quarter of an hour apart. It was just another crevice. He told me that when the river is full, most of the islands are submerged and that one's head spins from seeing and hearing the foaming water. After I had spent the whole day roving round with this good fellow Doëga, for that was his name, I made ready to leave in the morning."

The following day the group travelled a few hours to some Namneiquas living on a large, lushly vegetated island in the river. Their two elders, or chiefs, told Gordon about their constant sparring with other tribes in the area.

"They complained most about the Ogoqua, but they owe each other nothing. I told them that our great Chief wanted them

BACK TO TOP



Gordon took copious measurements of a giraffe, which he called a 'cameeleopard', and even dissected it to draw its skeleton.

all to live in peace and that I would also discuss this with the Ogoqua, at which they were delighted. Nothing astonished them more than my long hair which I was wearing loose at the request of Toenema, my thick beard as well. No king in Europe could have received more respect than that which they had for me in their own manner."

After another half-day's travel, the group reached the Hartbees River, which Gordon noted was some 200 paces wide, full of dry reed and cypress trees, but with not a drop of water in it. Here, Gordon decided to send the wagon back to the Namneiquas with three of his men, so that the rest of the group could cross the Orange River just upstream, near present-day Kakamas, taking only as much as four pack-oxen could carry.

"We crossed, without unloading the pack-oxen, and without getting wet above our hips and generally not above the knee. Around noon we were on the other side, having crossed three streams."

And so the group continued following the river on foot, Gordon everywhere making friends at kraals of the local clans – the Goeringneis, Geisiqua, Koraquas and Hoekingeis, among others – and noting their customs in his journal. On 5 November, having come to a place where the river passed between high mountains, Gordon decided that this was as far as they would go. Today, this is the site of the Boegoeberg Dam, which lies more than 900 km from the Orange River mouth, taking the watercourse's winding route into account.

Before leaving their hosts, Gordon's staff bartered beads and tobacco for some cattle, after which he presented a small but thoughtful gift.

"I gave them a little mirror for the women and girls of the kraal. I gave it to the oldest woman to keep in case they should want to paint themselves. They were most astonished and happy at this. One of them, hearing me sing, asked if we always sang without dancing."

On 7 November, they started back the way they had come, and on the 16th they crossed to the southern side of the river in the Kakamas area. Later that day, upon reaching the dry Hartbees River, Gordon went ahead on his own.

"Here for the first time on the whole journey I mounted a horse, being uneasy as to how things were with the wagon and our people at the Namneiqua; and I rode on my own to the wagon in two-and-a-half hours, even though I got lost, and found it in good order and my people praising the Namneiqua. Found some of these Hottentots at the wagon and they showed as much joy at my return as my own three Hottentots. They said that the other people must have been rascally since I had come back so thin. I said no; it was because I had had to walk so hard."

Five days later, Pienaar left for his cattle-post, and Gordon sent his artist, Shoemaker, with him "because he is out of control, as much from lack of drink as from the length of the journey." Gordon and his four remaining men struggled on with the wagon, which was starting to fall apart. Finally, Gordon went ahead to Pienaar's cattle-post and sent nails and hoop irons back to repair it. "Am sleeping next to my boat under a black ebony tree," he wrote on 28 November. "Everything except my scotch cloak is at the wagon. It is a great wonder that one can sleep thus on the bare earth and still be free of snakes and scorpions."

Two days later Pienaar left for the Cape, while Gordon waited for the wagon, which arrived on 2 December. After a day spent reinforcing the repairs, they set off to the west, and on 8 December Gordon and a small party crossed to the northern side of the Orange River with five pack-oxen to explore the area. They ascended the dry Leeuwen River, now known as the Hom, and on 11 December reached the hot spring known as Warmbad, which later became a popular resort. After venturing a little further north, Gordon decided to head home to the Cape. They followed a road back to the Orange River to cross over at the Compagnies Drift, and found the wagons a little further downstream at the drift then called Goedouw or Gudaos – meaning sheep path – but now known as Goodhouse.

On 19 December they left the Orange River, and by New Year's Day had reached a farm a few kilometres upstream of the Groen River mouth on the west coast. They arrived back in Cape Town in mid-January, and the following month Gordon took over as senior commanding officer at the Cape after the resignation of the previous incumbent. In April he married a Swiss woman in Cape Town, Suzanne Nicolet, but the 'honeymoon period'

BACK TO TOP

of these two events was undoubtedly brought to an end by the outbreak of the Fourth Anglo-Dutch War at the end of that year. This resulted in various foreign troops from Dutch allies being stationed at the Cape to ensure its defence, and although Gordon was promoted to Colonel in March 1782 – the first officer to hold that rank at the Cape – he struggled to obtain a clear directive about his authority over these visitors.

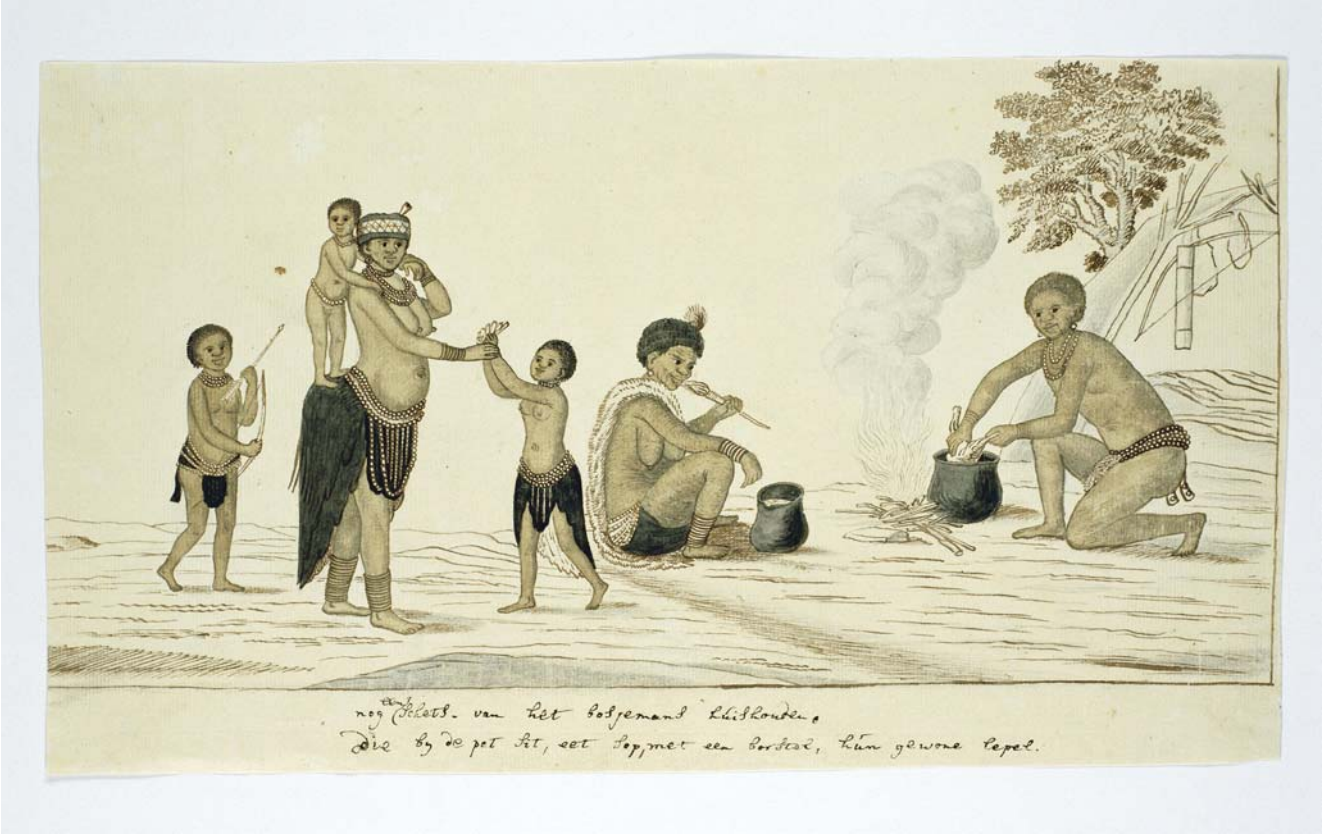
His responsibilities meant that he was unable to embark on another exploration until such time as the war ended. He subsequently departed on a final journey in November 1785, first travelling north to the mouth of the Jakkals River on the west coast, where the town of Lamberts Bay was later developed, and then crossing the Karoo to Algoa Bay on the east coast.

An Orange River white-eye as drawn by Gordon.

Here, during a detour to the Boesmans River mouth just north of the bay, Gordon walked up the beach and discovered an old, shattered monument atop a hill at Boknes. He gathered the pieces together to take back to Cape Town, and noted a few days later that they had been loaded onto the wagon. These are thought to be remnants of the stone cross erected by the Portuguese explorer Bartholomew Diaz in 1488, but their fate is unknown. In 1938 about 5 000 fragments of the 'Diaz Cross' were discovered at the site by Professor Eric Axelson, and the reconstruction using these and manufactured missing pieces is on display at Wits University's William Cullen Library.

Gordon was back in Cape Town by the end of March 1786, where he remained until the end of his life. Sadly, following the British invasion of the Cape and the Colony's surrender, Gordon – plagued by accusations of treason, his failing health and marriage problems – committed suicide in his home in October 1795. His widow and four children, the oldest of whom was 14, subsequently returned to Europe.

Translations of Robert Jacob Gordon's diaries by Patrick Cullinan and associates of the Rijksmuseum: https://www.robertjacobgordon.nl/

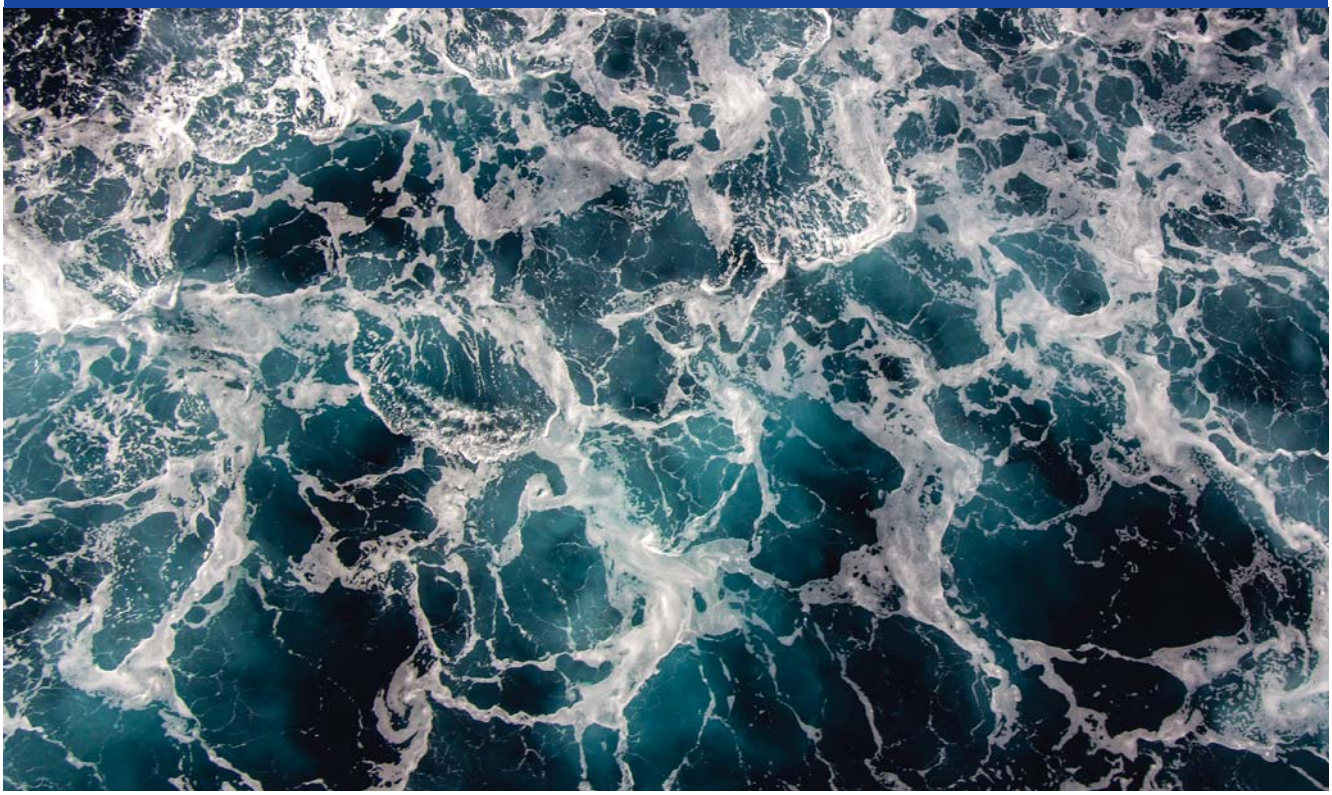


Gordon's caption states that this is a 'Bushman' family sitting by the cooking pot and eating soop using a brush as a spoon.

ALTERNATIVE WATER SUPPLY

Seawater desalination: Thoughts on implementation

As natural freshwater resources become increasingly committed, and less reliable due to climate change, so desalination is expected to rise in prominence. Dawid Bosman from the Trans-Caledon Tunnel Authority (TCTA) shares some thoughts on desalination implementation in South Africa.



The ability to derive freshwater from the sea, has long been an ambition of man. The ancient Greek philosopher, Aristotle, first wrote of it more than two millennia ago. Some sixty years ago, former US President, John F Kennedy, dreamed of the day when seawater desalination would be a feasible resource: "…if we could ever competitively get freshwater from saltwater…that it would be in the long-range interests of humanity which would really dwarf any other scientific accomplishment."

Kennedy would have been pleased with the progress made in the years that followed. Today, large-scale seawater desalination is a mature technology, and is becoming ever more cost-competitive. It is widely recognised as a strategic technology, and a means of mitigating some of the effects of climate change.

More than 15 000 plants produce a total of some 75 million kilolitres per day, and the benchmark exit prices, at the better plants, have come down to the level of (US) $0.50 to $0.60/kl.

Today, whereas desalination supplies only about 1% of global needs, its long-run rate of growth (about 6.5% per annum, on average, over the past 17 years) exceeds that of population (about 1.1% per annum) and economic growth (about 3.9% per annum) combined, suggesting that its share of the supply-side will grow.

Locally, there are firm indications that some of the coastal metropolitan hubs will be launching large-scale seawater desalination projects soon. Cape Town's Draft Water Strategy

BACK TO TOP

reveals planning for a first 50 Ml/d to be on-line by 2025 (or 2028, if a low-demand, mild climate change scenario plays out), followed by another 50 Ml/d, five years later; the planning and preparation for these projects are therefore imminent.

Umgeni Water conducted detailed feasibility studies for two 150 Ml/d plants, but pre-treatment challenges resulted in conventional options winning out, at least in the medium term. Several smaller local authorities are also investigating project feasibility of desalination. There appears to be a growing realisation that a changing climate could be eroding the reliable yield of existing water-supply systems.

Towards implementation

South Africa has not yet implemented a large-scale seawater desalination project anywhere; several smaller plants have been established, with the largest being the 15 Ml/d plant in Mossel Bay. Most, if not all, were constructed in response to a drought which had exceeded planned contingencies. As a result of the emergency nature of these projects, many of the plants were not optimally designed or procured, and the water exit prices achieved were invariably high, usually several multiples of the international benchmark.

The considerations for implementing large-scale seawater desalination largely depend on the degree of water scarcity. In the Middle East and North Africa (MENA) region, an absolute scarcity of freshwater creates a compelling argument in favour of an extensive reliance on large-scale desalination. Countries which suffer from lesser degrees of water scarcity, like South Africa, tend to have more options, and the adoption of large-scale seawater desalination, when it comes into the frame of consideration, is a much more complex matter. Here, typically, periods of water sufficiency are interspersed with periods of deficiency, and planners are often divided on the merit of desalination as a supply option.

The stakes are high in this area: The projects are complex, expensive and different in many respects from conventional surface water projects. Hence, it is essential for water managers to grapple with the considerations, and to have a nuanced, well-informed debate on the merit of desalination, and a sensible pathway towards large-scale implementation. The recent drought in the Western Cape, and, in particular, the plight of the City of Cape Town, has brought the desalination debate much closer to the forefront. Very likely, the issues being grappled with in Cape Town at present, on how to recover from the drought and increase resilience in the future, is a precursor of discussions yet to be had in other centres.

There is much to learn from countries that have already proceeded with large-scale desalination. The importance of international learning was recently emphasised by Christopher Gasson, the publisher of Global Water Intelligence: "What will really determine whether we are moving towards greater global water intelligence is the openness to international solutions. Different countries are having to address the same issues at different times, and I draw confidence from the fact that whatever the trend towards autarchy and aggression in global politics, there is still an appetite to learn from others' experiences in water."

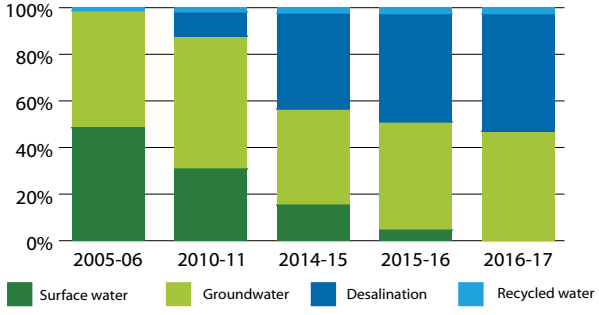
Drawing on lessons from the Australian build programme of 2005 to 2012, this article aims to contribute to the debate in two areas: 1) The ***value proposition*** of being substantially reliant upon desalination, and 2) Some thoughts on the very important matter of the ***timing the project***, through which some of the risks posed by climate uncertainty can be mitigated.

A value proposition for large-scale seawater desalination

Within the water utility context the value proposition of large-scale desalination is not widely understood, and hence is frequently dismissed as "too expensive", "too energy-intensive", or "too complex", relative to more conventional supply options. What is seldom considered is that desalination has unique attributes, which can fundamentally change the relationship we have with water.

Freshwater is consistently and justifiably positioned as a scarce natural resource to be treasured and conserved. However, freshwater derived from seawater desalination, albeit usually more expensive, is infinitely scalable and climate independent. It can be produced in whatever quantity is required, at a predictable price, regardless of the climate. It is impervious to drought, of course, but has also been found to be useful in the event of floods (for example, during the January 2011 floods in Southeast Queensland, much of the surface water resources were polluted by excessive stormwater. The Gold Coast desalination plant, being a closed system, was unaffected, and supplied between 40 and 80 Ml/d into the grid). As a result of these attributes, freshwater derived from seawater desalination becomes a renewable economic commodity, and water availability becomes merely a matter of planning, in a predictable, steady-state environment.

Whereas the above may appear hypothetical at first, there is comfort in knowing that it has been done. Figure 1 below demonstrates the transition of Perth, Western Australia, wherein their 50% reliance on surface water was entirely replaced by seawater desalination, over the course of less than a decade.



Volume of water sourced in Perth urban centre (%)
Seawater desalination has but replaced surface water abstraction in Perth's water mix of water sources. Meanwhile wastewater reuse remains a small part of the city's water supply. Public opinion was the key driver behind the decisiom by Water Corporation WA to pursue desalination over wastewater reuse in the late 2000s - the utility's tow-year construction timetable for groundwater recharge capacity was preceded by an 8-year PR campaign to win public support for indirect potable reuse.

Figure 1: Perth WA water supply mix, 2005 to 2017.

BACK TO TOP

When the water resource portfolio of a city is overwhelmingly climate resistant, as in the case of Perth, it brings a consistent and predictable assurance of supply, which is conducive to economic stability and growth. Water availability and tariffs are no longer question marks on the business case for an investment in a factory or an urban development. Sectors which are highly sensitive to water-supply uncertainty, such as tourism, hospitality and film, can be reassured. The water utility also benefits from the assured supply through consistent water revenue; it is now apparent that, because of reduced water sales during the water crisis, the City of Cape Town lost R700 million in revenue in the first six months 2018 alone. Furthermore, in an assured dispensation, tariffs need no longer be used as punitive instruments to discourage consumption, which eases ratepayer tension.

Timing

With increasing climate uncertainty, it has become very difficult to determine the optimal timing of a desalination project. Build too early, and you may be burdened with a vast amount of capital tied into an idle asset for years; build too late, and you will have no means of mitigating the impact of the drought when it comes, and the asset will be idle until the next drought. Perhaps the worst outcome is when the project is still underway when the drought is broken.

The thirteen-year Millennium Drought in Australia ended in 2010, at a time when the country had just completed three very large desalination plants in Perth, Gold Coast and Sydney, and three more were underway in Perth, Adelaide and Melbourne. Ample rains returned, and many people regarded the expensive new plants as a poor choice, wishing it could somehow be reversed. Someone made the wry remark, that the quickest way to end a drought was to build a desalination plant…

As it turned out, four of the six Australian plants were either mothballed or placed on 'hot stand-by' soon after completion, and were only re-activated years later, when a drought impacted water reserves. In Perth, the drought continued, and the city's two plants have been in full production since completion, gaining widespread support. In all the other cities, the desalination projects became controversial, being positioned by some as "insurance against a drought", and "wasteful stranded assets" by others.

Since the Australians were building these plants as a mid-drought response, the market environment into which these projects were launched was predetermined. Bids were generally higher than what had been expected, and environmental authorisations had to be rushed, leading to a number of very costly design concessions. Global economic conditions during 2007 and 2008 did not favour capital borrowing. When the dust finally settled, they had built the six most expensive desalination plants to date anywhere, and only two were being used. Clearly, the timing of these projects was a major issue.

Desalination is set to become part of Cape Town's water-supply mix in the near future.

BACK TO TOP

"It is essential for water managers to grapple with the considerations, and to have a nuanced, well-informed debate on the merit of desalination, and a sensible pathway towards large-scale implementation."

With the luxury of hindsight, they could have launched the projects years earlier, at a time when contractors had excess capacity, the cost of capital was low, and they had the time to plan the projects for optimal location and design; in other words, they could have built their plants in anticipation of a drought, and not in response to a drought. Comparing the two approaches, it is clear that both contain the risk that expensive infrastructure may be under-utilised for an unknown period of time; that seems largely unavoidable when planning in an uncertain environment. But, there seems to be a distinct benefit in implementing the project in a time when there is not a water crisis, latitude in timing allows for optimal project planning, design and construction, and there is less opportunism in the market.

Perhaps a refinement to this approach would be to implement the project in two phases, with an indeterminate pause in the middle. The first phase could be implemented during a time of ample water reserves, in anticipation of a drought; the second phase could be launched when a drought has come, and the outlook is that the plant will be required.

In the first phase, which would typically be an engineering, procurement and construction (EPC) contract, crucial project elements such as site selection and acquisition, environmental authorisation, grid integration, plant design, marine works and nearly all other civil works could be completed in advance. Long-lead items could be ordered, and stored on site, where appropriate. Procurement documents for Phase Two could be drawn up. These elements are generally durable, impervious to redundancy, and has little or no influence on the proprietary technologies and processes that would be installed later, during Phase Two. Upon completion of Phase One, the site would be secured and mothballed, in anticipation of a drought to come.

A drought never announces its arrival; it only becomes apparent during the course of a rainy season. Hence it is reasonable to assume that, by the time a drought is declared, water reserves would already be partly depleted, and the window for completing the desalination plant before reserves run out, already closing. For this reason, the remaining construction in Phase Two needs to be initiated and completed quickly. This is of critical importance in instances where per-capita water reserves are limited.

Let's take the Cape Town example. Under normal, unrestricted use, Cape Town's dams can last about two years with no rains, which is equal to the typical construction time of a large desalination plant (i.e. assuming that all procurement, design and permitting have already been completed). Some cities have much greater reserves; Sydney, for example, could last five years. The notion that Cape Town would have adequate reserves to allow a desalination plant to be built in time, before the reserves run out, is tenuous however. The decision to commence construction would need to be taken with all the dams 100% full, and yet complete conviction and foresight that a long-term drought has come, which is highly improbable. Hence, the imperative exists, especially where water reserves are limited, to reduce the construction lead-time.

This two-phased approach should have the following benefits: The first phase is completed during a period when crucial, cost-bearing project decisions are not made under time pressure. This allows for ample consideration and optimisation of site selection, environmental impact, grid integration, and plant layout and design. Drawing on the Australian lessons, there is evidence of time constraints having resulted in more costly design options being taken.

Once the first phase of work has been completed, it demonstrates a firm commitment to the project by the client, and provides additional comfort to bidders that serious intent exists. Usually, this would help solicit a more substantial response from the market during the second phase, and reduce the perceived risk arising from policy uncertainty or political commitment, which can cause bidders to add a "risk premium" to their tenders.

The risk of equipment and plant redundancy during the idle time, which could be several years, is much less than when the plant was built to completion, and then mothballed. In the two-phased approach, the elements most susceptible to redundancy, like membranes, energy recovery devices, pumps, control systems and process design in general, are held back until the drought eventually arrives, at which time the most current designs and technologies could be procured.

"With increasing climate uncertainty, it has become very difficult to determine the optimal timing of a desalination project."

Concluding remarks

In another 20 years' time, South Africa would most likely have procured a number of large-scale desalination plants and by then, our knowledge of how to do so would have advanced immeasurably. By then, due to the limitation of natural run-off, seawater desalination would probably have become a more regular choice to augment supply, and no longer the drought-response mechanism it is today.

In the short and medium term however, water managers would continue to grapple with the difficult choices around desalination, while it serves as a mitigation measure to climate change. The onus is upon us to be informed and prepared for the challenge.

BACK TO TOP

WATER AND THE ENVIRONMENT

Ecological Disaster took Kamfers Dam by Surprise

The Kamfers Dam flamingos made national news earlier this year when drought imperilled thousands of newly hatched chicks. Phetole Peter Ramollo reports from the Northern Cape Department of Environment and Nature Conservation.

Kamfers Dam is an endorheic saltpan situated north of Kimberley in the Northern Cape Province. This wetland is one of the most important breeding sites of the near threatened Lesser Flamingo species in Africa. Originally, this wetland was an ephemeral pan filled with water from rainfall only. The flamingos used the site as a 'stop-over' during their migrations and once the water dried out they continued their journey to other suitable pans.

Over the years, the Homevale Sewerage Works outflow has pumped enough wastewater into the wetland to change Kamfers Dam into a perennial wetland, consequently turning it into a conducive habitat for flamingos and other waterbirds. Today, Kamfers Dam is regarded as a permanent residence for Lesser Flamingos as it provides a suitable habitat and sustained food resources.

In 2006, an artificial breeding island for the flamingos was built at the northern edge of the wetland. This has benefited the flamingos by producing approximately 22 000 chicks between 2007 and 2009. The population count was estimated at more than 80 000 flamingos at the peak of breeding period on the bird island in the wetland.

In 2009, during the breeding season, increasing water levels coming from the city of Kimberley sewerage systems, stormwater and heavy rainfall exceeded the high water mark of the pan, causing the breeding island to be flooded, resulting in many of the chicks drowning.

In 2017, it was found that the flamingos were breeding on the south western edges of Kamfers Dam – the first natural breeding

BACK TO TOP

event not facilitated through human interventions since 2010. Flamingos built turrets (nests) and laid eggs successfully. Unfortunately, a number of eggs were abandoned in response to the declining water levels. Adults and mobile chicks moved to where feeding (water) was available, causing eggs exposed to harsh environmental conditions (heat especially). Eggs continued hatching until late March 2018, whereafter most of the chicks were able to feed and fly on their own.

This year, the flamingos bred again at the same spot where they previously bred in 2017. But this time the continued drought, exceptional high temperatures and winds brought a larger risk. The ongoing climatic conditions, leakages of sewarage pipes and diversion of water from the Homevale Wastewater Treatment Plant put the lives of these flamingos and other waterfowls in the greatest danger since their first breeding event. The residing water level came at a higher rate, steering the breeding event towards an ecological disaster.

The drastic drop in water levels and high rate at which water edges receded exposed more eggs and immobile chicks than even before to detrimental conditions. Adults and mobile chicks had to move far away from the eggs and immobile chicks for extended time periods, leaving the eggs and chicks behind. The chicks and eggs were exposed to severe climatic conditions (scorching heat) and starvation as adults did not return to feed the chicks on the turrets. Abandoned eggs continued to hatch, but no adults were present to feed them.

Thanks to volunteers, more than 2 000 chicks were rescued from Kamfers Dam from 25 January. The rescued chicks were taken to several facilities to assist with the mammoth task of feeding and protecting them. A portion of the chicks were taken to Gauteng, while others were taken to accredited rehabilitation facilities in the Western Cape and Kwazulu-Natal. Onderstepoort also looked after a group of chicks.

This was the first rescue event of its kind ever undertaken in South Africa. It was also the first time that such a broad spectrum of people, institutions and facilities collaborated towards one goal, i.e. to save the Lesser Flamingo chicks and thus securing a successful breeding event.

Partners towards this rescue event and the future management of the Kamfers Dam as habitat for flamingos included, among others, the non-profitable organisation Saam Staan Kimberley, Kimberley Veterinary Clinic (who provided local veterinary support), Ekapa Mining (who is also providing infrastructure support), members of the public, Kimberley Society for the Prevention of Cruelty to Animals (SPCA), National Zoological Garden (overseeing veterinarian care of all rescued chicks), BirdLife South Africa, Department of Environmental Affairs (DEA), Department of Water Affairs Kimberley, Department of Environment and Nature Conservation (DENC), Ushaka Marine World, South African National Foundation for Conservation of Coastal Birds (SANCCOB) and international organisation Texas State Aquarium Wildlife Rescue, South African National Parks (SANParks), Gauteng Department of Agriculture and Rural Development (GDARD), McGregor Museum, Sol Plaatje University and the local municipality.

Despite rescue efforts there was still a large flock of larger chicks and juveniles that were threatened by receding water levels as they were not yet fully fledged to fly off to another habitat and begin feeding on their own. An estimated 6 000 Lesser Flamingos chicks were thus at risk, and necessary short-term measures had to be taken to avoid these chicks succumbing to heat and starvation.

A team of engineers from Kimberley Ekapa Mining Joint Venture dug a 380-m trench around the reeds just below the final outlet at Homevale Wastewater Treatment Works in order to increase the volume of water flowing into the pan. The channel was initially closed and overgrown with reeds and grass which made volumes of water to spread around reeds and evaporate quickly instead of running into the pan.

After the channel was dug, a considerable volume of water reached the main waterbody and improved the situation. After a week of digging the trench, heavens also did not disappoint as Kimberley received much needed rainfall. The heavy rains brought relief as it filled the dam. The rainfall resulted in a considerable increase in the water level, and after a few days there were enough algae for the chicks and adults.

Again, Kimberley SPCA, as a key stakeholder, built special pens to house the flamingo chicks that stayed behind after the first expatriation to rehabilitation centres across the country. The ponds were used to keep the flamingo chicks that were transported back to Kimberley from different rehabilitation centres. The chicks were returned in batches of 200 and were kept in ponds at the Kimberley SPCA. BirdLife South Africa, together with other stakeholders, assisted in the monitoring of water levels, algal levels and chicks, checked whether they were ready to join the bigger crèche at Kamfers Dam. The local vets quarantined the chicks for any possible diseases for better chances of survival and released them at Kamfers Dam to be reunited with their parents.

The breeding activity of this year is further proof of the importance of Kamfers Dam for the survival of Lesser Flamingo as a species. Flamingos at Kamfers Dam are faced with many challenges and every effort should go towards protecting the integrity of this important site.

Unfortunately, not all of the chicks were rescued in time.

BACK TO TOP

DROUGHT

What Cape Town's drought can teach other cities about climate adaptation

There are several lessons to be learnt from Cape Town's drought especially for world cities as they prepare to deal with disasters exacerbated by climate change. This is according to Gina Ziervogel, African Climate & Development Initiative Research Chair.

Ashraf Hendriks/Groundup

Extreme weather events, such as Cyclone Idai that recently devastated Beira, Mozambique, and Hurricane Harvey that hit Houston, USA, in 2017, are the type of climate extremes that cities increasingly have to prepare for.

Cities, particularly those with extensive informal settlements in the developing world, are being it hard by these new climatic realities. Although rapid onset disasters often have devastating effects, slow onset climate events, such as drought, can also be detrimental.

Cities need to build their capacity to adapt to this range of impacts. One of the best ways to do this is to learn from other cities' experiences. Drawing lessons from other places that have gone through climate crises is a good way to guard against future shocks and stresses.

One recent case that cities around the world are watching is Cape Town's severe drought and the threat of "Day Zero" – when the city's taps were due to run dry. Although the city came close to having to turn off the taps, they managed to avoid it. After better rains in 2018 and a significant reduction in water use across the city, the dams are now reassuringly fuller than they were in 2017 and 2018, although caution is still needed ahead of the winter rains.

BACK TO TOP

A lot has changed and it is important to reflect on and share.

I conducted research to establish some key lessons to be drawn from the Cape Town drought. I found that local governments must focus on several important areas if they're to strengthen urban water resilience and adapt better to climate risk. These include improving data collection and communication, engaging with experts and enabling flexible adaptive decision-making.

And, crucially, I found that governance must be strengthened. Although three years of rainfall lead to very low dam levels, there were breakdowns in the interaction between national, provincial and municipal government that exacerbated the problem.

The findings

The research suggests that effective water management requires systems of mutual accountability between spheres of municipal, provincial and national government.

In South Africa, the national Department of Water and Sanitation is responsible for ensuring that there's sufficient bulk water available, often in dams, that can be transferred to municipalities. The municipalities are then mandated to provide clean drinking water. This means that intergovernmental coordination across the spheres of government is vital.

As it stands, different spheres' mandates overlap. This creates confusion and means the buck is often passed: one sphere of government will insist a particular competency isn't its job, and hand the work on to another sphere.

For this to be resolved there has to be clarity on shared responsibilities and roles, as well as the development of mutual accountability. To achieve this, technical skills, personal and institutional relations need to be strengthened. This requires strong leadership.

"A well-adapted city is one that understands who is responsible for what and has strong trust and partnerships between and within government."

Collaboration within municipal departments also needs to improve. The Cape Town drought highlighted the importance of this. Before 2017, there was limited collaboration between city departments on water issues. During the drought, however, collaboration between certain departments increased considerably as the complexity of the crisis became clear.

Not only is collaboration within government important, it needs to extend beyond government. During a crisis, all of society needs to be engaged, including citizens and the business sector. Technical expertise needs to be balanced with opportunities for a broader group to share its perspective and concerns. Partnerships can help gather the range of perspectives and support needed to respond to complex problems.

Municipalities which, during the course of their normal business activities, have developed strong relationships with their stakeholders, will be better placed to respond effectively to a crisis. That's because they will be able to harness stakeholders' collective knowledge and contributions more easily.

In Nelson Mandela Bay, the Business Chamber has done this by strengthening relations with the municipality to help to facilitate the ease of doing business in the city. They recognise that all business requires electricity, water, transport and logistics, for example, and so focus on improving these areas. The municipality developed task teams made up of volunteers from their member companies who have skills set in those areas.

Importantly, these is an agreement that the Metro places high level executives to sit in the task team meetings to ensure plans are put into practice. These types of relationships can be invaluable during a crisis.

Moving forward

While my study focused on Cape Town, its findings can be applied to other cities that want to strengthen their ability to adapt to climate change. Yes, cities need to pay more attention to how climate variability impacts on their resources, particularly water. But just as important is strengthening the governance of the water system. A well-adapted city is one that understands who is responsible for what and has strong trust and partnerships between and within government.

In order to build capacity to adapt, new types of skills are needed. Local government needs to pay more attention to how to build partnerships, enable flexibility and support learning. These are the types of skills needed for a well-adapted city, but still often lacking in local governments.

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BACK TO TOP

Water KIDZ

Africa's beautiful rivers

In celebration of Africa Day on 25 May, we take a look at Africa's most spectacular river systems.

The Blue Nile Falls, in Ethiopia.

Africa has several majestic river systems that are well known throughout the world. In this article we will glance at the main features of what are arguably Africa's most famous rivers: the Nile, Congo, Zambezi and Niger.

Nile River

Perhaps the most well known of all of Africa's rivers, the Nile River is the longest river in the world. The river starts south of the Equator and flows northward through north-eastern Africa finally flowing into the Mediterranean sea. The Nile is about 6 650 km long. The river flows through eleven countries: Tanzania, Burundi, Rwanda, the Democratic Republic of Congo, Kenya, Uganda, South Sudan, Ethiopia, Sudan and Egypt.

The Nile River is formed by three main streams, namely the Blue Nile and the Atbara which flow from the highlands of Ethiopia, and the White Nile, the headstreams of which flow into Lakes Victoria and Albert. the Blue Nile and White Nile merge together in the city of Khartoum in Sudan.
Perhaps the most famous section of the river is its floodplain which has fed and sustained millions of people through the centuries. The Nile has been an important source of life for people throughout history. Around 5 000 years ago, the Ancient Egyptians relied on the Nile for freshwater, food, and transportation. It also provided them with fertile land to farm on.

Historically, large quantities of silt washed down from the rich highlands of Ethiopia when the Nile River flooded. This silt was deposited by the floodwaters of the Nile onto the floodplain and was then planted with crops. Thus, a vital feature in the life of the Egyptian people was the river's behaviour, since a good harvest followed a good flood, and a poor flood often meant a later food shortage.

The Nile no longer floods each year, however. This is because in 1970 the Aswan High Dam was constructed. This huge dam now controls the flow of the river to generate electricity, irrigate farms and provide homes with drinking water. More than 95% of Egypt's population is dependent on water from the Nile River. The river is also home to wonderful wildlife. For example, many

BACK TO TOP

varieties of fish are found in the Nile system, mainly the Nile perch, the bolti, the barbel, several species of catfish, the elephant-snout fish and the tigerfish.

Congo River

The Congo is Africa's second-longest river. It is also the second-largest river in the world by discharge volume, following only the Amazon. It is also the world's deepest recorded river, with measured depths in excess of 220 m. Located in west-central Africa, the Congo flows for about 4 700 km from northeastern Zambia between Lakes Tanganyika and Nyasa (Malawi) and then in a giant counter-clockwise arch before draining into the Atlantic Ocean.

With its many tributaries, the Congo River forms the continent's largest network of navigable waterways. It is also home to spectacular waterfalls, such as the famous Inga Falls. This river is key to the economic development of the central African interior.

Numerous fish species live in the Congo – more than 230 different species have been identified. The riverine swamps, which often dry up at low water, are inhabited by lungfish, which survive the dry periods buried and enclosed in cocoons of mucus. The waters of the Congo also contain various kinds of reptiles, of which crocodiles are the most striking species. Semi-aquatic tortoises are also found, as are several species of water snakes. The fascinating manatee (sea cow) has been identified in the Sangha tributary of the Congo River.

Niger River

The Niger River is the main river of western Africa. It is over 4 180 km long. The river has a crescent shape and flows through Guinea, Mali, Niger and Nigeria before it reaches the Atlantic Ocean at the Niger Delta. The Niger River is the third-longest river in Africa.

The river's unusual shape made the northern part of the river, known as the Niger bend, an important area. The bend is the closest major river and source of water to the Sahara desert, and it thus became the main point of trade across the western Sahara. This lucrative trade made the bend the centre of the ancient kingdoms of Mali and Gao.

Nigeria and Niger take their names from the river. The people who live beside the river have many names for it, such as ***Jeliba*** or ***Joliba*** ('great river' in Manding), ***Isa Ber*** ('big river' in Songhay), ***Oya,*** (a Yoruba River Niger goddess), and ***Kworra*** or ***Quorra.*** The last name was the name that Europeans used for the lower part of the river before they knew that the upper and lower parts were connected.

Zambezi River

The Zambezi River is the fourth-longest river in Africa, after the Nile, Congo and Niger rivers. It is the longest east-flowing river in Africa. The river, which is 2 700 km long, flows through five countries, namely Zambia, Angola, Namibia, Botswana and Zimbabwe and ends at the Indian Ocean.

The power of the Zambezi River is being used at Kariba Dam in Zimbabwe and Cahora Bassa Dam in Mozambique, both located in the middle section of the river. Both these dams are sources of hydroelectric power and supply a large portion of power to Zambia, Zimbabwe and South Africa. The Victoria Falls mark the end of the upper course of the Zambezi, as its waters tumble with a thunderous roar and an enormous cloud of spray.

Named for Queen Victoria of the United Kingdom, Victoria Falls is one of the world's mightiest waterfalls. It is about twice as wide and twice as high as Niagara Falls in North America. The British explorer David Livingstone was the first European to see Victoria Falls, on November 16, 1855. The local people called the falls ***Mosi-oa-Tunya***, which means 'the smoke that thunders'.

The river's beauty has attracted tourists from all over the world and provides great opportunities for game viewing and various water sports. Hippopotamus, crocodiles, elephants and lions are some examples of wildlife that can be found along various parts of the Zambezi River.

Shoebill storks can be found in the upper Congo River.

Hippos grazing on the banks of the Zambezi River.

To discover the Congo River with the BBC News watch https://bit.ly/2wectXe

Sources

- www.britannica.com
- www.nationalgeographic.com
- www.natgeokids.com
- www.victoriafalls-guide.net
- www.allafricafacts.com
- https://kids.kiddle.co/Niger_River
- www.academickids.com
- www.easyscienceforkids.com

BACK TO TOP

NQWEBA DAM

Nqweba Dam

One of the most prominent features of the Camdeboo National Park outside Graaff-Reinet, in the Eastern Cape, the Nqweba Dam (formerly known as the Van Rynevelds Pass Dam) was one of the first large dams to be constructed in South Africa. Built between 1921 to 1924 across the poort at the Van Rynevelds Pass on the Sunday's River, the dam was originally constructed to meet irrigation water needs in the area. The dam consists of a mass concrete wall of gravity section, straight in plan of the overspill type. The upstream face is vertical and the downstream face stepped (a novel feature at the time). These steps are staggered to break up water coming over the crest in case of high floods and so reduce the pounding action on the toe of the dam and foundation. The spillway over the main wall is 169 m long, and an auxiliary spillway on the left flank 69 m long.

A removable reinforced concrete superstructure, 381 m long with a pedestrian walkway around 2 m wide, extends over the entire length of the top of the wall. The dam has a maximum height of 33 m above riverbed level. Like other dams in the area, Nqweba Dam has lost much of its capacity due to excessive siltation. This, in addition to an increase in soil salinity, has made irrigated agriculture a high-risk activity in the catchment, and today, the dam supplies water mostly to Graaff-Reinet.

BACK TO TOP

THE WATER WHEEL

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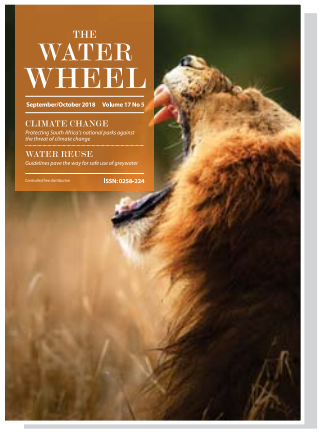

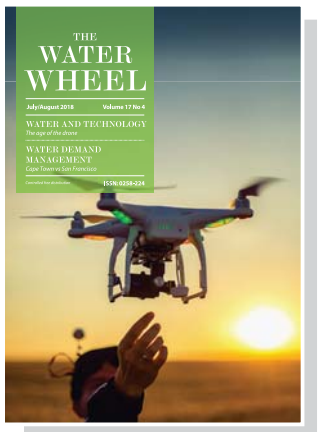

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